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Smart Grid projects in Europe: Lessons learned and current developments

2012 update

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EXECUTIVE SUMMARY

A smart electricity grid opens the door to new applications with far-reaching impacts: providing the capacity to safely integrate more renewable energy sources (RES), electric vehicles and distributed generators into the network; delivering power more efficiently and reliably through demand response and comprehensive control and monitoring capabilities; using automatic grid reconfiguration to prevent or restore outages (self-healing capabilities); enabling consumers to have greater control over their electricity consumption and to actively participate in the electricity market [EC 2011, EC JRC 2011, EEGI 2012, , EC 2007, US DoE 2009, KEMA 2012a, EURELECTRIC 2011a, Faruqui et al. 2010, Farhangi et al. 2010, WEF 2010, Fox-Penner 2010].

At this stage, smart grid (SG) projects are playing a key role in shedding light on how to move forward in this challenging transition. In 2011, therefore, the JRC launched the first comprehensive inventory of smart grid projects in Europe to collect lessons learned and assess current developments [EC JRC 2011].

The final catalogue was published in July 2011 and included **219 smart grid and smart metering projects** from EU27 Member States, Switzerland and Norway. The overall investment amounted to over € 5 billion.

The participation of project coordinators and the reception of the report by the smart grid community were extremely positive. It was therefore decided that the project inventory would be carried out on a regular basis so as to constantly update the picture of smart grid developments in Europe and keep track of lessons learned and of challenges and opportunities.

This study is the 2012 update of the inventory carried out in 2011.

A new on-line questionnaire was launched in March 2012 and information on projects was collected until September 2012. In parallel we conducted an extensive and detailed search of project information on the web and through cooperation links with European research organisations. The resulting final database is the most updated and comprehensive inventory of Smart grid and smart metering projects in Europe for 2012: it includes 281 smart grid projects and around 90 smart metering pilots and roll-outs.

Smart grid and smart metering projects will be analysed separately. The core of our analysis will focus on smart grid projects. Smart metering development, which is at a more mature stage, will be analysed only at aggregated national and European level and information from individual smart metering projects will be used only to support the analysis with concrete field information.[1]

[1] Despite the high number of smart metering projects that have been surveyed and included in our database, an accurate and comprehensive mapping of all smart metering initiatives would not be fully

Key messages

The analysis of the projects surveyed highlighted several key observations and lessons.

Smart grid projects — investments and scale

- ✓ Up to 2012, we identified a total of 281 smart grid projects across 30 countries (EU-27, Croatia, Switzerland and Norway), accounting for a total investment of € 1.8 billion;
- ✓ After a first phase with some sporadic activity (2002-05), activities in smart grid projects increased dramatically from 2006 onward;
- ✓ In the period 2008-12, investments in smart grid projects were consistently above € 200 million per year, reaching € 500 million in 2011;
- ✓ Project budgets have been growing steadily. The investment share of projects with budgets of over € 20 million grew from 27 % in 2006 to 61 % in 2012.

Geographical distribution of activities and investments

- ✓ The UK, Germany, France and Italy are the leading investors in Smart Grid projects. Denmark is the country most actively involved in R&D projects, supporting a large number of small-scale projects;
- ✓ Denmark is the country that spends the most on smart grid projects per capita and per KWh consumed;
- ✓ By far the most investment comes from organisations in EU15 countries.[2] EU12 countries[3] are lagging behind, with consistently low investment over the years.

Multinational smart grid projects — Cooperation links

- ✓ The catalogue contains around 60 multinational projects. The majority of cooperation links are between organisations from EU15 countries. Lead organisations in multinational projects are almost exclusively from EU15 countries;
- ✓ There are 12 multinational projects with a focus on consumer engagement (~20%);

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reliable, considering the very high number of smart metering installations across Europe, often at local level. More accurate information is available at aggregated national level.

[2] EU15 refers to the Member States of the European Union prior to the accession of ten countries on 1 May 2004, i.e. Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.

[3] EU12 refers to the countries that joined the European Union on 1 May 2004, i.e. Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia, or on 1 January 2007, i.e. Bulgaria and Romania.

- ✓ There is a very limited level of collaboration between organisations from EU12 countries;
- ✓ Organisations from Spain, France and Germany are the most active in setting up cooperation links in multinational projects;
- ✓ 95 % of multinational projects are supported by EC funding.

Diversity of organisations in the smart grid landscape

- ✓ DSOs/ utilities are best represented in all projects and are at the forefront in terms of investment. They are followed by university/research centres, manufacturers and IT/Telecom companies;
- ✓ There is a good level of diversity in the smart grid landscape: several types of organisation (utilities, universities, TSOs,[4] manufacturers, ICT[5] companies, etc.) participate to significant degrees in the smart grid projects;
- ✓ DSOs/utilities and universities/research centres are most active in terms of cooperation links with other organisations;
- ✓ An increasing number of companies from different sectors (particularly ICT companies) are getting involved in smart grids. These companies still do not play a leading role in most of the projects, but they are setting up new cooperation links which might bring innovation and changes to established business and operational practices (e.g. need for new ICT competencies within DSOs/utilities);
- ✓ Aggregators/retailers/service providers (particularly those not linked to an integrated energy player) still participate in a limited number of projects. They appear to have limited role in consumer involvement projects (typically led by DSOs/utilities). Their involvement appears also to be hampered by barriers (e.g. standardisation, regulatory uncertainties) to the marketing of new smart grid products and services to consumers;
- ✓ TSOs are leading around 10 % of the projects surveyed. The main TSO-led projects are financed by the EC. On the one hand this indicates that TSOs are increasingly pursuing joint projects of pan-European relevance, but on the other hand it may signal that barriers exist to direct investments by TSOs in new projects.

Private investment and funding of smart grid projects

- ✓ Persisting uncertainty over the business case for smart grid applications and the sharing of costs and benefits among participants is a factor limiting private investments;

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[4] Transmission System Operators.
[5] Information and Communication Technology.

- ✓ Funding still plays a crucial role in stimulating private investment in smart-grid R&D and demonstration projects. 87 % of the projects have received some form of funding. Their budgets amount to over 94 % of the total investment in smart grid projects.
- ✓ 55 % of the total budget for the smart grid projects surveyed comes from various sources of funding (national, EC, regulatory) and the remaining 45 % from private capital;
- ✓ 42 % of the budget comes from national and EC funding and 13 % from regulatory funding (e.g. Low Carbon Network Fund in the UK [OFGEM 2012]);
- ✓ Since 2011, the level of regulatory funding (specific funding from national regulators to support smart grid projects) is catching up with national and EC funding. In this context, a significant contribution comes from the OFGEM 'Low Carbon Network Fund' initiative in the UK. This already represents a considerable effort and the scope for increasing this support will arguably depend on local conditions. For example, in countries where regulatory support has already been allocated to capital-intensive transmission or distribution reinforcements or to smart metering, it might be difficult to raise additional support for a wide range of smart grid R&D and demonstration projects.

Smart grid applications

- ✓ New control/automation systems to improve the controllability and observability of the grid are becoming quite consolidated and widespread and are increasing capacity for the hosting of Distributed Energy Resources (DER);
- ✓ Projects focusing on distributed ICT architectures for coordinating distributed resources and providing demand and supply flexibility are probably in the majority:
    - distributed intelligence/multi-agent architectures are widely adopted at technical level, with successful trials of technical VPPs (e.g. coordination of DERs for voltage regulation);
    - a lack of standardised control and communication solutions means that costly ad-hoc configuration is required, which limits the participation of (in particular, small-scale) users;
    - more trials are needed to test the scalability of developed platforms, especially when real-time grid requirements and market signals have to be taken into account;
    - at market level, the main focus is on analysing the market potential of aggregation schemes and the viability of business models;

- recently, a few large scale demonstrators have been launched to test VPP coordination with market signals and grid constraints (integrated technical and commercial VPP). Scalability is a major focus, especially when thousands of agents need to be coordinated. Trials still involve limited numbers of users and consumer resistance to participation in trials is still high;
- regulatory and market barriers seem to be the main obstacles to the development of commercially viable aggregation applications, e.g. establishing clear rules for the technical validation of flexible supply/demand (demand-response) transactions by system operators; technical/commercial arrangements for the exchange of physical and market data; clear market roles and responsibilities and fair sharing of costs and benefits; new contractual arrangements;

✓ Electric vehicles (EV): an analysis of the projects in the catalogue shows that the current focus is on ensuring that the charging and communication infrastructure works before venturing into more sophisticated applications like vehicle-to-grid (V2G) services.

✓ Focus on storage appears to be on the rise. Use of storage as additional source of grid flexibility is one of the key themes of the main projects that started in 2012.

European Electricity Grid Initiative (EEGI)[6]

✓ Projects that might qualify for EEGI labelling as 'core projects' (with budgets of over €15 million) represent 14% of the total of around 40 projects and 66% of the total budget in the JRC catalogue (€1 200 million);

✓ Projects that might qualify for EEGI labelling as 'support projects' (with budgets of between €2 million and €15 million) represent 35% of all projects (around 100) and 29% of the total budget (around €530 million);

✓ The great majority (80%) of the budget is allocated to functional areas at the distribution level. The great majority of projects in the transmission clusters are 'support projects'.

Smart Metering

✓ Smart metering investment already undertaken amounted to over €4 billion, with the main investments in Italy (€2.1 billion) and Sweden (€1.5 billion);

[6] The European Electricity Grid Initiative (EEGI) proposes a nine year European research, development and demonstration programme to be initiated by grid operators to develop a Smart Grid for Europe by 2030 [EEGI, 2010]. A revision of the roadmap has just been published [EEGI 2012], but it has not been possible to take it into account in this study.

- ✓ On the basis of official commitments or strong interest from several Member States in the smart metering roll-out, we estimate that at least €30 billion will be spent and at least 170-180 million smart meters will be installed in EU-27 by 2020;
- ✓ Investment cost per smart metering point varies widely, from less than €100 to €400, depending on scale, what functionalities are implemented, communication technology and specific local conditions;
- ✓ The most common key monetary benefits of smart metering are energy savings, reduced meter readings and operational savings for the utility (e.g. technical and non-technical losses). Additional benefits are expected from the applications the smart meters will enable (e.g. demand response, new innovative services for consumers, etc.);
- ✓ The choice of a particular communication option is strongly dependent on the local conditions. However, available information indicates that the most widespread communication option is the combined use of PLC for the Smart Meter-Concentrator connection in the secondary substation and the use of GSM/GPRS for the Concentrator-Meter data management system connection;
- ✓ Multi-utility configuration (installation of water and gas meters together with electricity smart meters) is tested in a small minority of the projects surveyed. There still seems to be uncertainty as to whether the additional benefits of multi-utility configuration compensate the costs.

The role of consumers

- ✓ Increasing numbers of projects are focusing on consumer engagement (though the number is still limited — 65/281 answered). However consumer participation in the projects is still limited in size (typically up to 2 000 customers);
- ✓ Consumer resistance to participating in projects is still significant;
- ✓ Consumers participating in trials are typically volunteers (e.g. technology enthusiasts, green consumers, etc.), and are not representative of consumers in general;
- ✓ Lead organisations in projects focusing on consumer involvement are DSOs or DSO's associated energy company . Aggregators and retailers, who should have the commercial role of interacting with consumers, seem to have a more limited role in these pilots;
- ✓ Denmark and Germany are the leading countries with projects focusing on consumer engagement;

- ✓ Increasing numbers of multinational projects address consumer engagement as a key issue;
- ✓ The main factors used for motivating consumers are reduction of bill cost and environmental concerns.
- ✓ Many projects acknowledged a high level of consumers' scepticism and highlighted the importance of building trustful relationship with consumers.

Obstacles

Key barriers appear to be policy-related, social or regulatory, rather than technical:

- ✓ Lack of interoperability and standards (standardised plug and play would reduce costs and allow connectivity also of small DERs or small DR applications);
- ✓ Regulatory barriers: uncertainty over roles and responsibilities in new smart grid applications; uncertainty over sharing of costs and benefits and consequently over new business models;
- ✓ Consumer resistance to participating in trials;
- ✓ The range of regulatory arrangements in Europe might present significant barriers to the replicability of project results in different countries.

Data collection and dissemination

- ✓ To support the transition to a smart grid, it is crucial that project information is shared. However, there are many barriers to this: web information about projects is difficult to retrieve; many projects do not have a dedicated website; in some cases, websites are only in the national language;
- ✓ Making European funding subject to the extensive sharing of project results greatly contributes to knowledge-sharing in the smart grid community. Typically, EU-financed projects provide the most detailed and accessible information;
- ✓ The open dissemination platform launched by the JRC has proved to be a very valuable instrument. The setting-up of visualisation platforms to track project data and results is key to encouraging (voluntary) information-sharing. The JRC database is now recognised as the main repository of smart grid projects in Europe. Over 400 responses to the JRC project questionnaire were returned by project coordinators in 2011-12;
- ✓ The JRC will be further developing/maintaining the database/inventory on a periodical basis. Project results will also be used to perform detailed cost-benefit analyses of smart grid applications.

1. INTRODUCTION

A smart electricity grid opens the door to new applications with far-reaching impacts: providing the capacity to safely integrate more renewable energy sources (RES), electric vehicles and distributed generators into the network; delivering power more efficiently and reliably through demand response and comprehensive control and monitoring capabilities; using automatic grid reconfiguration to prevent or restore outages (self-healing capabilities); enabling consumers to have greater control over their electricity consumption and to actively participate in the electricity market [EC 2011, EC JRC 2011, EEGI 2012, , EC 2007, US DoE 2009, KEMA 2012a, EURELECTRIC 2011a, Faruqui et al. 2010, Farhangi et al. 2010, WEF 2010, Fox-Penner 2010] .

Key capabilities of the smart grid system include the integration and aggregation of (i) distributed energy resources (distributed generation – DG, electric vehicle – EV), (ii) demand response (DR) and (iii) large-scale renewable energy sources (RES) [Battaglini et al. 2010, Wissner 2011, Wolfe 2008]. System integration is crucial to enable these capabilities [Verbong and Geels 2010; Foxon et al. 2010]. Making the smart grid system work requires the cooperation and integration of multidisciplinary players with different business interests, and the adoption of new compatible business models and regulations [Fox Penner 2010, Eurelectric 2011b, WEF 2009, WEF 2010]. Moreover, it is imperative to make sure that consumers are on board, as the extent of the smart grid transformation should be tailored to consumers' needs and to their willingness to pay for its implementation [Diaz-Rainey and Ashton 2008, Valocchi 2007, Valocchi 2009, Brennan 2007, Jackson 2005].

At this stage, smart grid projects are playing a key role in shedding some light on how to move forward in this challenging transition. In 2011, therefore, the JRC launched the first comprehensive inventory of smart grid projects in Europe to collect lessons learned and assess current developments [EC JRC 2011].

The data collection phase of the 2011 JRC inventory of smart grid projects ran from November 2010 to April 2011. A project questionnaire was distributed through different channels (e.g. EEGI steering committee[7], Smart Grid Task Force[8], JRC website[9]) to European associations, system operators, utilities and Member State representatives.

In summary, some of the key results of the 2011 JRC inventory were:

- Around 300 responses were received;

[7] http://setis.ec.europa.eu/technologies/Smart-grids/info
[8] http://ec.europa.eu/energy/gas_electricity/smartgrids/taskforce_en.htm
[9] http://ses.jrc.ec.europa.eu/

- The final catalogue was published in July 2011 and included **219 projects** (195 smart grid projects and 24 smart metering pilots/roll-outs);

- The overall investment in smart grid and smart metering projects was over €.5 billion;

- The **majority** of the projects are **in EU15** while most of the EU12 countries lag behind;

- **Smart metering** is the **most developed** area, with by far the greatest share of allocated investment.

The participation of project coordinators and the reception of the report by the smart grid community were extremely positive. It was therefore decided that the project inventory would be carried out on a regular basis so as to constantly update the picture of smart grid developments in Europe and keep track of lessons learned and of challenges and opportunities.

This study is the 2012 update of the inventory carried out in 2011.

1.1 Boundaries of the smart grid catalogue

In line with the definition of smart grids in [EC Smart Grid Task Force, 2010],[10] we followed four main screening rules in compiling our catalogue:

1. We included projects focusing on individual new energy technologies and resources (e.g. new storage devices, electric vehicles, distributed renewable generators) only if their integration in the grid was also part of the project;
2. We included projects aimed at making the grid smarter (through new technologies and new ICT capabilities);
3. We did not include projects aimed at making the grid stronger (e.g. through new lines, substations and power plants) using conventional design approaches;
4. We did not include projects where significant information gaps did not allow a reliable project assessment.

1.2 An open platform for data collection and dissemination

The JRC inventory exercise conducted in 2011 highlighted a number of important lessons about the dissemination and sharing of smart grid results and experiences:

[10] A smart grid is an electricity network that can efficiently integrate the behaviour and actions of all users connected to it — generators, consumers and generator/consumers — in order to ensure an economically efficient, sustainable power system with low losses and a high quality and security of supply and safety.

- √ Caution in sharing quantitative data and lessons learned: As the majority of projects shared information on a voluntary basis, data confidentiality and reluctance to share negative results still represent a barrier to data-sharing. Institutional actors have a clear role in guaranteeing data confidentiality and unbiased analysis;
- √ Lack of a common framework for data sharing and analysis: Carrying out a comprehensive and detailed mapping of smart grid projects in Europe proved challenging. The difficulties encountered during the data collection process suggest that improvements are needed in data collection/exchange, including a common structure for data collection (definitions, terminology and categories) and strengthening project repositories at the national and European level;
- √ Fragmentation of initiatives for sharing project results: There is a need to keep track of and coordinate initiatives on smart grids and to exchange data and results. On the basis of the positive experience of the 2011 smart grid project-mapping exercise, the JRC sees merit in institutional actors acting as reference points for several stakeholders, thus avoiding a duplication and fragmentation of initiatives.

Against this background, with the 2012 update of the smart grid project inventory, the JRC's broader objective was to establish an open platform for the collection and dissemination of project information involving all Member States, international organisations and energy operators. Therefore, a new on-line questionnaire was prepared which allowed the standardised input of data by project coordinators and simplified the data collection and processing phases (see Section 1.3).

The data collected have been checked for consistency and included in the JRC smart grid project database, which functions as the single repository of European smart grid projects. The JRC will regularly publish an updated version of the database (all financial/economic information will be treated confidentially and only aggregated data will be published) to be used by different users (institutional, industrial, etc.), as shown in Figure 1. All users are encouraged to contribute to the mapping exercise.

An instrumental role is played by visualisation platforms, linked to the JRC database, which map projects across Europe. Project data can be tracked on the JRC website (ses.jrc.ec.europa.eu) and on the interactive smart-grid map (www.smartgridsprojects.eu) produced by the JRC together with the European electricity industry association (EURELECTRIC). Other interested parties are encouraged to use the database to create their own visualisation platform or perform their own tailored analysis.

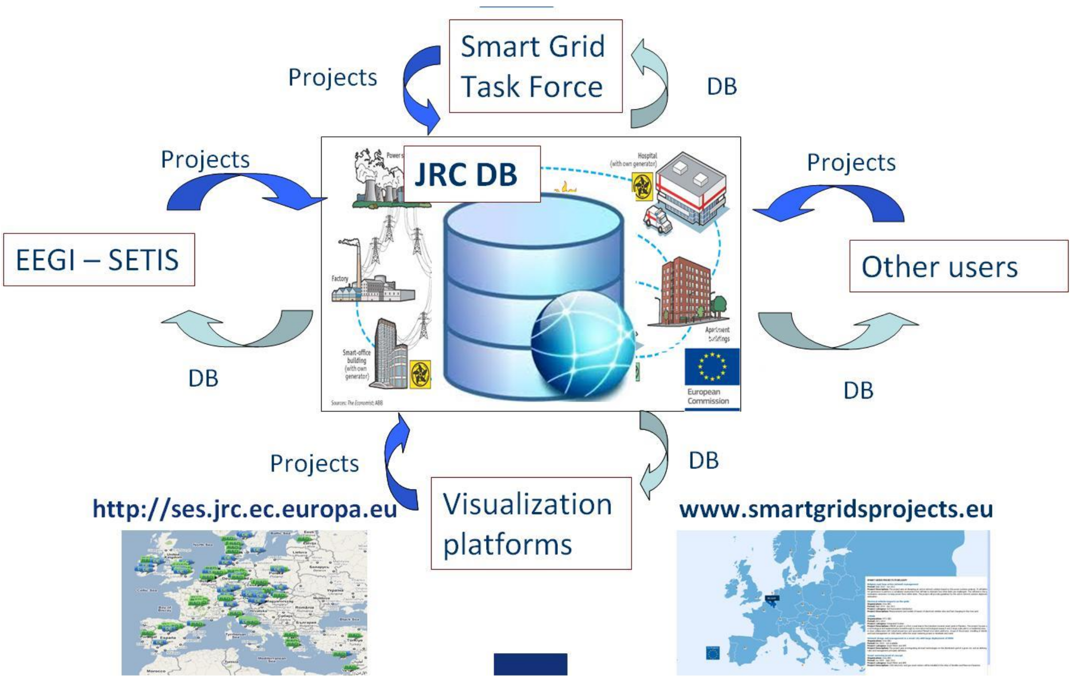


Figure 1 — JRC platform for the collection and dissemination of data and results of smart grid projects

1.3 What's new in the JRC questionnaire?

A number of improvements were made to the JRC questionnaire on the basis of the 2011 exercise and feedback from project coordinators.

The main changes are as follows:

- ✓ Where possible, we have tried to make it easier and less time-consuming to fill in project data. The questionnaire can now be filled in directly on-line and in many cases predefined options are available to be clicked;
- ✓ The list of project application categories has been revised to focus more on the applications enabled by smart grid projects (e.g. integration of DER, integration of large-scale RES, demand response, etc.) than on technical functionalities (e.g. distribution automation);
- ✓ We have included a dedicated section on the European Electricity Grid Initiative (EEGI) roadmap [EEGI 2010, EEGI 2012] in order to assess the project's contribution to progress in the different functional areas.

Also, new fields and new sections have been added to allow a more refined assessment of the project. In particular, sections on contribution to policy goals, consumer involvement and social impact are new.

The on-line questionnaire (see Annex I) is composed of the following seven sections:

1. Project overview

This includes information about:

- Participating organisations, project location and start/end dates;
- Main project applications can be chosen from the following list:
  - √ Smart Network Management
  - √ Integration of DER
  - √ Integration of large scale RES
  - √ Aggregation (Demand Response, VPP)
  - √ Smart Customer and Smart Home
  - √ Electric Vehicles and Vehicle2Grid applications
  - √ Smart Metering
  - √ Other (e.g. communication infrastructure, storage)
- Technical parameters (grid characteristics in terms of voltage or power level, number of users involved, number of EV charging stations or of smart meters, etc.);
- Current stage of development (R&D, demonstration or deployment);
- Overview of project results, including lessons learned, obstacles and potential for scalability and replicability.

2. Project financial information

This section includes information about:

- Total project investment;
- Sources of funding (national funding, EC funding, regulatory funding, private investments);
- Estimates of monetary costs and benefits.

3. Smart grid focal areas

This section includes information about which functional areas of the EEGI roadmap the project is contributing to. The project is linked to the corresponding functional areas of the EEGI roadmap.

4. Project contribution to policy goals

This section includes quantitative/qualitative information about the contribution of the project to the following energy policy goals:

- **Sustainability and integration** (e.g. estimated CO_2 reductions via reduced energy losses, energy savings, integration of RES; additional DER hosting power input in the grid (incl. EV and storage)/maximum power load);
- **Security and quality of supply** (e.g. duration and frequency of interruptions, SAIDI/SAIFI/CAIDI, etc.);
- **Energy efficiency and savings** (e.g. energy savings [%]; Reduced peak load [%]);
- **Coordination and interconnection** (increased internal transfer capacity between TSOs or DSOs [MW]; additional interconnection capacity).

5. Consumer involvement

This section includes qualitative information about specific strategies and results achieved in the project on consumer involvement (e.g. main motivational factors used to involve consumers; innovative business models to involve consumers; main observed benefits for consumers).

6. Social impact

This section includes qualitative information about social issues addressed by the project, e.g. social acceptance, job creation/loss, safety, vulnerable consumers, etc.

7. Data privacy, security & interoperability

This section includes qualitative information about whether data privacy, security and interoperability have been addressed in the project (e.g. has the project addressed corresponding risks? has the project addressed the issue of interoperability?)

1.4 R&D, demonstration and deployment

The projects surveyed were classified into R&D, demonstration and deployment categories. To identify R&D projects we used the definition in the Frascati Manual, according to which R&D projects comprise *creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications* [OECD, 2002]. The term R&D covers three activities: basic research, applied research and experimental development.

Demonstration projects can be regarded as a 'preview' phase before marketing. The concept includes projects designed to test the performance of a technology in different operational environments, through to full market trials in which the technology is used in customer installations [Brown, 2009]. The aim of these projects is to expose the technology to realistic user environments to test its suitability for more widespread use.

Finally, deployment and roll-out projects refer to the implementation of a technology, application or system as a default solution within the project's geographical boundaries. Some deployment projects are nationwide; others are limited to a smaller geographical area.

As shown in Figure 2, there is an inverse relationship between risk and cost through the different stages of maturity of a technology or application, from R&D to demonstration up to final roll-out. Clearly the boundaries between the different phases are blurred. Projects might have both an R&D phase and a demonstration phase, for example. In these cases, for the sake of simplicity, we have assigned the project to the stage that seemed to best characterise the project and to which most project time and budget were allocated. (In the questionnaire, project coordinators were asked to provide an estimate of the share of the budget and of the time of the project allocated to the R&D and demonstration phases).

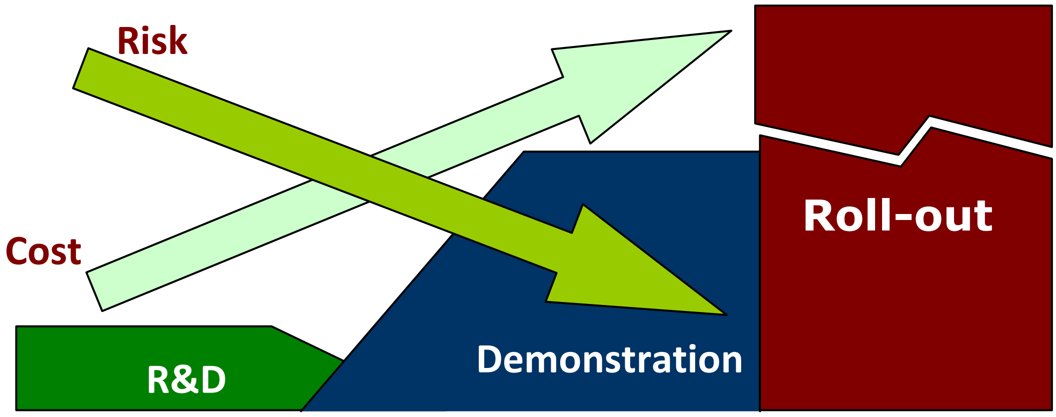


Figure 2 — Risk and cost levels in R&D, demonstration and roll-out projects

In characterising the level of maturity of a project, we have also considered other factors, like project size and budget, the number and type of partners involved and the level of maturity of a certain application (e.g. demand response) in general and in the area where the project was implemented.

1.5 Smart metering vs smart grid projects

As became clear from 2011 inventory, smart metering is the area where the most significant progress has been made throughout Europe. In fact, the deployment projects in our catalogue are essentially smart metering roll-outs. Smart metering roll-outs and large-scale pilots account for most of the total investment of the projects surveyed. Therefore it seems natural to divide smart grid and smart metering projects into two different sub-sets and analyse them separately. More specifically, we can distinguish three types of smart metering projects: smart metering roll-outs (with regional or national coverage), smart metering pilots (typically for conducting the CBA of a full roll-out) and smart metering installations which are part of a wider smart grid project.Projects in this last category type 'straddle' the dividing line between smart grid projects and smart metering pilots and are covered in both sets of analysis in this report.

Figure 3 shows the links between the smart grid and smart metering project subsets analysed in following chapters. Projects in the area highlighted in red are common to both analyses.

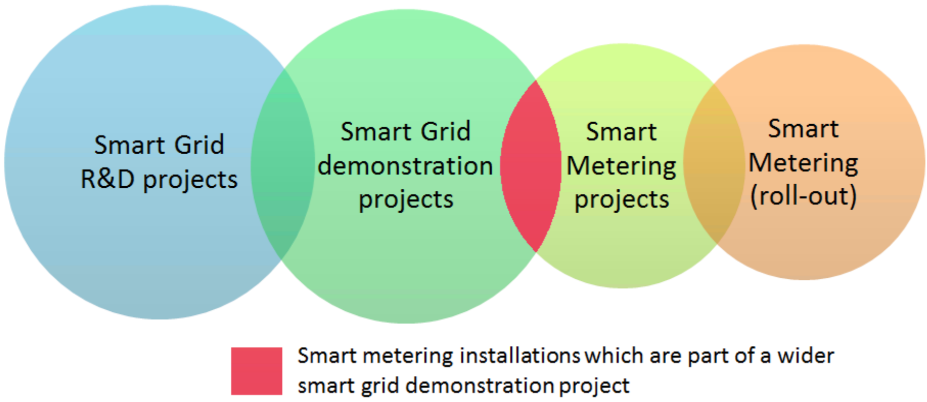


Figure 3 — Smart grid and smart metering project subsets covered in the analysis

1.6 Data collection process for the 2012 inventory update

The new on-line questionnaire was launched in March 2012. The cut-off date for submissions was set for July 2012, but projects submitted by September 2012 were also accepted.

In parallel we conducted an extensive search of project information on-line and through participation in conferences and workshops. We then contacted project coordinators directly to ask for more information on the on-line form.

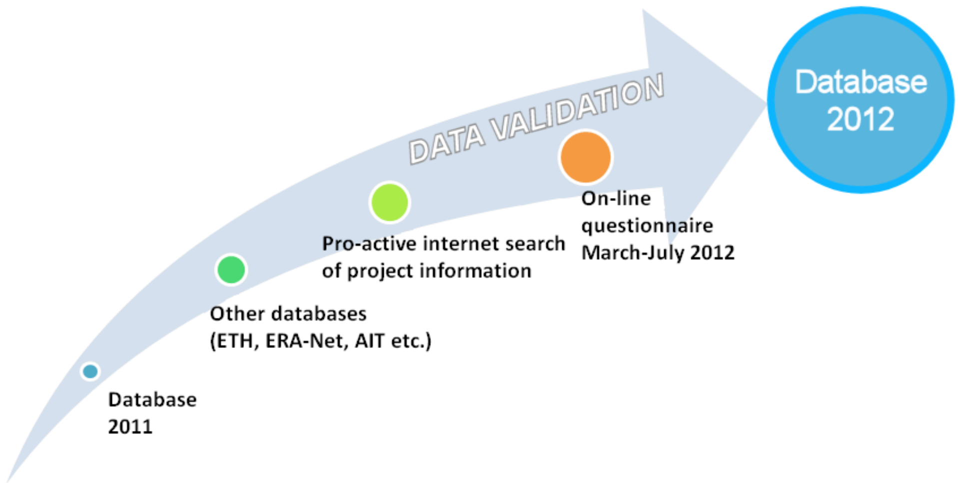


Figure 4 — Data collection and validation process for the 2012 inventory update

Data collected from respondents were double-checked in various ways to ensure consistency. For all projects we checked the website of the project (where applicable) and of the lead organisation to corroborate the information we received. Where discrepancies were found or the template was not clear enough, we also contacted the lead organisation by e-mail or phone.

Based on the data validation process, eight (very small) projects previous inventory have been excluded, as the data was considered not sufficiently reliable. These projects, along with projects not yet included/known/started, will be considered for inclusion in the next edition of the report, provided that reliable/complete information is delivered.

Lastly, we established links with research institutions which had already produced some sort of smart grid project inventory (in particular, ETH Zurich, ERA-Net and the Austrian Institute of Technology) and went through their databases, rigorously checking all relevant information before integrating it in our database (see Figure 4).

The database was then split into two parts (see Figure 5), as follows:

- √ 2012 database of smart grid projects (**281 projects**); and
- √ 2012 database of smart metering projects (**91 projects**).

Accordingly, the remainder of the report contains separate analyses for the two sub-sets of project (Figure 5).[11]

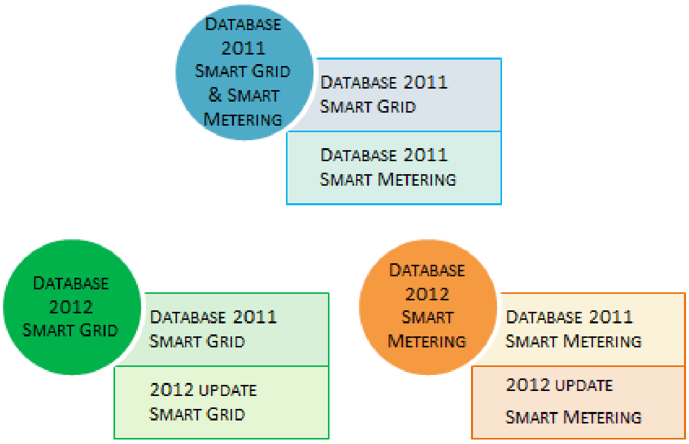


Figure 5 — Relationship between the 2011 and 2012 JRC database

The analysis of the smart grid projects (Chapters 2 and 3) represents the core of the report.

Chapter 2 will present a macro-perspective of smart grid projects in Europe, aggregating project data in order to answer questions such as 'How many projects have been carried out?', 'In which countries?', 'Who is investing?', etc.

Chapter 3 will present a micro-perspective, focusing on results and lessons learned from individual smart grid projects.

Chapter 4 will present an overview of the activities on smart metering in Europe.

Finally Chapter 5 will assess the role of consumers and their current level of engagement.

[11] The Database 2011 Smart Grid & Smart Metering included 195 smart grid projects (Database 2011 Smart Grid) and 24 smart metering projects (Database 2011 Smart Metering).

2. SMART GRID PROJECTS IN EUROPE: MACRO-PERSPECTIVE

In this chapter we use project data to support an analysis of macro trends and developments concerning smart grids in Europe from different perspectives. We will focus on smart grid projects only, considering R&D and demonstration stages of development. As mentioned, smart metering pilots and roll-outs will be analysed in Chapter 4 and are therefore excluded from the analysis that follows.

2.1 Overview of smart grid projects in the catalogue

The JRC's 2012 Smart Grid database contains 281 smart grid R&D and demonstration projects from 30 European countries (EU27, Croatia, Switzerland and Norway), representing a total investment of € 1.8 billion. The catalogue includes around 150 R&D projects with a total budget of around €500 million and around 130 demonstration projects with a total budget of around €1 330 million. The projects surveyed have an average budget of € 6.5 million and an average duration of 35 months (Table 1). The majority of the projects surveyed (62 %) are still ongoing, with 17 % due to end in 2013.

NUMBER OF SMART GRID PROJECTS	TOTAL INVESTMENT	PERCENTAGE OF ONGOING PROJECTS	AVERAGE BUDGET	AVERAGE DURATION
281	€1.8 billion	62 %	€6.5 million	35 months

Table 1 — Summary of smart grid projects in the 2012 JRC catalogue

2.1.1 What's new in the 2012 smart grid inventory?

Figure 6 shows the number of smart grid projects in the catalogue by starting year, highlighting projects surveyed in the 2011 inventory (in orange) and projects surveyed in the 2012 update (in red). Around 80 % of the projects surveyed in 2012 started in the period 2010-12. Considering that the cut-off date for the 2011 inventory was April 2011, this confirms that that inventory was quite complete.

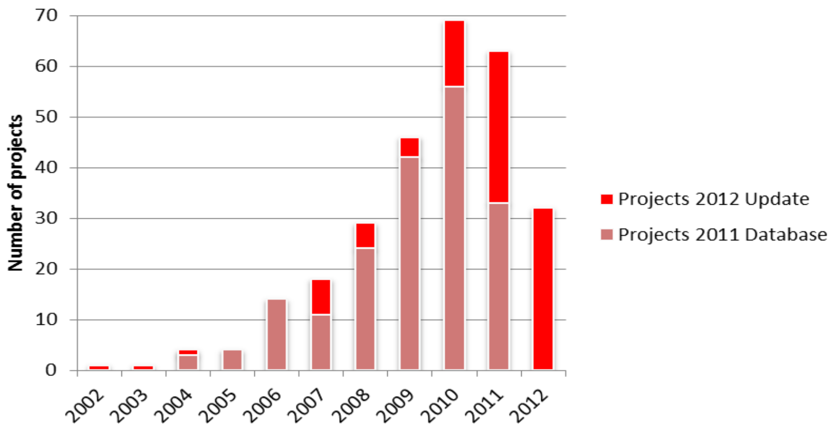


Figure 6 — Number of SG projects surveyed in 2011 inventory (old) and in the 2012 update (new) across starting years (smart grid projects)

The catalogue includes a relatively small number of projects which started in 2012. This might be due to the deadline set for filling in the questionnaire (September 2012) and not necessarily to a decrease in the number of projects starting in 2012.

Figure 7 shows the geographical distribution of the projects in the catalogue, distinguishing between smart grid projects already in the 2011 JRC database (in light pink) and projects added for 2012 (in dark red).

70 % of all projects are in seven countries: Denmark, Germany, Italy, Austria, the UK, France and Spain.

For some countries, there is a major change in the number of projects surveyed. Italy and France each have 14 new smart grid projects (which started in 2010-12) this year in addition to four and six respectively last year. In this context, public sector support has played an important role (see also Section 2.7), in particular through the smart grid programme of France's *Agence de l'Environnement et de la Maîtrise de l'Energie* [ADEME 2012] and the regulatory incentives for smart grid projects set up by the Italian regulatory authority AEEG [Delfanti M. et al. 2011].

The 2012 inventory confirms the low participation of EU12 countries, with countries like Estonia, Latvia and Lithuania participating in just one project (see Section 2.3).

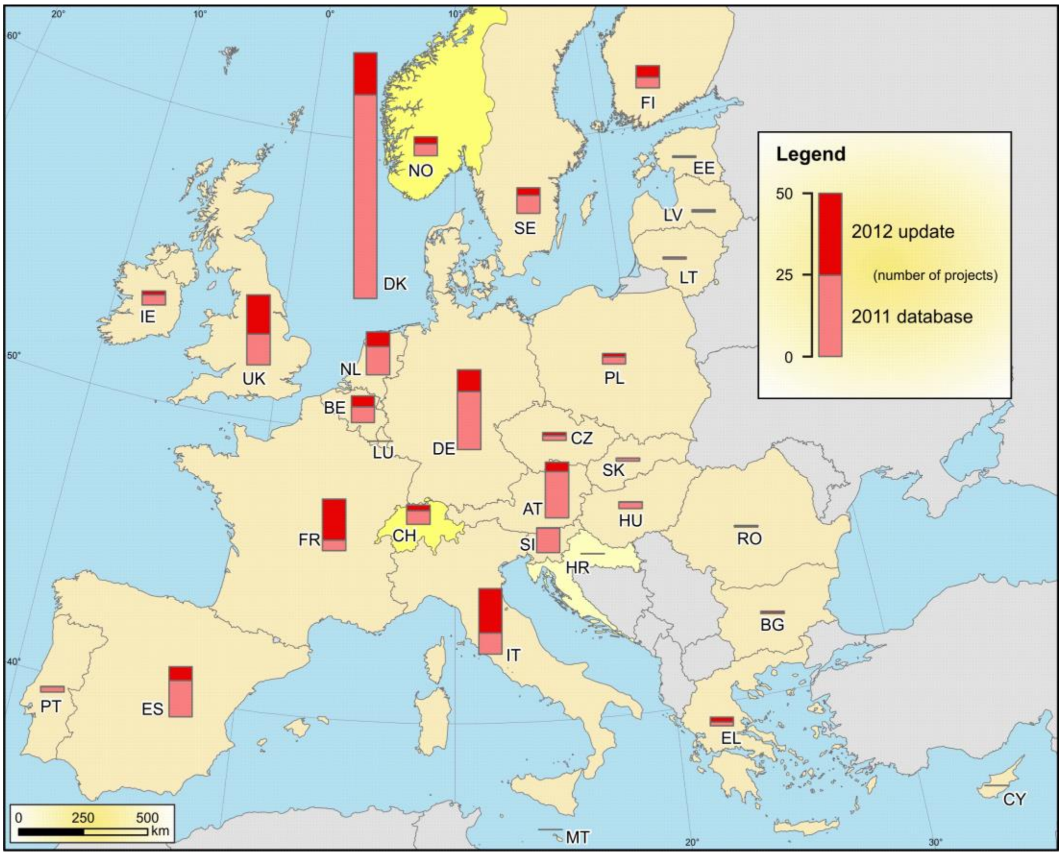


Figure 7– Geographical distribution of the number of SG projects surveyed in 2011 inventory (old) and in the 2012 update (new)

Figures 8 and 9 compare the number and the budget share of R&D and demonstration projects in the 2011 and 2012 smart grid database. As most of the projects surveyed in 2012 started in 2010-12, we note that in the last two years the share of projects in the demonstration phase has increased both in terms of number and total allocated budget. This could be a sign of the growing maturity of smart grid applications, which are shifting from the R&D to the demonstration phase.

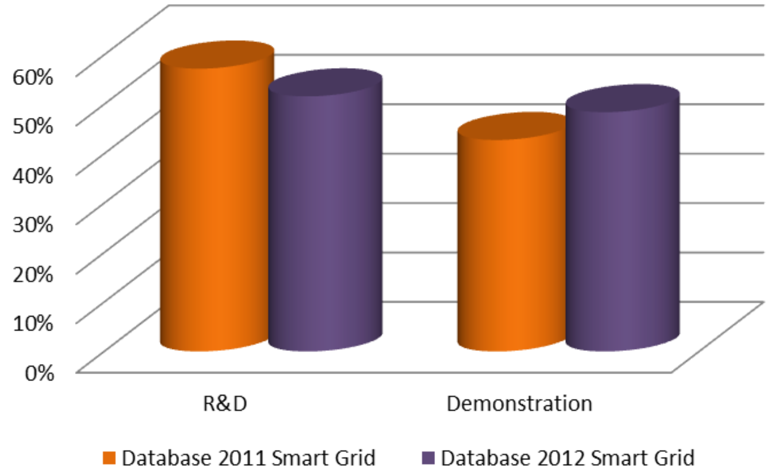


Figure 8 — Number of R&D and demonstration projects in the 2011 and 2012 SG Databases

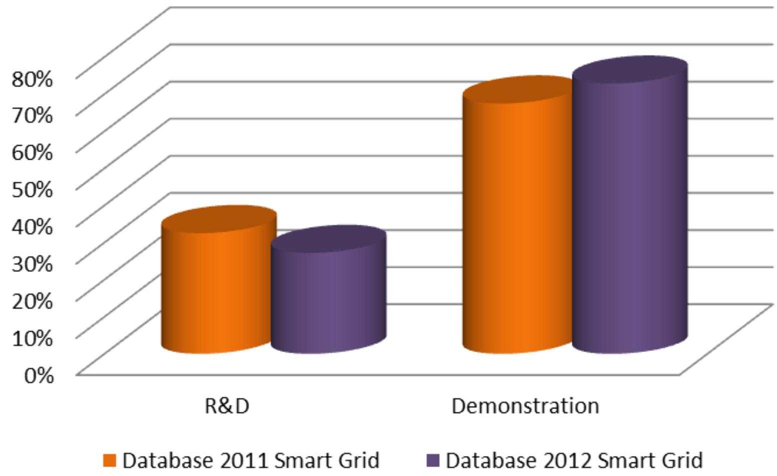


Figure 9– Budget share of R&D and demonstration projects in the 2011 and 2012 SG Databases

2.2 Project maturity

Figures 10 and 11 show the number and investment of R&D and demonstration projects by year.[12] The data for 2012 are partial, as they cover the period to September only.

We can identify a first phase with some sporadic activity and no large variations in terms of number of projects and investments (2002-05); and a second phase (starting in 2006 and peaking in 2008-12) where we observe a dramatic increase in the number of smart grid projects

[12] It is assumed that the whole project budget is allocated to the starting year of the project.

starting each year and in the corresponding investments. In particular, Figure 11 shows that investments in smart grid projects since 2008 have consistently exceeded € 200 million a year.

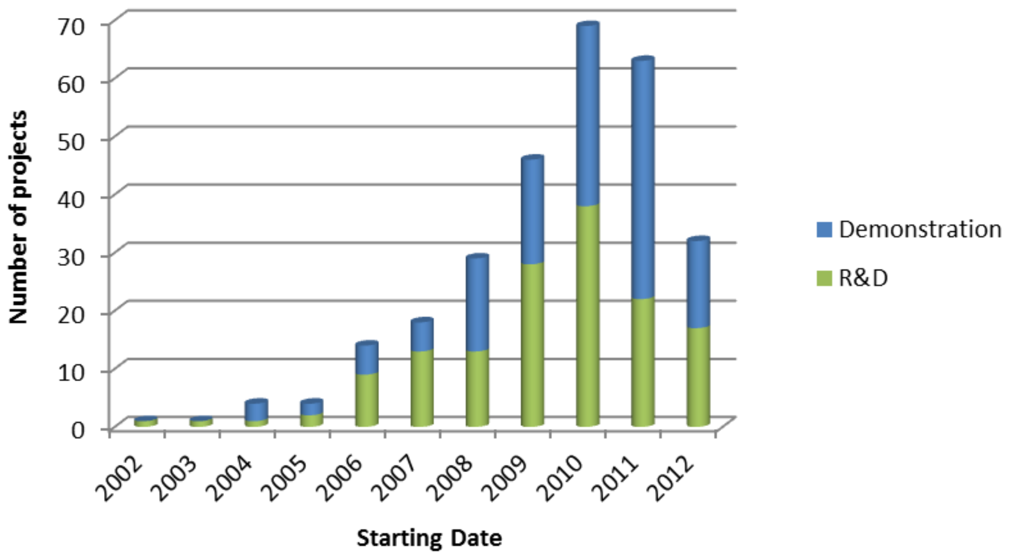


Figure 10 — Number of R&D and demonstration SG projects starting each year

The level of investments committed in 2011 is remarkable. Based on the information in the catalogue, this can be attributed to some large publicly-funded projects, in particular the first batch of projects funded by the ambitious Low Carbon Network Fund (LCNF) in the UK (total investment of around € 120 million), a significant number of large-scale demonstrators financed under FP7 (e.g. Grid4EU, Linear, Green eMotion) or with European regional funding (particularly the *POI* project, a large-scale grid automation project for RES integration in the south of Italy).

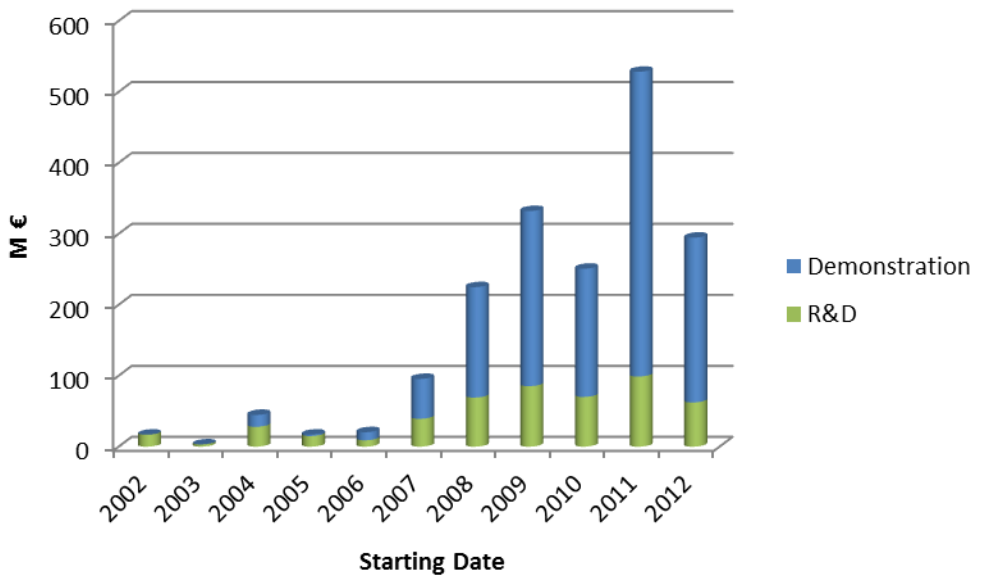


Figure 11 — Budget of R&D and demonstration SG projects starting each year

Figure 12 shows the average budget of R&D and demonstration projects across the years. Between 2006 and 2012, the average budget for R&D projects varied from €1 to €5 million. Overall, R&D projects have an average budget of €3.5 million. For demonstration phase projects, in the period 2007-12, the average budget is situated between €15 million and €15 million.[13]

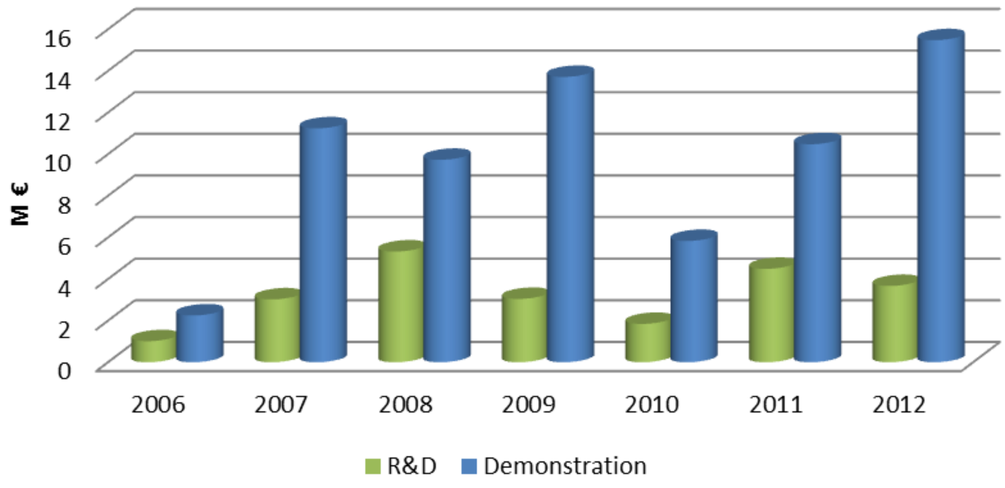


Figure 12 — Average budget of R&D and demonstration SG projects across years

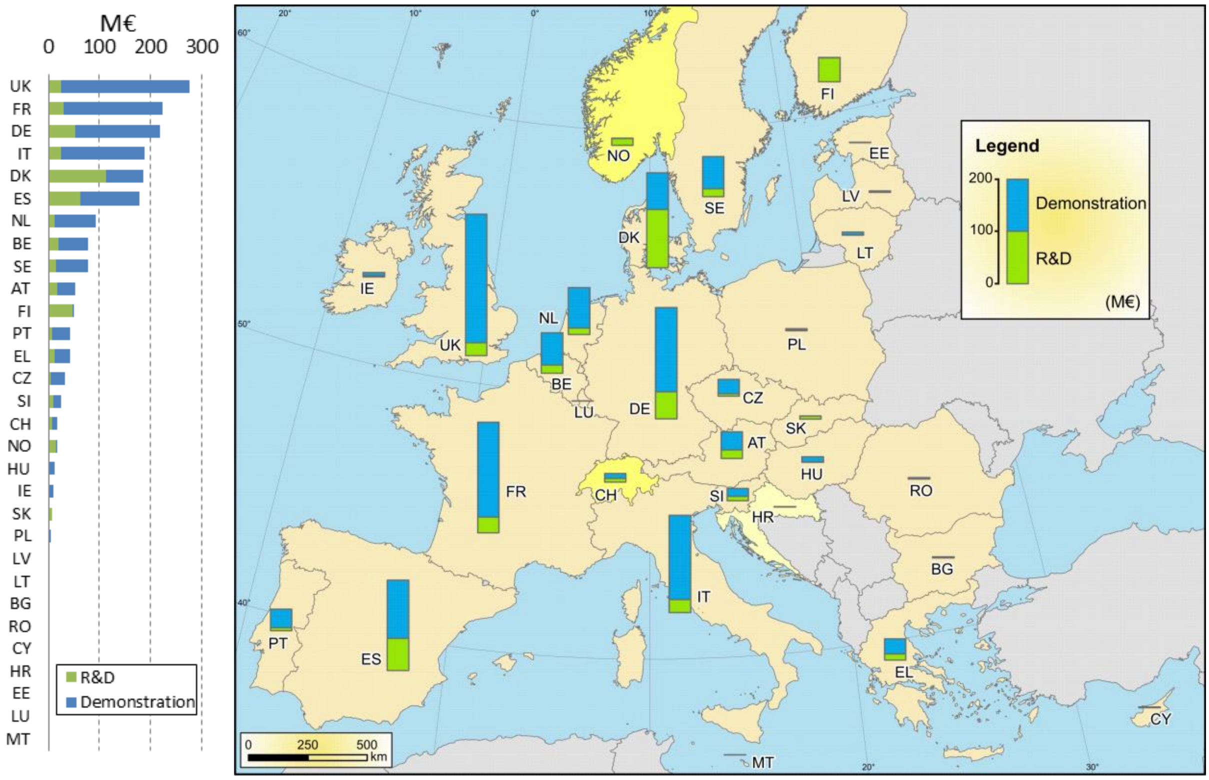
2.3 Geographical distribution of investments

Geographically, the smart grid projects and investments are not uniformly distributed across Europe (Figures 13). The great majority of projects (93%) are in EU15 countries, while EU12 countries are still lagging behind significantly.[14]

A few countries stand out in terms of spending. The UK's represents 15% of the total, Germany's and France's 12% each and Italy's, Denmark's and Spain's 10% each. The UK and Germany together account for investments of around €0.5 billion. The majority of UK investments are from projects supported by the LCNF (total investment of around €200 million).
Denmark is the leading country in R&D projects and is particularly active in several small-scale projects supported by the Forskel funding programme (see Sections 2.4 and 2.7) [Energinet.dk 2012].

[13] In Figure 12, for the sake of simplicity, only the period 2006-12 has been considered. Before 2006, the number of projects was very limited.

[14] For the allocation of the number of projects and the budget of projects across different countries and project categories, a weighted method was used. Demonstration projects and their budgets (as investments) were assigned to the country or countries with at least one implementation site. Projects with several implementation sites in different countries were assigned evenly among them, along with their budgets. For R&D projects where information on budget shares were not available, the budget was assigned evenly across the participating organisations and thus also across their countries of origin.



Figures 13 – Investments in R&D and demonstration SG projects across Europe

Figure 14 shows a different perspective, with investments per capita (blue bars) and per KWh of electricity consumed in each country (cumulative consumption in the 2002-12 period covered by the inventory).

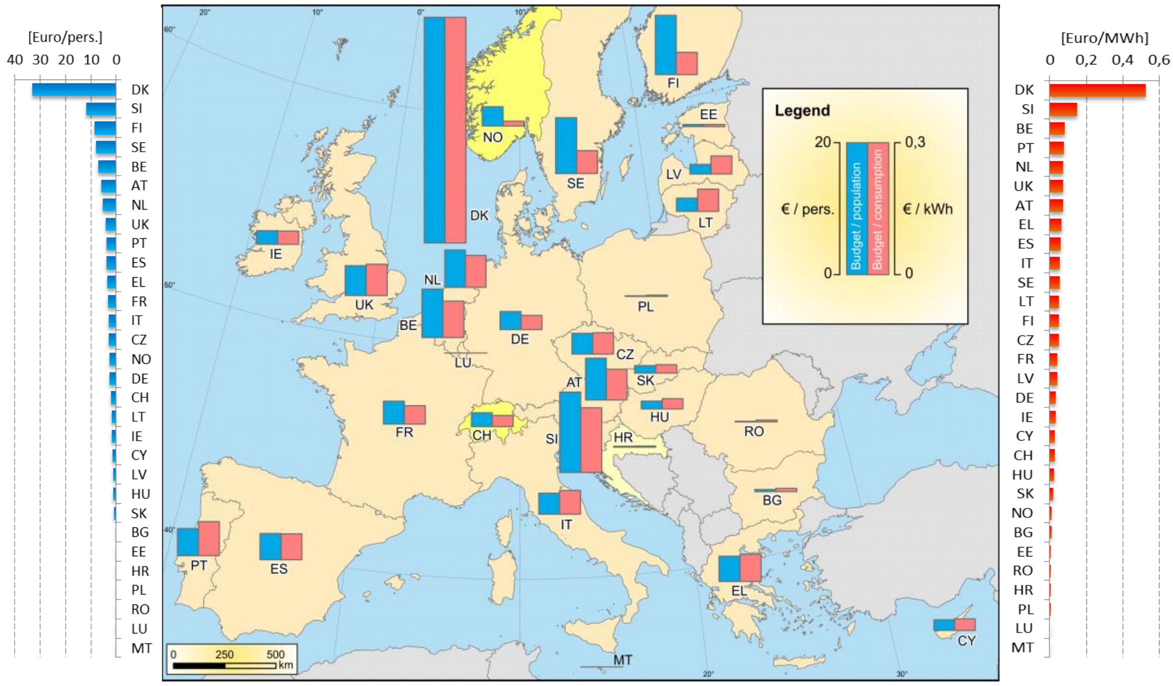


Figure 14 – Investments in SG projects across Europe per capita (blue) and by electricity consumption (red)

Denmark is the country that invests most both per capita (over € 30 per person) and per KWh of consumed electricity (€0.5 per MWh), followed by Slovenia (around 70 % of projects in which Slovenia participates are co-financed by the EC via FP6, FP7 or regional development funds).

2.4 Project scale and budget range

The analysis in the previous section considers only the aggregated amount of investment in the different countries over the years, without reflecting the size of the projects. An overall high level of investment in a country could be achieved through a few large-scale demonstrators or a high number of small-scale projects. The latter scenario might suggest a more exploratory approach in smart grid applications, whereas the former might imply that investment is being focused on more consolidated applications.

To shed some light on the budget size of the projects surveyed, Figure 15 shows the budget of all the smart grid projects in the catalogue. By clustering projects with similar budgets, we have identified five different project sizes:

- ✓ Very small-scale projects: €0< budget<€2.5 m (represented in blue in Figure 15)
- ✓ Small-scale projects: €2.5M€ < budget<€7.5 m (in red)
- ✓ Medium-scale projects: €7.5M€ < budget<€20 m (in green)
- ✓ Large-scale projects: €20M€ < budget<€30 m (in purple)
- ✓ Very large-scale projects: budget>€30 m (in orange)

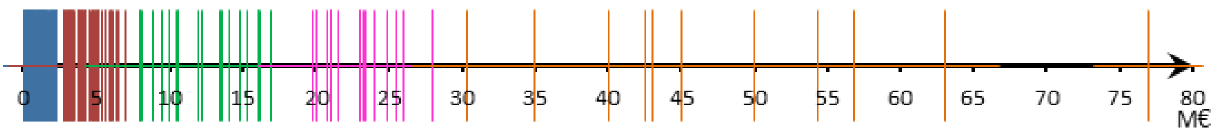


Figure 15 – Budget ranges for the projects in the 2012 database

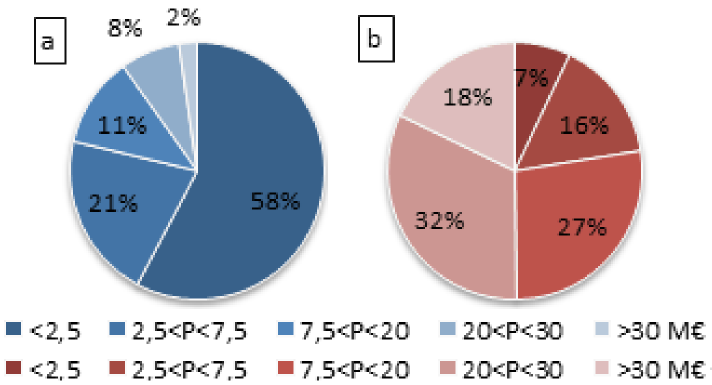


Figure 16 – Total share of each cluster in terms of number (a) and budget (b)

Figure 16 shows the total share of each cluster in terms of number (16a) and budget (16b). Most smart grid projects in the catalogue (around 80 %) have a budget of less than €7.5 million and can thus be labelled 'very small-scale' and 'small-scale'. 76 % of the projects have a budget below the average of €6.5 million.

Figures 17a and 17b show the share of projects in each cluster over the years, in terms of number and budget respectively. Two shifts, in terms of both number and budget, can be noted: the 'small-scale' cluster is increasing at the expense of the 'very small-scale' cluster and the 'medium-scale' cluster is shrinking in favour of the 'large' and 'very-large scale' ones. For example, the investment share of projects with budgets of over €20 million (i.e. large- and very large-scale projects) grew from 27 % in 2006 to 61 % in 2012, whereas in the same period the budget share of 'medium-scale' projects shrank from 52 % to 17 % (see Figure 17b).

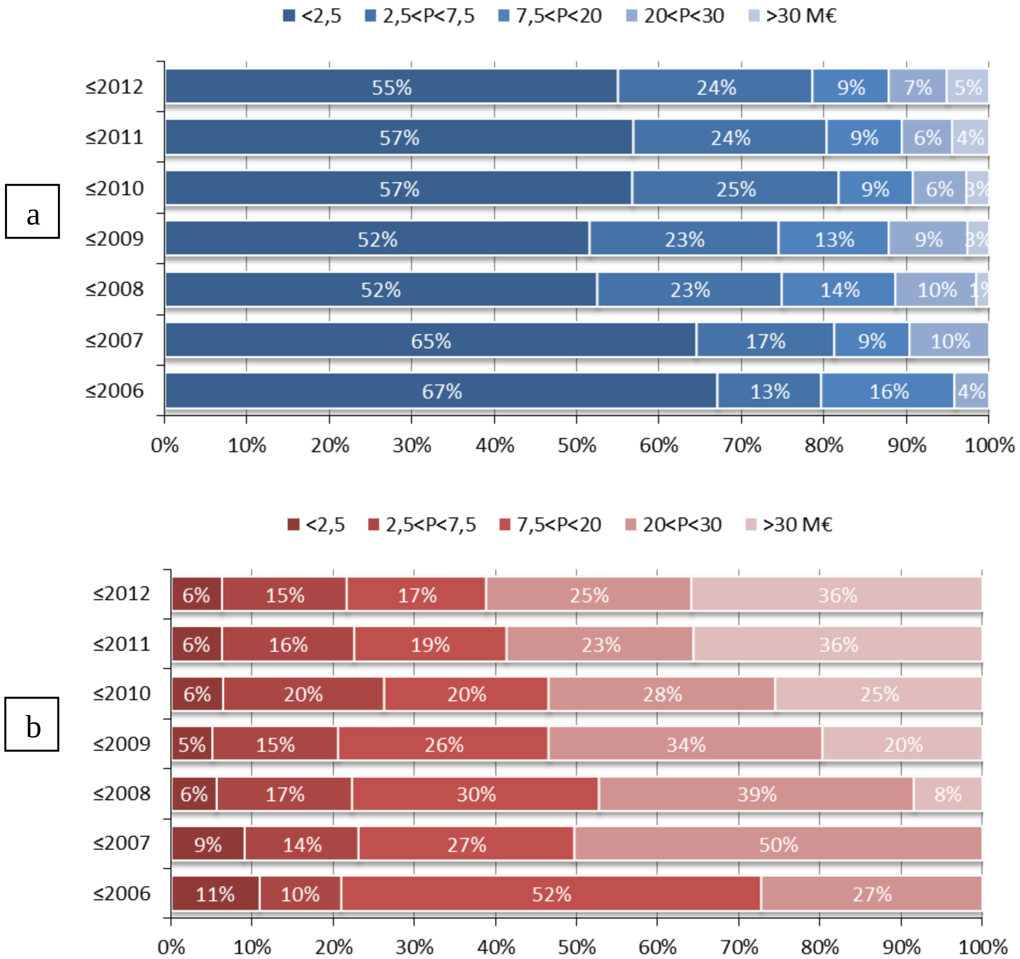
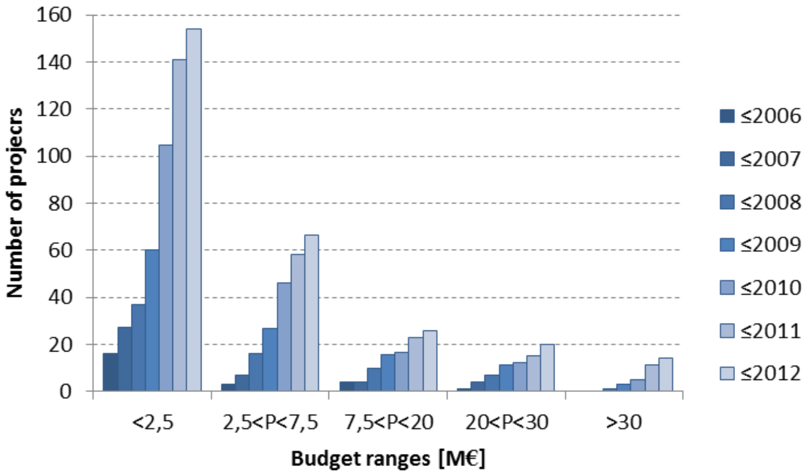


Figure 17 — Share of projects in each budget range across the years, (a) in terms of number; (b) in terms of budget

In other words, the size of projects is generally increasing, showing positive signs in terms of the scalability and maturity of related smart grid applications. In 2006, projects with budgets below €20 million accounted for over 70 % of the total investment. In 2012, this share shrank to less than 40 %, in favour of large and very large-scale projects, which now represent the bulk of investments in SG projects.

Figures 18a and 18b show the number of smart grid projects and its yearly variation by budget range and starting year. It is interesting to note that there seems to be a decreasing trend in the number of projects with a budget smaller than €7.5 million ('very small', 'small' and 'medium'), whereas the number of projects in larger budget ranges appears stable or slightly on the up.

a



b

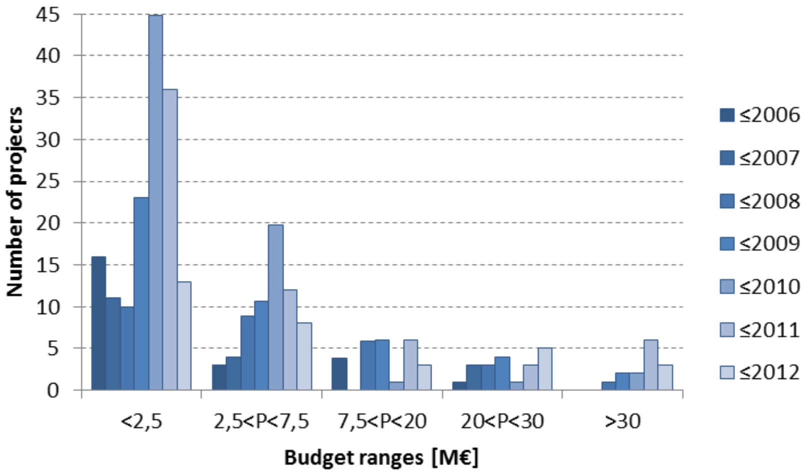
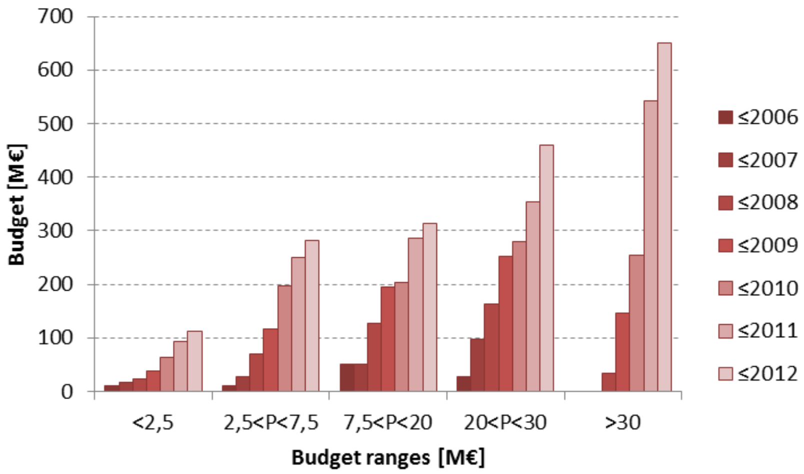


Figure 18 – Cumulative number of SG projects (a) and number of projects starting each year (b) per budget range across the years

a



b

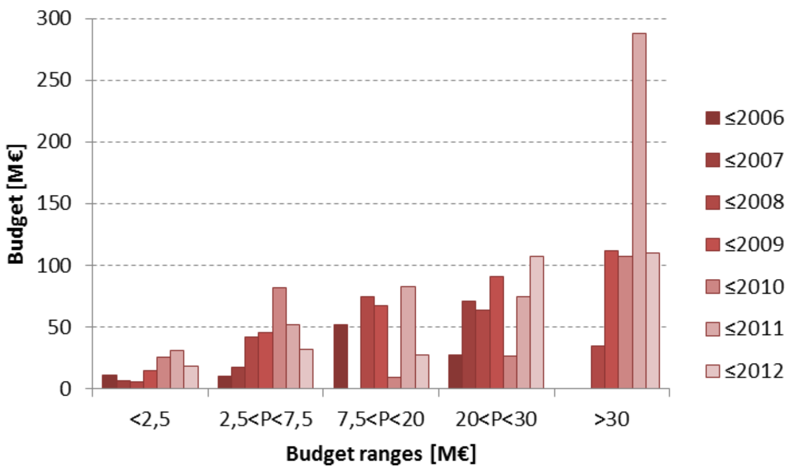


Figure 19 — Cumulative budget of SG projects (a) and yearly investment (b) per budget range across the years

For the sake of completeness, Figures 19a and 19b show the budget of all projects and yearly variation per budget range across the years, highlighting the trends shown in Figure 17b.

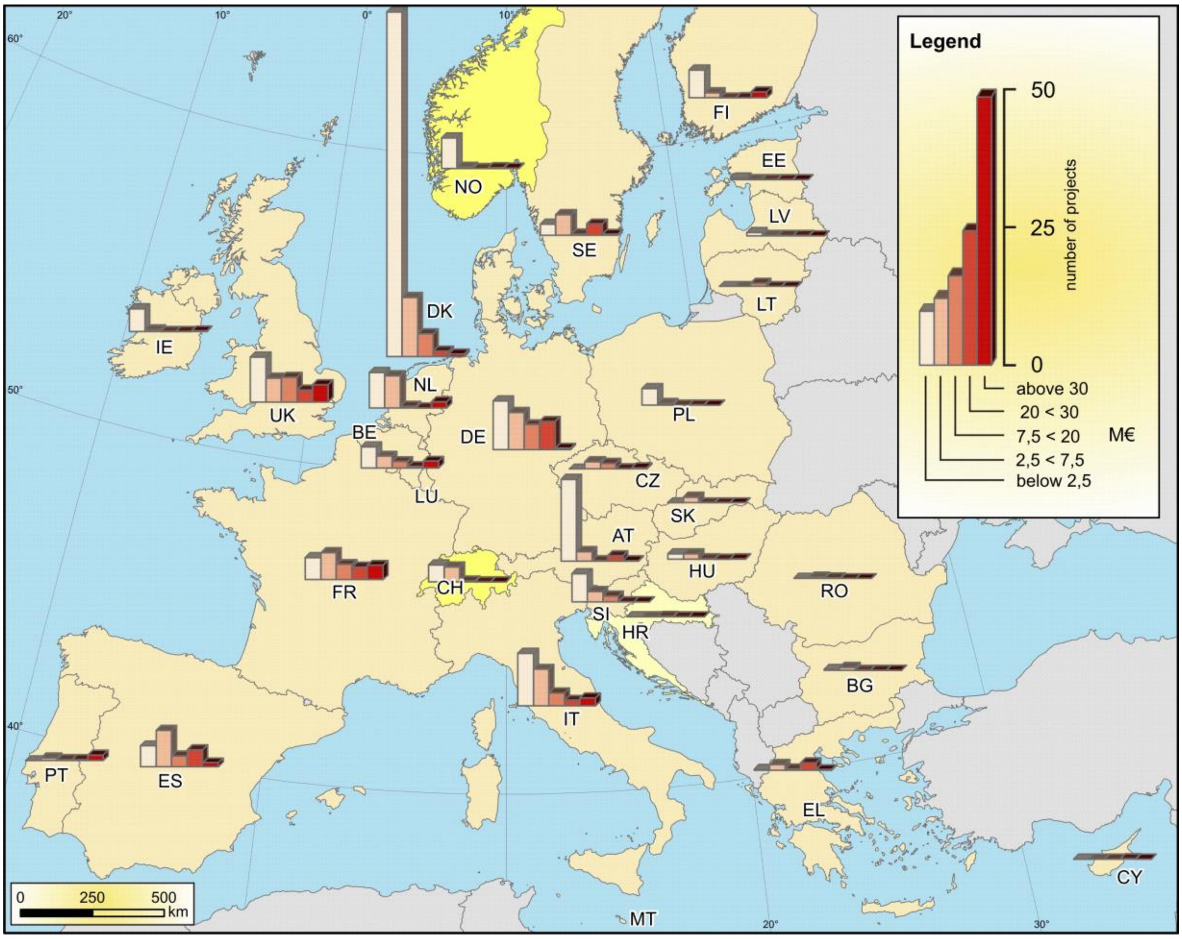


Figure 20 – Number of projects per country according to budget range

Figure 20 gives an overview of smart grid investments per country grouped according to budget ranges. We observe that, among top investing countries, Denmark has a very high number of small-scale projects, whereas projects in Germany, the UK and France are more evenly spread across the five budget ranges.

2.5 Multinational collaboration

The catalogue includes around 60 projects carried out by multinational consortia. The number of countries in these multinational consortia ranges from two to 16 and averages six. 95 % of these multinational projects receive EU funding.

An analysis of the countries involved in these projects (based on the nationality of the organisations concerned) provides an interesting picture of the links between smart grid players in different Member States. For this analysis, we looked at all the cooperation links between the countries/organisations involved in each project in the database.

As an example, Figure 21a illustrates the cooperation links between organisations from 11 different countries involved in one large multinational project. Figure 21b shows the links between Germany and other European countries taking account of all the projects in the catalogue.

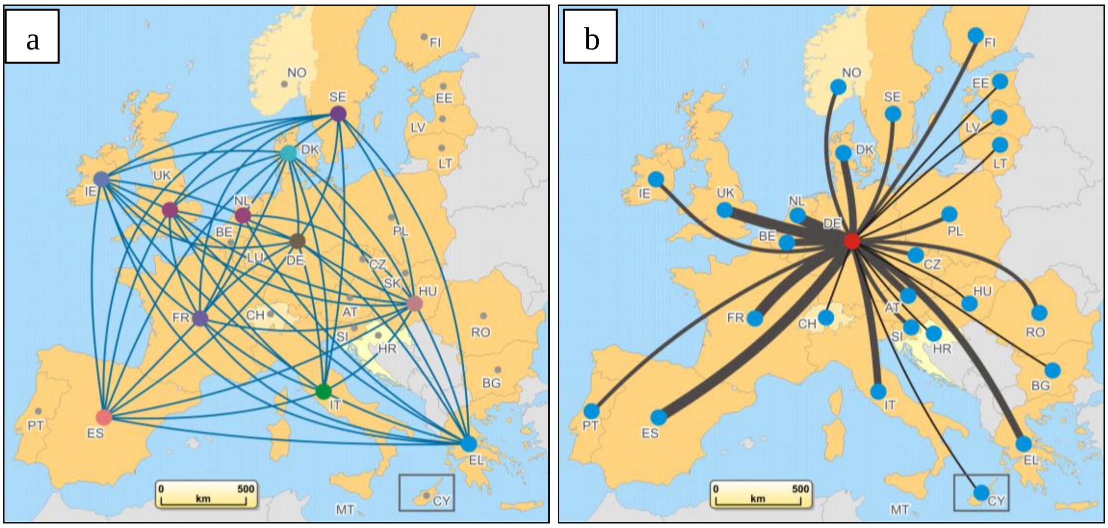


Figure 21(a) Collaboration links in a multinational smart grid project. (b) Collaboration links between Germany and all other European countries in all the projects in the catalogue

By counting each link as '1' and adding all of them together, we obtain a matrix representing the cooperation links among organisations in European multinational projects. The resulting matrix is represented as a heat map in Figure 22a,[15] where the links have been weighted according to project budget (the higher the budget, the stronger the links). Cells corresponding to country pairings represent the strength of the link between two countries. The same data are presented differently in Figure 22b, where the strength of the cooperation links is shown in the thickness of the lines.

[15] A heat map is a graphical illustration of data where the individual values enclosed in a matrix are represented as colours..

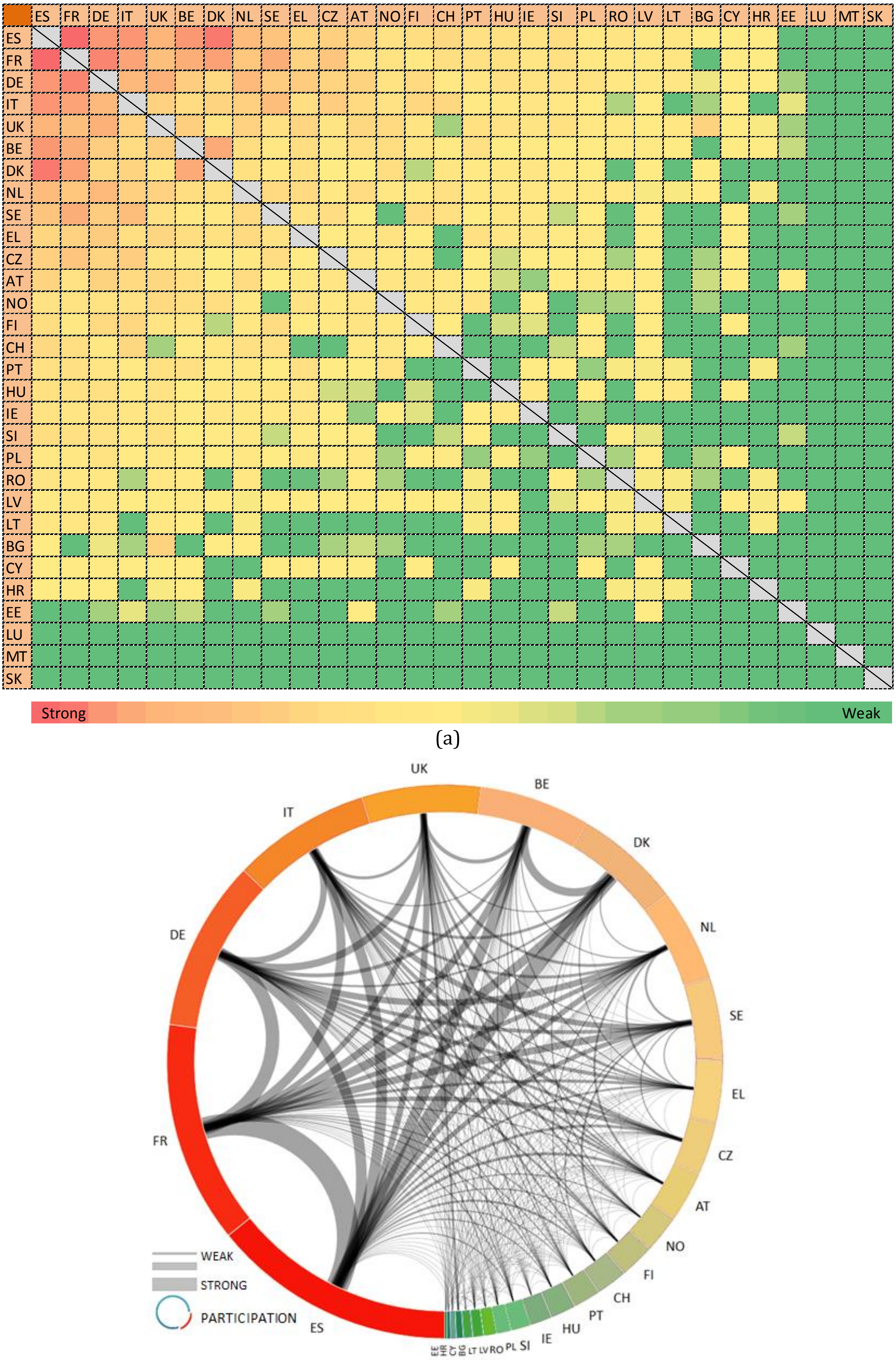


Figure 22 — Collaboration links in European multinational projects (weighted by project budget) –a) heat map representation; b) link-representation

Figure 22a shows quite clearly that the majority of collaboration links exist between companies from EU15 countries (red cells). In this representation, organisations from Spain, France and Germany are the most active in multinational projects (with Spain leading). Italy and the UK also have a high number of collaboration links, particularly with Spain, France and Germany. A second group of countries emulating these leading countries includes Belgium, Denmark, the Netherlands, Sweden, Greece, the Czech Republic and Austria, which have high levels of collaboration mainly with countries in the first group or among themselves (yellow cells).

EU15-EU12 COOPERATION

EU12 countries have a much lower number of collaboration links and those that exist are essentially with EU15 countries (yellow cells). EU12 countries invest mainly in projects started by EU15 countries and seldom participate in multinational projects with other EU12 countries (green cells).

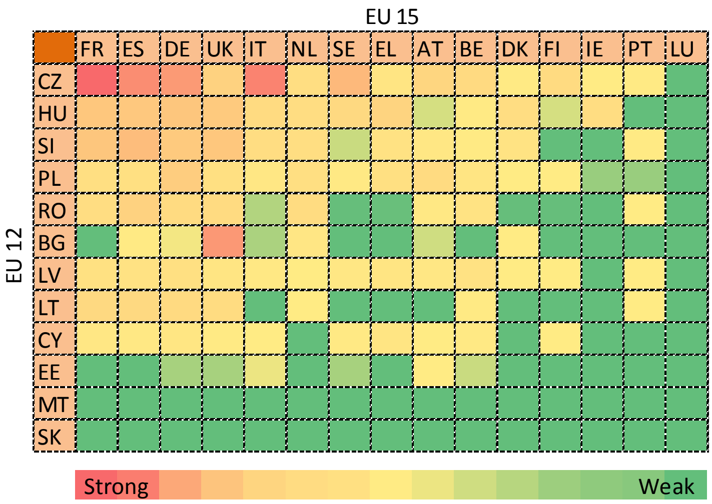


Figure 23 — Collaborations links in European multinational projects (weighted by project budget) between EU15 and EU12 countries

For the sake of clarity, Figure 23 shows only the collaboration between EU15 and EU12 countries from Figure 22. Companies from France, Spain, Germany, and the UK are the most active in projects involving EU12 countries, mainly organisations from the Czech Republic (e.g. large projects like Grid4Eu, Internet of Energy for Electric Mobility, EU-DEEP) and Hungary (e.g. large projects like Green-eMotion, EU-DEEP).

LEAD ORGANISATIONS

A different approach in analysing the collaboration links in multinational projects is to consider the links between the lead organisation and the other participating organisations. In this approach, the country of the lead organisation acts as a hub for the project.

Only the links of the lead organisation to the other participating organisations are considered; those between the other participating organisations are not counted. This is intended to highlight organisations (and countries) promoting projects.

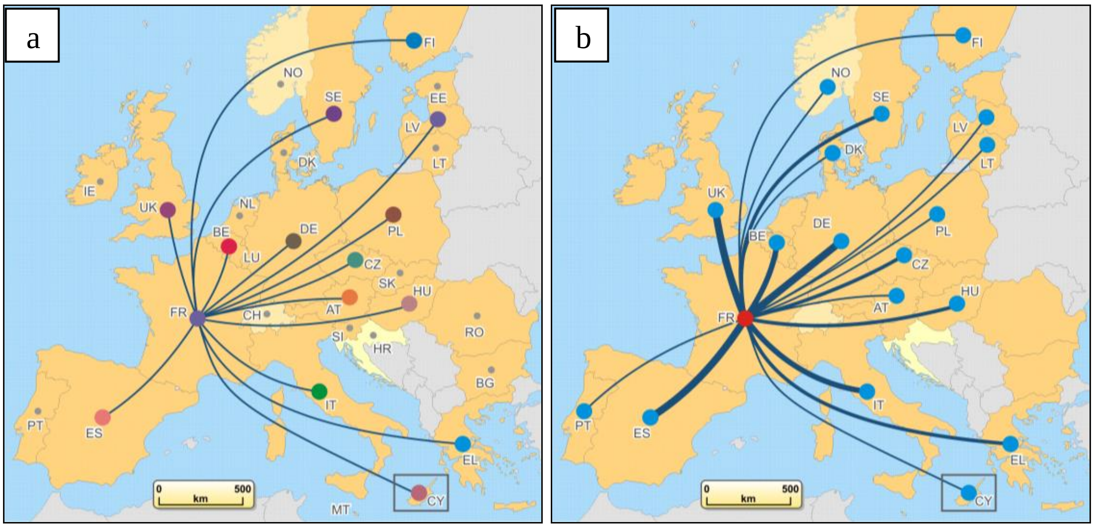


Figure 24 — (a) Collaboration links of the lead organisation in a multinational smart grid project. (b): collaboration links in all projects led by a French organisation with other European partners

As an example, Figure 24 shows the links of one project in which the lead organisation is French (Figure 24a) and cooperation links taking account of all projects where a French organisation is leading a multinational consortium (Figure 24b; the higher the number of cooperation links, the thicker the lines).

The matrix showing cooperation links between the countries of the lead organisations (columns) and the countries of the participating organisations (rows) is shown in Figure 25. As in the previous section, the links are weighted according to project budget.

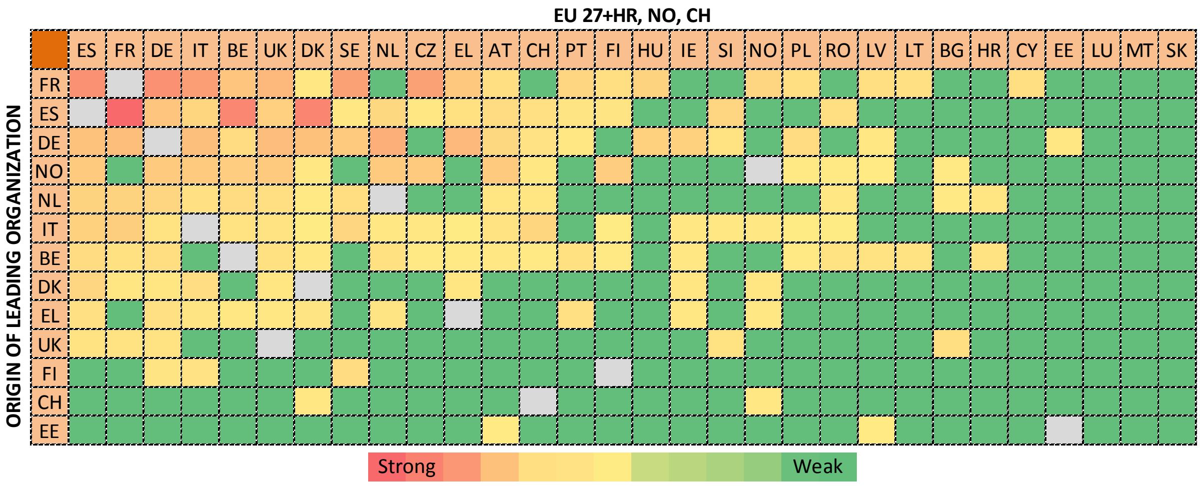


Figure 25 — Cooperation links (weighted by project budget) in European multinational projects, highlighting the countries with lead organisations.

Organisations from Germany and Spain are the main hubs of multinational projects.

By comparing Figures 22 and 25, we observe that organisations from countries like Austria or Sweden, although actively participating in European multinational projects (Figure 22), are not leading any multinational project themselves (Figure 25). Also, none of the lead organisations in multinational projects comes from an EU12 country (with the exception of a project led by an

Estonian company). Again, the countries hosting lead organisations cooperate with each other to a higher degree than with the other countries.

Lastly, we note that, of the non-EU countries, Norway is very active in promoting multinational projects (mainly R&D) and seeking collaboration with European partners, particularly from EU15 countries.

2.6 Who is investing?

The 281 smart grid projects in the catalogue have an average of seven participating organisations. The organisations have been classified into different categories: DSO/utilities/energy companies, TSOs, universities/research centres/consultancies, manufacturers, IT/telecoms, etc.

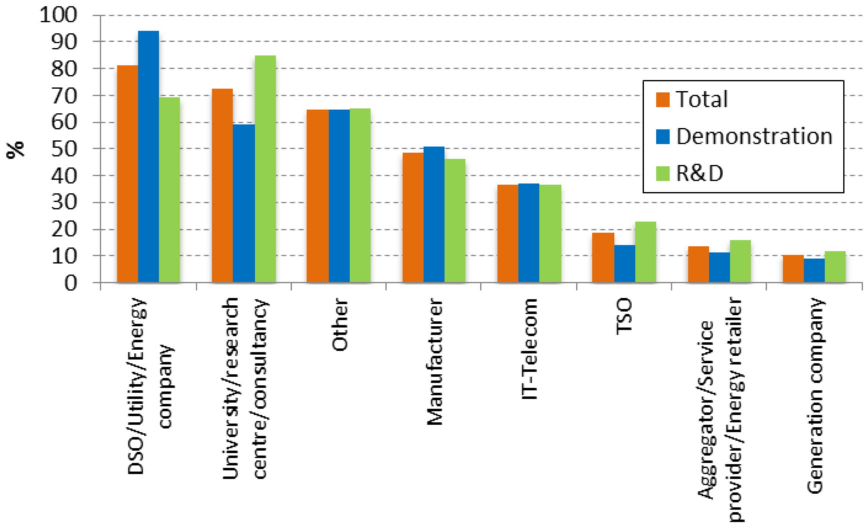


Figure 26 – Participation by type of organisation (proportion of projects with at least one representative of respective types of organisation)

Figure 26 shows participation by type of organisation as the proportion of projects with at least one representative of the respective types of organisation. It shows that DSOs/utilities/energy companies are involved in over 80 % of the projects. Universities/research centres are involved in over 70% of the projects, followed by manufacturers (over 45 %) and IT/telecoms (over 35 %).[16] TSOs are involved in around 20 % of the projects.

For most projects, information on the budget share of each participating organisation was not available. We have therefore assumed that the budget of the project is allocated entirely to the lead organisation. This gives us an idea of the share of the total investment in the catalogue for which each organisation was responsible (Figure 27).

[16] The 'other' category includes a diverse set of organisations such as engineering companies, municipalities/public authorities, associations, etc.

The data seem to confirm the leading role of DSOs and distribution utilities in promoting smart grid development in Europe. DSOs/utilities/energy companies are taking the lead in a total of 115 projects (DSOs: 70; utilities/energy companies: 45) with investment equal to 57 % of overall investment in smart grid projects.

Projects led by universities/research centres/consultancies account for to 23 % of overall investment and those led by manufacturing companies, IT & telecom companies, TSOs and others for 20 %.

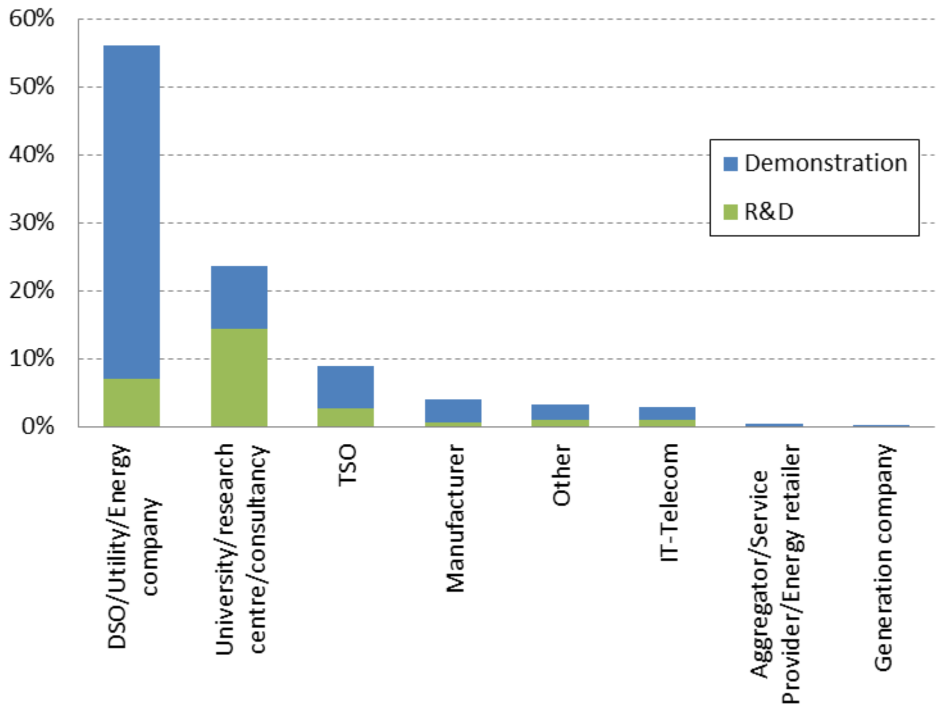


Figure 27 – Budget share of projects by type of lead organisation

DSOs/UTILITIES

Currently, total investment in smart grid projects led by DSOs and utilities amounts to over € 1 billion. Different factors might explain their prominent role. First of all, DSOs/utilities have the responsibility for the operation of the grid and therefore need to participate actively in any project (mainly demonstration) directly affecting this. They are the 'incumbents' in the electricity sector and can build on established technologies, business models and regulation. They also have direct access to regulatory funding, particularly innovation-based funding such as the LCNF in the UK and the AEEG smart grid incentives in Italy.

In addition, in the current phase of smart grid implementation, the main focus of projects has been on the technical architecture of the smart grid (e.g. automation/ICT solutions for the integration of decentralised resources). DSOs/utilities clearly have a leading role in these investments on the technical layer, which are a precondition for a market architecture (e.g. use of market signals to coordinate the behaviour of decentralised users, taking into account grid constraints) where new players might find incentives to invest and join new projects.

TRANSMISSION SYSTEM OPERATORS

Transmission system operators (TSOs) are the lead organisations in 23 smart grid projects, equally split between R&D and demonstration projects, with a total budget of around €160 million.

In Denmark, Energinet.dk is a particularly active TSO, leading eight smart grid projects with a total budget of €50 million, including the major EcoGrid EU project. Another example of a TSO actively involved in the leadership of smart grid projects is Spain's Red Eléctrica de España (REE), which is leading projects of a total value of €80 million.

The main TSO-led projects are all financed by the EC. On the one hand, this is an indication that TSOs are increasingly pursuing joint projects of pan-European relevance; on the other hand, it may signal that barriers prevent TSOs investing directly in new projects.

As regards the content of TSO-led projects, three key themes can be identified:

- ✓ Stronger cooperation at the interface between DSOs and TSOs, integration of demand-side management (DSM) in TSO operation, ancillary services by DSOs to support TSO operation (e.g. Cell Controller Project, EcoGridEU);
- ✓ New tools for coordinated operation of the transmission grid by different TSOs (e.g. PEGASE, iTESLA, REALISEGRID);
- ✓ Specific work on the integration of large-scale RES (e.g. off-shore wind farms in TWENTIES project), including forecasting tools (e.g. SAFEWIND project).

TELECOM and ICT COMPANIES

In this category we include software (e.g. SAP), system integrator (e.g. IBM) and telecom companies.

ICT companies are the lead organisations in 17 projects (mostly R&D) with a total budget of around €55 million. The most targeted applications are 'aggregation', 'smart customer' and 'smart home'. The focus is on ICT technology to foster flexible production (e.g. integration of fluctuating DER, storage) and consumption (home energy management, consumer involvement). Telecom companies mainly focus on the communication infrastructure to support the DSO operations.

Despite leading only a handful of projects, ICT companies have participated in an increasing number of new smart grid projects over the years. ICT companies have increasingly entered the smart grid scene since 2006 and are carving out a role for themselves alongside ‘incumbents’ in more and more smart grid applications, particularly in the setting-up of VPP and demand response platforms (Figure 28). This could bring change and innovation in the electricity sector [Erlinghagen et al. 2012]. For example, as DSOs/utilities are increasingly working together with ICT companies, we expect this will require DSOs to strengthen their ICT competencies.

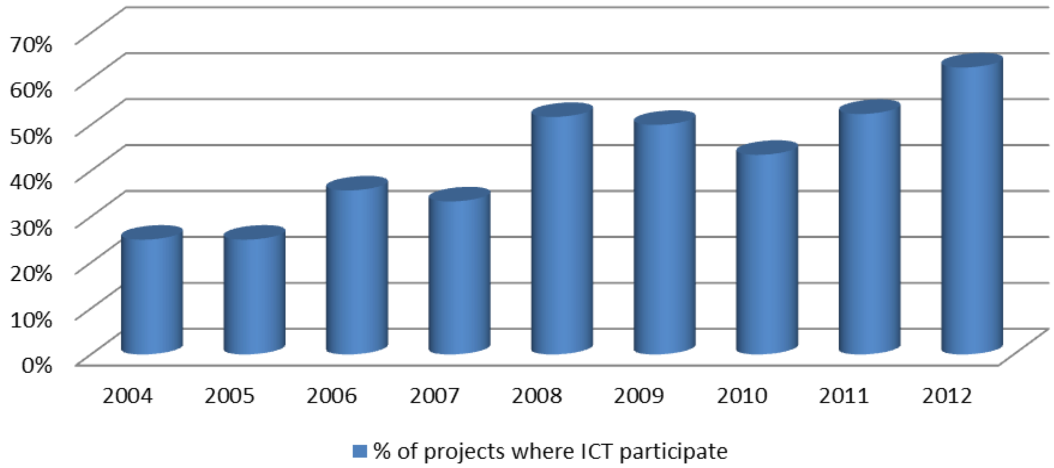


Figure 28 — Participation of ICT/telecoms companies (percentage of projects involving at least one ICT company)

MANUFACTURERS

Manufacturers are leading around 12 projects with a total budget of over €75 million. These projects aim at developing and testing concepts for the integration of new technological applications like software/hardware solutions for Optimisation and Control of Renewable Energy and Electricity Network, integration of DERS (e.g. voltage control of photovoltaic installations, energy-efficient control of heat pumps and water heaters), integration of storage devices (e.g. fuel cell), data platforms for data exchange (including solutions for EV charging).

It is natural that manufacturers may not feature most as project promoters, but nevertheless they are well represented in the projects surveyed.

UNIVERSITY AND RESEARCH COMPANIES

University/research centres are leading around 95 projects with overall budgets of around €430 million. They are the key players in R&D projects and the budgets of the projects they lead amount to over 50% of all R&D investment in our catalogue.

2.6.1 Concentration of company types and collaboration links

It is interesting to analyse the level of participation of the different types of organisation discussed in the previous section. In this analysis, we look at the number of representatives of each type (e.g. number of manufacturers) in each project. We cover both demonstration and R&D projects, as this can offer an indication as to which organisations are more active in the preview phase before smart grid applications are marketed.

Figure 29 shows the share of participation in all projects by different types of organisation. University/research centres/consultancy are best represented (i.e. most numerous) in all projects, followed by DSOs/utilities/energy companies, manufacturers and IT/telecom companies. A more limited number of TSOs and aggregators/service providers participate in the projects.[17]

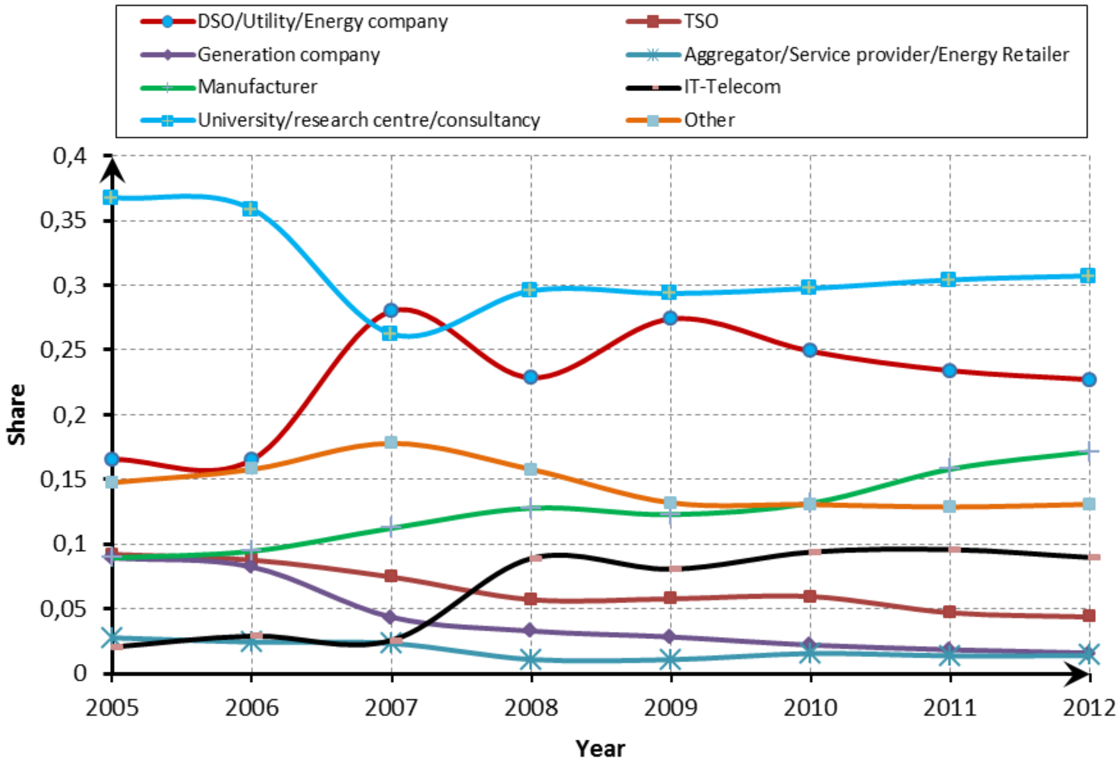


Figure 29 – Share of participation in smart grid projects (demonstration and R&D) by organisation type (presence weighted with the budget)

Based on the share of participation of the different organisation type, we then calculated a 'diversity index' measuring the degree of concentration of different organisation types in the smart grid projects surveyed.[18]

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[17] The 'other' category includes a diverse set of organisations like Engineering Companies, Municipalities/Public authorities, Associations.

[18] The diversity index was calculated with the following formula:

$$D = \sum_{i=1}^{n} p_i^2 ,$$

where n is the number of types of participants and p is the share of each type of participant.

A diversity index of ‘1’ represents a situation where only one organisation type is participating in the projects. The lower the index, the higher the level of diversity among organisations participating in the projects. Figure 30 tracks the value of the index across the years. Qualitatively, we can say that a good degree of diversity exists among companies participating in smart grid projects and that the level of diversity has remained steady over time.

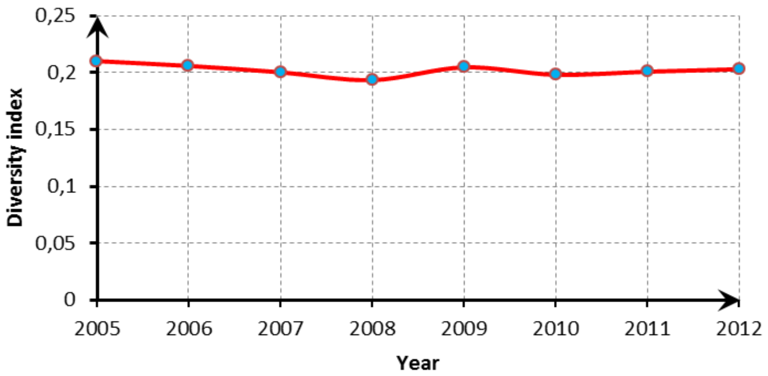

Figure 30– Diversity index weighted by project budget

Finally figure 31 reports the most recurrent cooperation links among the different players in collected projects. DSOs/utilities and universities/research centres are the most active players, significantly collaborating among themselves and acting as “cooperation hubs” for other players like Manufacturers and IT–telecom companies in numerous projects (red area in figure 31).

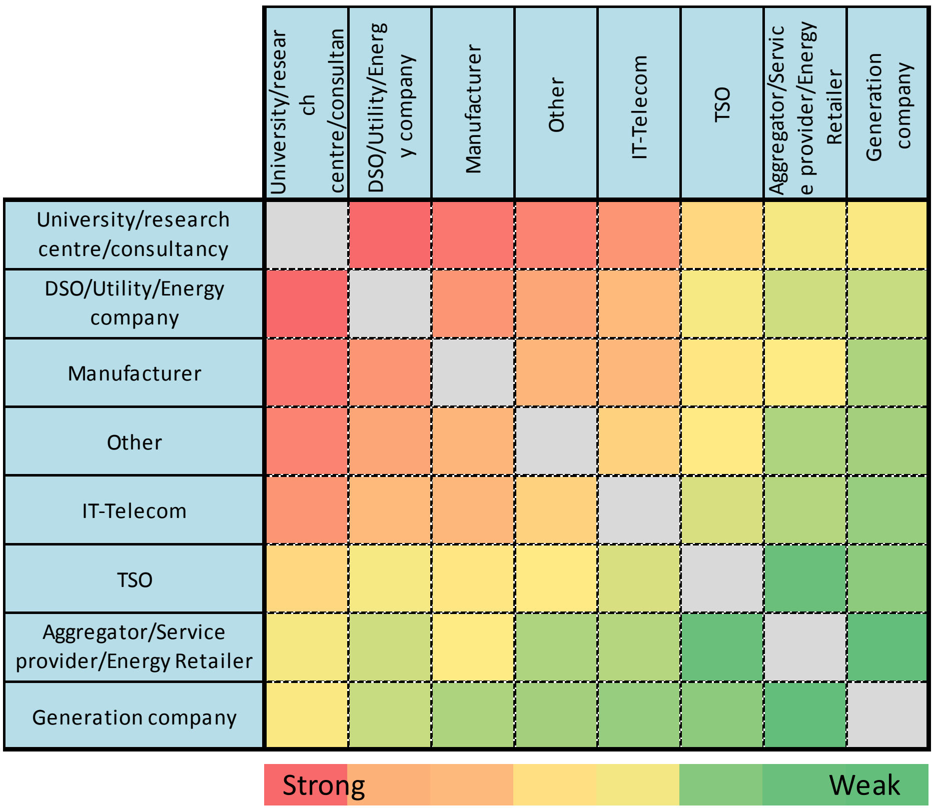

Figure 31 — Collaboration links between different types of organisation

2.7 Sources of funding

The role of funding for smart grid projects is very important. Of the overall budget of the projects in the JRC catalogue, 55 % (€974 million) comes from various sources of funding and 45 % from private capital. Around 80 % of the projects have received some form of public funding.

These figures indicate that decisions to invest in smart grids are not yet being taken independently/autonomously and project coordinators still rely on funding institutions to invest in RD&D smart grid projects.

For the purposes of the analysis, funding sources were categorised as European, national and regulatory.

Regulatory funding — In this category we consider specific smart grid programmes managed by regulators to support innovative smart grid projects. For example, more than 50 % of the Danish projects in the catalogue are supported by the Forskel programme, which is financed from tariffs.

Since 2010, the UK regulator OFGEM has set-up the low carbon network fund (LCNF) to provide regulatory funding for particularly innovative smart grid projects. In other countries, regulators are supporting the development of smart grids with specific tariff schemes guaranteeing an additional rate of return on smart grid investments. In Italy, for example, an additional 2 % rate of return is given for smart grid investments which fulfil certain innovation criteria [Delfanti et al. 2011].

National and European funding — At the European level, smart grid initiatives have been receiving wide support through different channels (6th and 7th Framework Programmes, European Regional Development Plan). In several European countries, smart grid investments are receiving increasing levels of national support funded by innovation or energy ministries (e.g. the E-ENERGY Programme in Germany). These funding initiatives are targeting RD&D projects across different countries and technological applications.

Figure 32 shows the cumulative value of the total budget and of the different funding sources over the years. In plotting the curves, it has been assumed, for the sake of simplicity, that the total budget and the funding of a project are distributed evenly over the duration of the project. The area under each curve represents the budget allocated by funding type for smart grid projects over the years.

A relative steady increase over the years can be observed in the cumulative total and in the funding source budgets. The fact that the curves have decreasing trends in the future is misleading: the only information that can be gleaned from the future side of the graph concerns the funding already allocated for ongoing projects.

The most significant back-up to private investment comes from national and EC funding. A sharp increase in regulatory funding can be noticed in 2011 following the launch of OFGEM's Low Carbon Fund initiative in the UK.

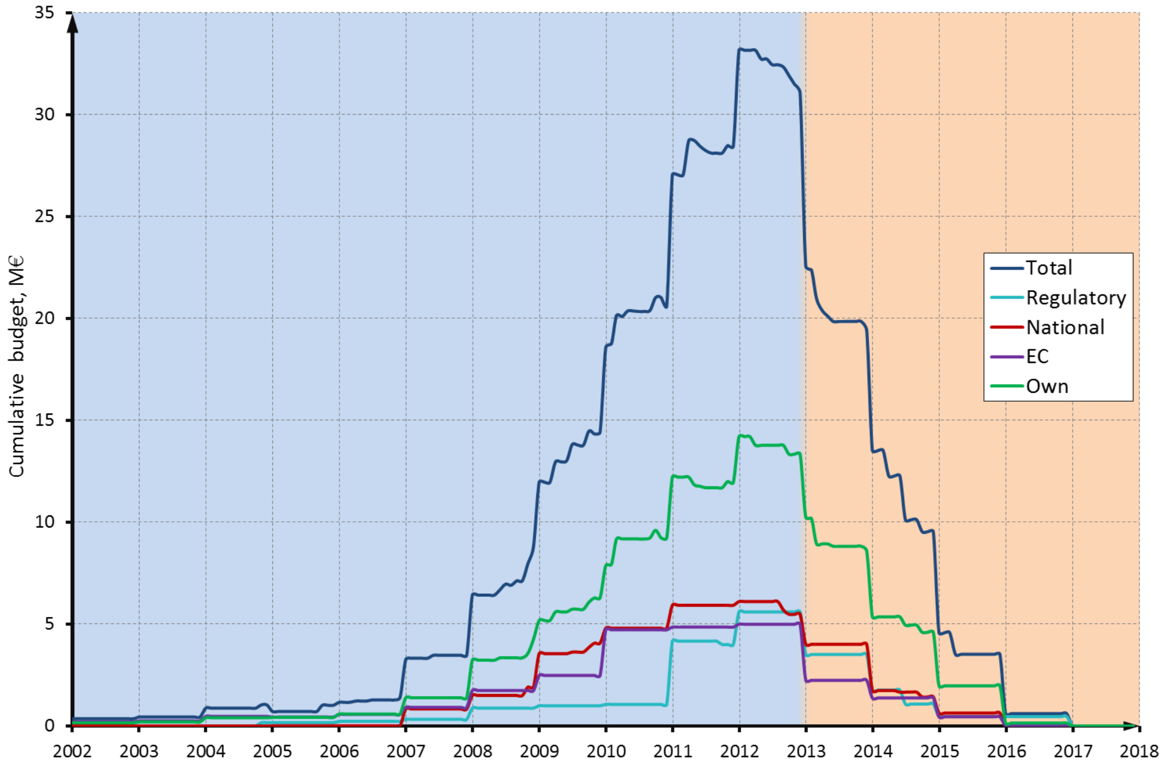

Figure 32 — Allocated funding over the lifespan of SG projects

Flagship Funding Programmes
France:
The French Agency responsible for Environment and Energy Management (ADEME) has launched a 'Smart Grid Programme' to provide financial support for smart grid R&D and demonstration projects. Among the main goals of the Programme are: a) to facilitate the integration of DER; b) to test new business models that will contribute to structuring new actors in smart grids; c) to enable significant action to manage demand; and d) to prepare the ground for anticipated changes in the grid environment (smart meter deployment, integration of electric vehicles, efficient-energy buildings etc.).
The Programme will allocate a potential budget of € 250 million through refundable grants and subsidies for the period 2010-14. ADEME launched two calls for expressions of interest in 2009-10 and in 2011. Of the smart grid projects submitted, ten have already been selected (with a total budget of € 150 million). ADEME's total contribution toward these projects amounts to about € 40 million.
Out of the total budget of € 150 million, 85 % is for four large-scale projects with budgets of over € 20

million: *Greenlys*, *Millener*, *Venteea* and *NiceGrid*.

The main aim of these flagship projects is to harmoniously integrate a high proportion of solar panels, windfarms and energy storage batteries into the distribution network. The *NiceGrid* project received both national and European funding since it is part of the European GRID4EU project.

The other six ADEME-funded projects are mainly small- and medium-scale projects with budgets of less than €10 million. For example, projects like *Reflexe, EnR-Pool, Modelec* and *Omere GE* are focused more on developing systems and business models in which new players like aggregators will participate or on exploring the application of consumers' demand response.

Germany:

In Germany the Parliamentary State Secretary in the Federal Ministry of Economics and Technology (BMWi) initiated the 'E-Energy: IKT-based energy system of the future' competition providing national funding for smart grid projects.

The goal of the programme was to finance projects that demonstrate how information and communication technologies (ICT) can be exploited to achieve even greater cost-effectiveness, security of supply, and climate and environmental compatibility in electricity distribution [BMWi 2013].

The competition took place in 2008 and an independent jury chose six winners from among 28 top-scoring projects: *Smart W@TTS, RegModHarz, Model City Mannheim, MEREGIO, E-DeMa* and *eTelligence*. The overall budget was €120 million, almost half of which came from the E-Energy funding programme. The projects were implemented in six different 'model regions'. BMWi provided up to €40 million for four regions and the remaining €20 million for the other two regions were provided by the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU).

The main goal of the projects was to test aggregation/demand response in real conditions by creating technical and virtual platforms bringing together generators, consumers, energy service providers and network operators. Overall, 8 150 electricity end-users of different categories, and from the six model regions, are participating in the trials.

UK:

In 2010, the British regulator OFGEM established the Low Carbon Networks (LCN) Fund. The Fund runs for a period of five years (2010-15) and provides up to £320 million in financial support to encourage DNOs to conduct projects trying out new technologies and operating and commercial arrangements. The objective of the projects is to help all DNOs understand what they need to do to provide security of supply at value for money as Britain moves to a low carbon economy [OFGEM

2012].

The LCN Fund provides two tiers of funding. The first tier is designed to help DNOs to invest in small-scale projects with budgets of less than £0.5 million. In total, 28 small-scale projects have already been financed through the First Tier Fund, including *Clyde Gateway* and *Ashton Hayes Smart Village*.

Under the Second Tier of the LCN Fund, OFGEM organises an annual competition for an allocation of up to £64 million to help fund a small number of flagship projects. Second Tier Funding has already provided £120 million for ten projects with a total budget of £175 million. These projects include *Customer-Led Network Revolution*, *Low Carbon London* and *New Thames Valley Vision* [OFGEM 2012].

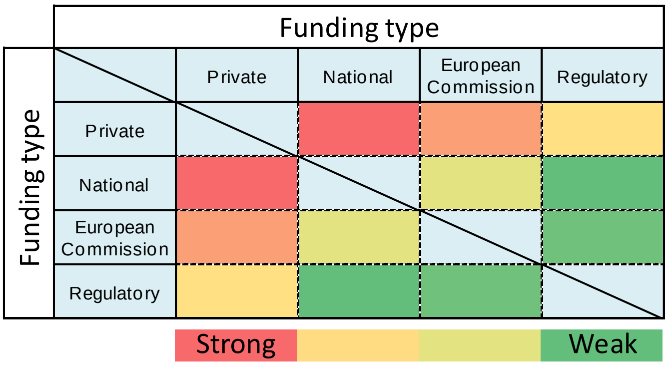

Figure 33 — Combination of funding sources in the project budget

Figure 33 shows the most common combinations of financing across the projects.

Typically, projects are co-financed from a single funding source (national, European or regulatory). National funding provides the highest rate of co-financing combined with private funding (red cell in Figure 33), followed by European funding (orange) and regulatory funding (yellow). Figure 33 also shows that there are a few projects which have received both EC and national funding (light green), whereas the combination of regulatory support and EC or national funding is rare (dark green).

The analysis of funding sources also shows that:

- 45 % of all investment in the smart grid catalogue is co-financed through national funding, which amounts to around 20 % of the total;
- 35 % of all investment in the catalogue is co-financed through EC funding, which also amounts to around 20 % of the total;
- Since 2011, the level of regulatory funding has been catching up with levels of national and EC funding following OFGEM's Low Carbon Fund initiative in the UK;
- 13 % of all investment in the catalogue is co-financed through regulatory funding (e.g. LCNF in the UK);

- Regulatory funding is not sufficient to support projects in all areas of the smart grid. For example, in countries where regulatory support has already been allocated to capital-intensive transmission or distribution reinforcements or smart metering, it might be difficult to raise additional support for a wide range of smart grid RD&D projects.

2.8 Which smart grid applications are most targeted by projects?

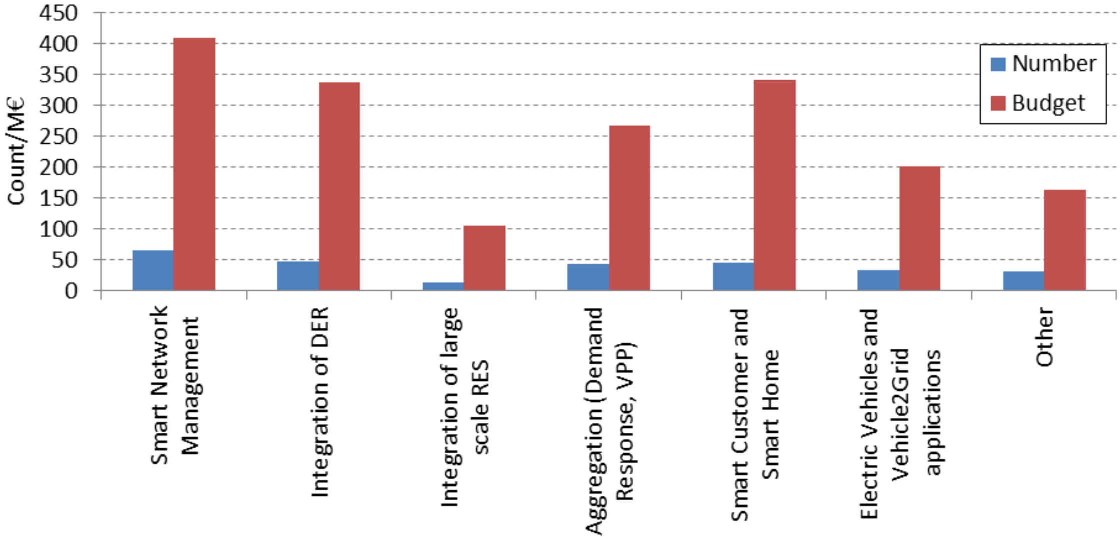

Figure 34 – Cumulative budget and number of projects by application

Figure 34 shows the distribution of projects across the different project applications (in terms of number and budget). The analysis has been carried out by identifying the main project application(s) by project. In the absence of more detailed information from project coordinators, the project budget has been split equally (as an approximation) among the different applications relevant to that project.

2.8.1 Smart network management

In this category, we consider implementations focusing on increasing the operational flexibility of the electricity grid, like substation automation, grid monitoring and control, etc.

Typically, the goal is to improve the observability and controllability of the networks (particularly at MV and LV level, where the majority of the projects in our database are focused).

Observability (tools to observe the behaviour of the network)

In this area, some of the key themes addressed in the projects are:

- ✓ implementation of smart meters to collect and store, on demand and in real time, specific high quality and accurate data for each consumer and group of consumers;
- ✓ improving distribution grid monitoring to cope with volatile states in the grid;

- ✓ real-time asset monitoring;
- ✓ fault identification and localisation.

Project results confirm that the tools developed or used to observe the network are mature and reliable. Some areas of improvement are related to standardisation and interoperability, particularly on the communication infrastructure. Finally, at transmission level, emphasis is also placed on the development of tools for the coordinated operation of pan-European networks, e.g. advanced simulation and state-estimation tools.

Controllability (tools to control the behaviour of the network)

In this area, some of the key themes addressed in the projects are:

- ✓ implementation of new capabilities for frequency control, reactive control, power flow control;
- ✓ controllable distribution sub-stations, controllable inverters and charging; development and testing of Distributed Generation and Load Intelligent Controllers; smart protection selectivity (smart relays);
- ✓ smart auto-reconfigurable networks, easily stabilisable on-line tap changer;
- ✓ dynamic line rating;
- ✓ deploying a range of leading-edge transformers across a number of LV and MV circuits, together with use of Capacitors, VAR control devices, and electronic boosters which when optimised together will lead to reduced losses from the power system.

Some of the control technologies are already highly developed and efficient. Areas for improvement include cyber security and scalability of applications from small-scale to large-scale projects.

2.8.2 Integration of large-scale RES

Most projects in this category are concerned with the integration of RES mainly at transmission level. Key areas of focus are:

- ✓ Tools for planning, control and operation of renewables in order to facilitate their market integration;
- ✓ Integration of demand-side management and ancillary services by DSOs to support TSO operation;
- ✓ Tools to forecast RES production;
- ✓ Off-shore networks for wind power integration.

2.8.3 Integration of DERs

In this category, we include projects focusing on new control schemes and new hardware/software solutions for integrating DERs while assuring system reliability and security.

The projects focus on technical solutions, such as:

- ✓ Active grid support through DERs: implementation of voltage control/reactive power control of DERs for the provision of ancillary services;
- ✓ DER production forecast and active/reactive power measurement for network observability;
- ✓ Innovative DER protection settings for anti-islanding operation;
- ✓ Use of storage together with distributed generation for voltage control, power flow modulation, balancing, etc.;
- ✓ Centralised vs decentralised (e.g. agent-based) control architectures;
- ✓ Aggregation of controllable DERs into technical VPP (e.g. Cell-Controller Project, TWENTIES; EU-DEEP) and into micro-grid configurations.

Project results show that technical solutions for the integration of DERs are becoming quite consolidated. One area where technical progress might still be required is the flexibility of inverters to allow a cost-effective provision of system services by renewable energy systems.

However, project results also show clearly that the integration of DERs requires much more than just technical solutions. Significant progress is required in the following areas:

- ✓ Regulatory framework to create a market for the provision of DER-based ancillary services (e.g. clear definition of roles and responsibilities, incentives for DSOs to run technical VPPs);
- ✓ Coordination of physical and market requirements (i.e. between physical and market platforms), e.g. technical validation of commercial transactions (see section on 'Aggregation');
- ✓ Standardisation of control and communication technology to avoid costly customised configurations.

Finally, it should be noted that our catalogue includes only projects focusing on the integration of storage in the grid, not those focusing on the development of storage technology. Particularly relevant is the use of storage in VPP (see section on 'Aggregation'). Projects in this area use storage (pump storage, batteries, flywheels) for short-term load balancing; however, other projects see scope for long-term balancing storage and investigating other storage options (e.g. hydrogen).

2.8.4 Aggregation (virtual power plant, demand response)

In this category, projects focus on the implementation of aggregation mechanisms like virtual power plants and demand response[19] to aggregate the supply and demand flexibilities of decentralised resources taking account of grid constraints and market signals.

The data confirm the intensive efforts made in the last five years to demonstrate demand response and VPP applications. Before 2007, there were a few projects with minor/limited budgets mostly aimed at testing the application in laboratory conditions. After 2007, there was a general and rapid increase in the budgets allocated to aggregation applications.

ICT companies are increasingly involved in aggregation projects, with established players like IBM active in some of the major demonstrators in this area.

As regards **technical VPPs**, in a first phase (up to 2008-09), projects focused mainly on technical feasibility (coordination of distributed resources taking into account grid variables and constraints — voltage, reactive power, etc.).

The projects surveyed confirm the technical feasibility of aggregation mechanisms (e.g. Web2Energy, REFLEXE, Virtual PowerPlant, EU-DEEP, FENIX), with technical solutions applied on an increasingly wide scale (e.g. CELL-controller project in Denmark). An interesting technical development is the growing number of projects using agent-based technologies. The technical challenges include scalability (coordination of thousands of distributed resources) and standardisation. A widespread smart metering infrastructure is also a key enabler for integrating distributed users.

Building on the results of projects focusing on technical VPPs, key interesting demonstration projects (e.g. EcoGridEU, PowerMatchingCity, E-Energy projects) have been testing complex coordination mechanisms among distributed users, taking into account grid constraints and market signals and considering flexibilities of supply and demand. Challenges in this area are:

- ✓ Analysing the market potential of aggregation schemes, the viability of business models and consumer involvement through market signals;
- ✓ Simple contract formulae and financial predictability (e.g. fixed monthly rate for flexibility) might encourage small-scale DERs and users to participate;

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[19] A virtual power plant is a link-up of small, distributed power stations, like wind farms, CHP units, photovoltaic systems, small hydropower plants and biogas units, but also of loads that can be switched off, in order to form an integrated network. The plants are controlled from one central control room. Demand response is a mechanism to adapt electricity demand to grid conditions or in response to market prices. In many projects, the notion of VPP is used extensively, encompassing coordination both of DERs (supply side) and demand response..

- ✓ Control and communication solutions must be standardised to avoid costly customised configurations (which particularly hinder the participation of small-scale units);
- ✓ Clear regulatory requirements are needed for units participating in VPPs;
- ✓ Since regulation and market rules play a key role, transferring project results from one country to another might not be straightforward.

More recently, a key focus of VPP projects has been estimating the benefits of maximising the flexibility of a portfolio of distributed energy resources (demand flexibility, storage, distributed generation) at industrial, commercial and household level. A common theme in these projects is therefore assessing the viability of aggregators' business models.

One success story is a RWE-led VPP project which tested trial operations with hydro power plants, combined heat and power units, and emergency power systems in 2008-10 and since 2012 has been able to trade electricity on the Energy Exchange (EEX) in Leipzig.

In this context, projects under the German E-Energy programme are also particularly interesting. For example, the EDEMA project involves aggregating flexibility of supply (14 micro-CHPs) and demand (1 500 households) based on market signals. The eTelligence project integrates two cold-storage warehouses, a windpark, a thermal power station and a swimming pool (acting as shiftable load) in a common marketplace. The projects show the feasibility of the concept with all participants exposed to marketing and price risks.

Projects in this programme have shown that:

- ICT control of flexible generation plants (controllable inverters, current regulated use of cogeneration stations) and localised purchase of reactive power can support grid stabilisation;
- The integration of decentralised, small producers will be feasible in the future with ICT without endangering grid stability and with less extensive grid expansion;
- There will be at least one new market function on the energy marketplace — flexibility operators will ensure market access for small suppliers and bundle their energy outputs and flexibilities into marketable units for grid operation or electricity trading.

In projects focusing on demand response, one important topic for analysis is consumer involvement. Trials at household level are still testing the small-scale aggregation of demand response, typically involving a few hundred consumers (up to 2 000 or 3 000 in some cases). For example, the EcoGrid EU project involves over 2 000 residential consumers in flexible demand response to real-time price signals by means of residential demand-response devices/appliances using gateways and 'smart' controllers.

At industrial level, demand response is a much more consolidated application and the challenges pertain to issues of scale or industry-specific requirements.

For example, the *EnRpool* project in France aggregates and measures several hundreds of MW of renewable energy output from wind and solar sources and operates systems that accordingly modulate the consumption of several large electro-intensive industrial sites. In the *Flexlast* project in Switzerland, a supermarket chain's industrial freezer warehouses are used as a buffer to help balance energy fluctuations stemming from sun and wind availability. The challenge is to minimise energy costs while taking account of warehouse logistics (goods moving in and out) and frozen storage requirements.

2.8.5 Smart Customers and Smart Home

In this category, we have included projects that test smart appliances and home automation together with new tariff schemes. Such projects typically require the active participation of consumers or aim at analysing consumer behaviour and fostering consumer involvement. Key lessons learned in this area are:

- ✓ Several projects are testing dynamic rates with promising results (e.g. shifting of 6-8% of loads in the Model City Mannheim project). Monetary incentives and education lead to observable behavioural change (with 5-10% energy savings potential) but long-term sustainable change can be achieved only with automated systems;
- ✓ Dynamic rates (based on variables such as exchange price, forecasts, residual load, grid condition) are the best way of adapting demand to grid conditions. However, fixed grid charges prevent their full potential from being realised. Regulations need to be updated in line with the new opportunities for flexible system charges offered by the detailed grid information provided by smart grid technology;
- ✓ In the great majority of projects, energy management systems are seen as a necessary complement of dynamic tariffs. These include sophisticated algorithms for the scheduling and optimisation of smart appliances in households (e.g. Beywatch, ADDRESS, Model City Mannheim);
- ✓ Agent-based technology is widely used and shows promising results in terms of scalability (e.g. Beywatch project);
- ✓ There are as yet no widely accepted standardised solutions: it is still not clear which means of communication and which protocols will have market dominance. This means that costly ad-hoc configurations are required. Also, the full remote control functionality of appliances is still constrained by white-goods manufacturers (e.g. interrupting a cycle

might compromise quality); new smart-appliance capabilities like self-tuning and self-healing would also help;

- ✓ Consumer resistance is still an important factor in the development of smart home applications. Consumers are afraid of losing control of devices in their own household and are sceptical about new rates and applications;
- ✓ Trusted third parties (e.g. independent institutes, consumers' association) can play a key role in raising consumers' awareness and willingness to take advantage of the new opportunities.

A more detailed analysis of how projects are addressing consumer involvement is provided in Chapter 5.

2.8.6 Electric vehicles and vehicle2grid applications

Projects in this category focus on the smart integration of electric vehicles (EVs) and Plug-in Hybrid Vehicles (PHEV) in the electricity network. In this area of research, projects ultimately aim at answering questions such as the following: How could EVs be smartly coordinated with the production of local DERs to reduce the peak load on the power grid? How can we achieve maximum benefit from the charging and discharging of EVs in future electricity networks? Is the smart integration of EVs feasible in technical and economic terms?

10 % of the projects in the catalogue (28 projects) have the integration of EVs in the electricity grid as the main project objective. These projects have a total budget of around € 190 million and involve a few thousand EVs and charging stations. The great majority of EV projects are small- to medium-scale with budgets of less than € 10 million. The growing interest in this area is reflected in the fact that over 60 % of the projects have started since 2010.

EVs are also included as part of 15 wider smart grid project (e.g. Smart City Malaga, Low Carbon London). Projects focusing solely on the installation of charging stations without any reference to EV integration into the grid have not been considered for this report.
The projects surveyed indicate that efforts in this area are promising but still at an early stage.

An indication of the state of play in this field can be gleaned from the objectives of the GreenEmotion project, which is the most ambitious effort at European level to support electro-mobility and the largest demonstrator on EVs in our catalogue. It includes seven pilot regions in various European countries and presently encompasses 2 000 EVs and 2 500 smart charging stations. This will increase to around 70 000 EVs and more than 80 000 charging posts in 2015. The project also uses the existing EV infrastructure (car fleet and charging station system) of smaller-scale national EV projects.

The main focus of Green eMotion is on the (Europe-wide) interoperability of the electro-mobility system and optimising the charging infrastructure in terms of type, number, location, user acceptance and grid enhancement costs.

This objective is shared by most of the other EV projects in the catalogue. In other words, an analysis of the projects in the catalogue suggests that the main concern currently is to ensure that the EV charging and communication infrastructures work before venturing into more sophisticated applications like vehicle to grid (V2G) services. Project efforts concentrate on the following areas:

- ✓ Standards and interoperability;
- ✓ IT architecture, certified metering functionalities, customer billing management (including roaming);
- ✓ Analysis of user needs; charging times and patterns; loads on the network;
- ✓ Recommendations on optimal charging infrastructure in terms of type, number, location, user acceptance and grid enhancement costs.

Currently, there are no demonstrators testing the use of electric vehicles for the provision of system services, dynamically adapting the charging/discharging cycle in response to price signals. At present, the typical chargers available on the market do not support V2G functionalities (EDISON project).

2.9 How do projects fit into the European Electricity Grid Initiative?

The European Electricity Grid Initiative (EEGI) proposes a nine-year European research, development and demonstration programme to develop a smart grid for Europe by 2030 [EEGI, 2010]. A revised roadmap has just been published [EEGI, 2012], but it has not been possible to take it into account in this study.

The EEGI establishes a smart grid model identifying the critical building blocks of the smart grid system. The system is divided into five different levels, each of which is then sub-divided into nine clusters (e.g. Smart customers, Smart Energy Management, Pan-European Grid architecture) which in turn are broken down into functional project areas (e.g. active demand response, tools for pan-European network observability). Overall, the EEGI smart grid model consists of 14 functional project areas at the transmission level, 12 functional project areas at the distribution level and five functional project areas at the interface of transmission and distribution.

The nature of EEGI projects is two-fold: support projects (with budgets of €2 m to €15 m) and core projects (budgets over €15m). In the analysis that follows, we have considered all such projects with budgets of over €2m (around 50 % of the projects in the catalogue), split them into core/support projects and mapped them into the different clusters and functional areas.[20]

Table 2 shows the number and budget of projects that might qualify for EEGI labelling as 'core projects' (budgets over €15m) and 'support projects' (budgets of €2m to €15m).

Projects that might qualify as 'core projects' represent 14 % of all projects and 66 % of the total budget in the JRC catalogue. Those that might qualify as 'support projects' represent 35 % of all projects and 29 % of the total budget in the catalogue.

The EEGI roadmap estimates that investments of € 1.8 billion are needed in the period 2010-18, assuming a coordination of projects in the different areas of the roadmap. If we restrict the analysis to projects that started in the period 2010-12 (the EEGI roadmap starts in 2010), the overall budget of projects that might be eligible for EEGI labelling amounts to around € 1 billion. However these data are difficult to compare directly. Our analysis includes projects which have not been designed for the EEGI, are independent and not coordinated; it is quite possible that they overlap.

However, the purpose of this analysis is to give a qualitative indication of how the projects fit in with the EEGI roadmap. This could usefully be fed in to the on-going analysis (outside the scope of this report) of progress on the EEGI roadmap [Gridplus 2012].

	'Core' projects BUDGET≥€15 m	**'Support' projects** €2 m≤BUDGET<€15 m
Number	40	100
Corresponding budget (€ m)	≈1 200	≈530

Table 2 – Number and associated budget of projects that might qualify for labelling as EEGI core and support projects

We therefore mapped each project in our catalogue that might qualify for EEGI labelling (budget greater than €2 m) into the most relevant clusters/functional areas of the EEGI roadmap. We then split the project budget equally among the corresponding functional areas. The resulting graphs in Figures 35 and 36 show the cumulative budget across the different clusters and the different functional areas.

Figure 35 shows that the 'smart customers', 'smart integration' and 'smart distribution network' clusters are those most targeted by the projects in the catalogue.[21]

[20] The EEGI labelling process is still ongoing and the projects in the JRC catalogue are not EEGI-labelled projects. The mapping exercise in Figures 35 and 36 is intended only to show how the projects surveyed fit in with the EEGI roadmap and which functional areas they target.

[21] The limited budget for the smart metering cluster is due to the fact that this analysis covers only projects in the smart grid database. As mentioned in Chapter 1, the only smart metering installations in the database are those which are part of a wider smart grid installation.

In the smart customers cluster, main targeted functionalities relate to the implementation of demand response applications and use of smart appliances and in-home displays to achieve energy savings. The smart integration cluster includes projects aimed at hosting distributed energy resources (including storage and EVs) in LV and MV networks. This cluster is conceptually similar to the integration of DERs, as discussed in Section 2.7.

The smart distribution network cluster includes projects aimed at increasing observability (e.g. grid monitoring sensors, fault identification) and controllability (e.g. automation and control systems in feeders and substations). This cluster is conceptually similar to smart network management, as discussed in Section 2.8.

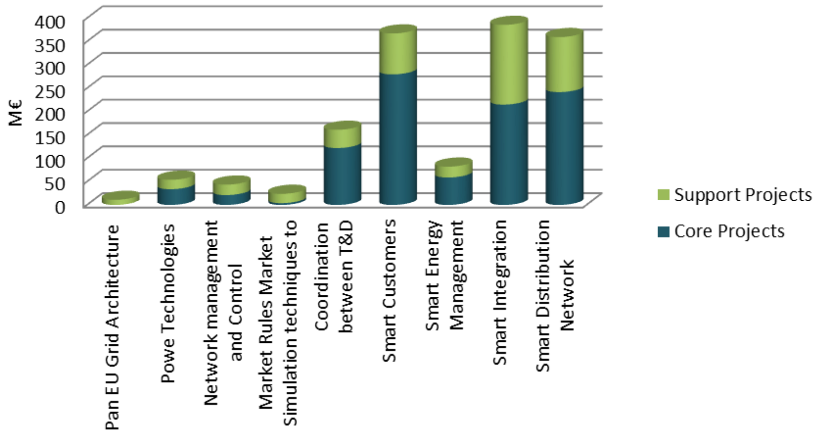

Figure 35 — Cumulative budget in EEGI functional areas for core (budget≥€15m) and support (€2m≤ budget<€15m) projects

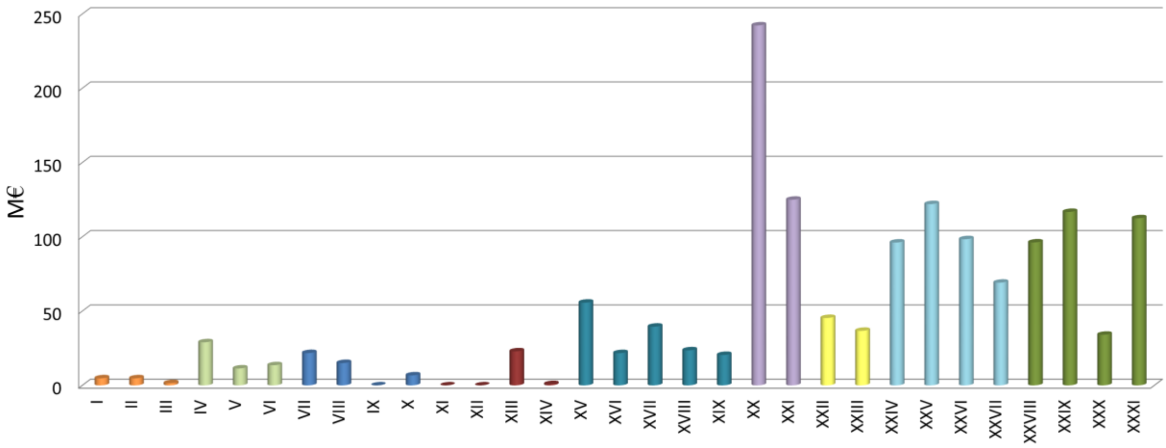

Figure 36 – Trend in the number of projects focusing on the integration of distributed energy resources, demand response and large-scale renewable energy sources[22]

[22] I)A toolbox for network architecture assessment for the pan EU transmission system
II) Tools to analyse pan EU transmission systems expansion
III) Methodology for public acceptance
IV) Demonstration of power technologies for more network flexibility
V) Demonstration of power technologies for power architecture
VI) Demonstration of renewable integration

Figure 37 shows the share of the budget allocated to the functional areas at transmission and distribution level and at the interface between transmission and distribution.

80 % of the budget is allocated to functional areas at distribution level. 70 % of the projects in the transmission clusters are 'support projects'.

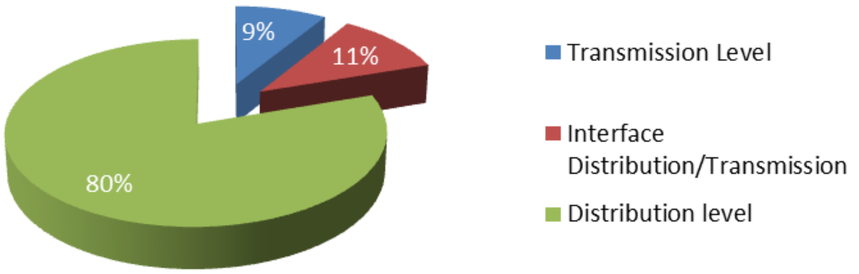

Figure 37 – EEGI transmission, distribution and T&D interface clusters: share of project budget (projects with budgets over €2 m)

VII) Tools for pan EU network observability
VIII) Innovative tools for coordinated operation
IX) Improved training tools for improved coordination
X) Innovative tools for pan EU network reliability assessment
XI) Tools for pan EU balancing markets
XII) Advanced tools for congestion management
XIII) Tools for renewable market integration
XIV) Tools to study market integration of active demand
XV) Tools for improved system observability and network interactions
XVI) Integration of DSM in TSO operation
XVII) Ancillary services by DSOs
XVIII) Improved defence and restoration plans Joint task force on IT system protocol and standards
XIX) Active demand response
XX) Energy efficiency from integration with Smart Homes
XXI) Smart metering infrastructure
XXII) Smart metering data processing
XXIII) DER hosting capacity of low voltage networks
XXIV) DER hosting capacity of MV networks
XXV) Integration of storage
XXVI) Integration of EV and PHEV in distribution networks
XXVII) Infrastructure to host electric vehicles
XXVIII) Monitoring and control of low voltage networks
XXIX) Automation and control of medium voltage networks
XXX) Integration of Methods and system support
XXXI) Integrated communication solutions in distribution networks

3 A CLOSER LOOK AT THE SMART GRID PROJECTS IN THE CATALOGUE

Chapter 2 presented a 'macro' perspective of all the smart grid projects in our catalogue, providing information at aggregated level about investments, countries, organisations and progress in different areas.

In this chapter, we take a 'micro' perspective and provide details of some of the projects in the light of the analysis already carried out last year [EC JRC 2011]. First of all, we will analyse the key findings and lessons learned from the main projects that ended in 2011 and 2012. Then we will present the areas of focus of the projects that started in 2012 to give an indication of where the attentions of the smart grid community are currently directed.

3.1 — Project results 2011-12

In this section, we provide an overview of the results of some important projects that ended in 2011 and 2012.

MODEL CITY MANNHEIM (DE, 2008-12)

In the Model City Mannheim project, 200 households were equipped with smart appliances. A home energy controller (energy butler) was put in charge of making the most effective use of appliances with variable usage times, such as washing machines and deep freezers, in response to price signals.

Key findings

- ✓ Load shifts of 6-8 % in low-tariff periods;
- ✓ Load management potential of 0.1 kW per household;
- ✓ 80 % of participating customers said that they would not pay for the provision and display of electricity consumption data;
- ✓ For about 30 minutes, almost 20 % of installed capacity can be used as positive balancing power through switch-off or delayed switch-on.

eTELLIGENCE (DE, 2009-12)

The project explored and demonstrated various approaches to using modern ICT and advanced operation to improve the current energy supply system and provide flexibility of demand according to the fluctuations of RES generation. The system included:

- ✓ 650 households with in-home displays for real-time electricity monitoring and smart meters;

- ✓ An incorporation of dynamic rates or other approaches for giving retail customers (residential, commercial and industrial) access to wholesale conditions (automatic market participation and access);
- ✓ An integration of demand response: several cold stores and wastewater treatment facility;
- ✓ An integration of DERs by means of VPPs bundling resources and balancing fluctuating generation by incorporating consumers with shiftable loads. The VPP includes renewable sources (wind, solar and biogas), CHP and fuel cells, electric vehicle charging.

Key findings

- ✓ 13 % monthly reduction of energy consumption for participating consumers;
- ✓ 12 % monthly reduction of consumption in the expensive period for participating consumers;
- ✓ eTelligence demonstrated that thermal energy systems, in particular, such as cold-storage depots and block-type thermal power stations, can be used very effectively as energy storage facilities, achieving savings of up to 8 % of their normal electricity costs;
- ✓ Telecommunication expertise is necessary.

ENERGY DEMAND PROJECT (UK, 2007-11)

The *Energy Demand* project explored the responses of around 60 000 different households to different visual displays of energy consumption (smart meters and in-home displays). The trials began in 2007 and finished towards the end of 2010.

Key findings

- ✓ A large-scale trial (18 000 households with smart meters) showed savings from smart meters with in-home displays were generally around 3 %, with savings of up to 11 %;
- ✓ The savings were found to be generally durable, rather than short-term;
- ✓ Savings are not guaranteed simply by implementing a particular type of measure – the impact depends on **how** it is implemented.

GROW-DERS (EU, 2009-11)

The GROW-DERS project (Grid Reliability and Operability with Distributed Generation using Flexible Storage) investigates the implementation of (transportable) distributed storage systems in the networks.

Key findings

- ✓ In the current market, the application of storage systems is technically very attractive, but economically not yet viable;
- ✓ Uncertainty in legislation is a barrier to the development of grid-connected storage applications;
- ✓ Industrial players need to invest in early demonstration projects to be involved in this market in the longer term;
- ✓ A new commercial software for the techno-economic assessment of grid-connected storage systems was developed.

WEB2ENERGY (EU, 2010-12)

The Web2Energy project is composed of three pillars:

1. Smart metering — the consumer participates in the energy market: 200 households were provided with smart meters and access to a customer portal;
2. Smart energy management – clustering of small power producers;
3. Smart distribution automation — higher reliability of supply; regulating power by an industrial VPP;

Linking the users: All three pillars of smart distribution required an exchange of information between the users of the network (consumers, producers, terminals, network operator's control centre, traders and VPP).

The project included three day-ahead tariff zones (green, red and yellow) produced by the VPP on the basis of spot-market electricity price forecasts and wind and sunshine intensity. Higher demand (as compared with a reference profile) is ensured during green periods and lower demand during red periods.

Key findings

- ✓ During the first three months of data collection, observed energy savings represented on average 3 % of the households' daily consumption;
- ✓ The daily load peak was reduced by approx. 15 % by shifting heavy demand from red to green phases. Some families follow, and respond to, the red and green phases on a daily basis.

CELL-CONTROLLER PROJECT (DK, 2004-11)

The Cell Controller project established a control system capable of coordinating distributed energy resources (DER) in order to support DER-based ancillary services and safely island the study region, maintain autonomous operation and resynchronise with the main network.

The project implemented a distributable control architecture capable of rapidly islanding a distribution network below a 150/60 kV substation upon receiving a one-second trigger signal from the transmission system operator. The distribution network is divided into cells that can be islanded and controlled autonomously.

The system included:

- ✓ one 150/60 kV substation with tap changer controlled transformer;
- ✓ 13 substations (60/10 kV);
- ✓ five CHP plants;
- ✓ 47 wind turbines, 69 load feeders, and numerous additional assets (breakers, SLC, SC, etc.)

Key findings

- ✓ While islanded, the system would maintain the stability of the cell until the cell was required to re-join the main grid, at which time the system would resynchronise with the grid, re-connect and return to normal operation;
- ✓ The project demonstrated that it was possible simultaneously to provide various stakeholders with multiple services, such as active power services, active and reactive power balancing operations, and voltage control services, when the cell was running parallel with the high-voltage transmission system in its normal operation state. This is key to being able to offer the market-driven integration of DERs.

The project also provided a successful technical demonstration of:

- ✓ Active distributed control of a large power system via existing communications infrastructure;
- ✓ AGC-like controls achieved through low-cost software upgrades to existing, not island-capable machines;
- ✓ Reliable state estimation in a distribution grid with high DG penetration; able to monitor voltage/loading on portions of the network where no direct telemetry is available;
- ✓ Controls-in-the-loop testing: distributed controls running on deployable hardware tested for runs against transient power system simulation in lieu of field power system;
- ✓ Topology data analysis in real time;
- ✓ Perform frequency control of islanded power system with fast-switching load bank (SLC) in the presence of high DG transients.

PREMIO (FR, 2008-12)

The PREMIO project includes a VPP which integrates approximately fifty distributed resources (distributed generation, storage technologies and customers' curtailable loads). Ten resource types were being investigated, such as small generating plants using renewable energy (solar or biogas), systems for controlling heating, heat pumps and public lighting, and/or electricity or heat storage solutions.

Key findings

- ✓ Significant load reductions (up to 40 %) were observed during the project;
- ✓ The analysis of aggregated results showed that differences between the types of distributed resources must be taken into account if the results are to be used as leverage to enhance performance: (a) Control unit optimisation and distribution processes are validated and every DR responds to load reduction requests during the period of alert; (b) Load variations within a couple of hours demonstrate the capacity to provide high flexibility in the load curve based on multiple DRs;
- ✓ Control improvements are needed for more sensitive demand response;
- ✓ The maturity of distributed resources technologies does not by itself guarantee the success of the VPP. ICT is crucial.

HYBRID ENERGY PROJECT OF IKARIA (EL, 2007-12)

An integrated renewable energy network was built on Ikaria Island (Greece), allowing renewables to form the backbone of the public power supply. The island has a population of 8 000 in the winter and 20 000 in the summer. Currently, 94 % of the power supply is covered by diesel (6 050 kW installed capacity) and 6 % by wind power (385 kW). The project represents the first phase of a programme to reverse this ratio so that 90 % will come from renewables and only 10 % from diesel. After the first phase, it is expected that electricity from renewables will cover nearly 50 % of demand.

Key findings

- ✓ Successful installation of smart grid master control system for the integration of diesel generator, wind power generator and hydroelectric plant. The 'smart' system (intelligent power dispatcher) is a technical VPP that regulates energy availability, frequency, voltage regulation, fuel economy, emission reduction and noise reduction;
- ✓ The project could be a pilot for the implementation of hybrid systems (power generation that includes the innovative combination of wind power and hydroelectric power) on other islands with similar energy supply problems.

PEGASE (EU, 2008-12)

The PEGASE project was aimed at removing algorithmic obstacles to the monitoring, simulation and optimisation of very large power systems.

Key findings

- ✓ The project produced powerful algorithms and full-scale prototypes validated on the European Transmission Network to enhance cooperation among transmission system operators for the real-time control and operational planning of the system;
- ✓ The lack of adequate tools for state estimation, dynamic simulation and optimisations no longer appears to be a technical barrier to progress towards a more integrated pan-European power system.

REGMODHARZ (DE, 2008-12)

The goal of the Regenerative Model Region Harz project is the technical and economic development and integration of distributed energy sources by deploying modern information and communication technology. Grid operators, energy suppliers, municipal utilities, wind farm operators, universities, research institutes and ICT companies develop tools, infrastructures and strategies to supply a complete district with electricity solely from renewable energy. Different renewable energy producers, controllable consumers and energy storage devices were connected by a variety of means, such as electronic market places and distributed control mechanisms, to a large virtual power plant (VPP).

Key findings

- ✓ Energy storage requirements can be reduced through short-term wind forecasts;
- ✓ Load shifts on the consumer side help to improve voltage regulation in the distribution grid and compensate for forecast errors;
- ✓ In bundling and marketing the decentralised generated electricity, the new pool coordinator will play a central role on the new markets.

EDISON (DK, 2009-11)

One of the main goals of the EDISON project was to develop technologies to improve the charging of electric vehicles in line with the needs of the power system.

Key findings

- ✓ Further attention needs to be given to technical barriers to the use of EVs to provide grid services (e.g. connected converters and inverters will emit harmonic distortion into the power system; switching on and off charging can lead to fast voltage changes causing flicker problems);

- ✓ It is not likely to see V2G functionalities in EVs on the market for some years yet. Chargers currently on the market do not have V2G functionalities.

3.2 What projects started in 2012?

As shown in Chapter 2, around 30 smart grid projects started in 2012 with a total investment of around €300 million. The topics they address provide an indication of the state of play in smart grid demonstrations, the areas that attract most interest and the challenges that remain.

In the following, we provide a short overview of the key themes addressed by some of the main projects that started in 2012. The main projects focus on the system level rather than on individual components or applications. They are mostly designed to test an integrated system which coordinates input from different resources: flexible demand, storage and fluctuating RES generation. They are also large or very large in size, which is a positive sign in terms of maturity and scalability.

Two areas of interest seem particularly to stand out: demand response and consumer involvement and the use of decentralised storage in VPP.

Lastly, there are a few other projects which focus more on the grid side, in particular on the development of innovative network technology and tools.

DEMAND REPONSE AND CONSUMER INVOLVEMENT

Demand response and consumer involvement are key themes in projects starting in 2012. The projects aim through market mechanisms (using demand response, dynamic tariffs and home energy management controllers) to make consumers participate actively in grid operations. The number of consumers involved (up to 1 000) is in line with trials in previous years, so there is no increase in the size of the trials in terms of consumer participation.

In the *Greenlys* project (FR), building on the LINKY smart metering infrastructure, 1 000 residential customers and 40 commercial sites (offices, shops, etc.) are testing flexible demand options. In the *MILLENER* project, around 1 000 customers are provided with an energy controller that can manage the use of PV and storage equipment and optimise home energy management.

Customers participate through voluntary recruitment. It still appears to be difficult to come up with a statistically unbiased selection of consumers according to different customer segments.

The *INCAP* project addresses how consumers can be encouraged to adopt varying tariffs and automatic response technology for common household appliances at costs that make this widely attractive. The project involves a large-scale field experiment using an automatic response application for a common appliance (e.g. refrigerators). It claims to use a novel approach allowing estimation of the distribution of adoption barriers across a large representative sample of power consumers and gauging consumer acceptance. No additional information is available at this stage.

Demand response applications for large load customers is at a more mature stage.

The *New Thames Valley Vision* project is implementing automated demand response system in 30 commercial and residential buildings (over 200 KW) which sheds loads during peaks. Results from a previous pilot show reduction potential of around 10-20 %. Another part of the project is to understand how domestic and commercial customers (1 000 domestic customers and 100 small commercial customers involved) will use electricity in the future, so industry can forecast demand more accurately.

Another interesting concept is the one developed in the *Capacity to Customers C2C* project. Large load customers (residential customers are not included) are rewarded if they accept flexible requirements with respect to outage restoration. In other words, if the customers accepts having less critical loads (e.g. air conditioning) restored later after an outage, they have economic benefits. This reduces the need for emergency capacity following an outage and saves capacity for normal operations. As a result, some reinforcement investments can be deferred despite growing demand.

STORAGE INTEGRATION

Storage integration to enhance grid flexibility is an important element of some of the main projects starting in 2012.

The *MILLENER* project will install (in three sites: Corsica, Guadeloupe and Réunion) 500 storage systems (total 3 MWh of energy) at customers' premises together with PV and energy load controllers. Energy load controllers, connected through a communication link with the system operator, will then be used to optimise storage and PV generation according to demand and grid conditions. Control of local storage is to ensure the real-time balance between electricity demand and production at consumers' premises.

The use of storage together with demand response in order to ensure demand flexibility and peak shaving is also a key element of the *New Thames Valley Vision* and *Smart Grid Hyllie* projects.

The aim of the *INGRID* project is to use storage to provide grid balancing services. The project combines electrolysis, hydrogen storage and smart grid monitoring and control to balance power supply and demand in a scenario of high penetration of renewables. A 39 MWh energy storage facility will combine a 1.2 MW hydrogenics electrolyser with hydrogen storage capacity of up to 1 tonne using solid state technology. Several potential value streams are being considered for the carbon-neutral hydrogen that will be generated at the facility.

The *VENTEEA* project will also study the use of storage to provide ancillary services to distribution networks (MV, 20 kV in France), in rural areas with strong wind power generation (800 MW wind capacity). The project will explore how the installation of storage close to decentralised production resources can offer ancillary services to the grid (grid stabilisation, voltage control, controllability of wind farm output).

INNOVATIVE NETWORK TECHNOLOGY AND TOOLS

ITESLA

The purpose of the *iTESLA* project is to develop a common toolbox, allowing TSOs to increase coordination and harmonise operating procedures. The toolbox will support the future operation of the pan-European electricity transmission network and introduce a major innovation: the carrying-out of operational dynamic simulations in the context of a full probabilistic approach, thus going beyond the current 'N-1' approach and optimising the transit capacities of the grid over different areas (national, regional, pan-European) and timescales (two-days ahead, day-ahead, intra-day, real-time).

Flexible networks for a Low Carbon Future

The *Flexible Networks for a Low Carbon Future* project in the UK will trial targeted energy efficiency and demand reduction measures for industrial and commercial customers in cooperation with the buildings research establishment, energy supply companies and an independent party. This will focus on the use of technology such as voltage optimisation, power factor correction and low energy appliances that do not directly require customer behaviour change. Innovative network technology to be deployed will include dynamic rating of network assets to create additional headroom where possible, flexible network control to help re-balance network loading using neighbouring network groups to support demand, and the integration of voltage regulation and power compensation equipment to release voltage constrained capacity, and to assist with re-balancing the network.

The objective is to increase of network capacity by 20 %.

3.3 Obstacles and remaining challenges

There is great value in understanding and sharing what has not worked in smart grid projects. An analysis of the obstacles encountered in a project can serve to highlight where more efforts are needed and inform the design of upcoming new projects.

In our questionnaire, a specific section devoted to collecting information about obstacles and challenges was left unanswered by many respondents. The limited number of responses in this section (10 % of respondents) indicates that project coordinators are reluctant to share problems encountered in their project.

The most common technical obstacle reported was the lack of interoperability between different smart grid elements, e.g. the incompatibility of the different IT protocols and components (BeMobility 2.0), the lack of communication standards for EVs (Context Aware Electric Vehicle Charging Based on Real Time Energy Prices), the completely different communication standards of smart grid devices (PREMIO) or the lack of standards in the interoperation of home gateways with smart grid applications (Encourage).

Another technical obstacle is the technological immaturity of certain smart grid components. For example, this was one of the obstacles encountered in the *Inovgrid* project. Some of the technical components of the *Inovgrid* architecture were expressly developed by some local manufacturers.

Regulatory barriers loom large across many projects, particularly the uncertainty among players over roles and responsibilities in new smart grid applications (e.g. in the ancillary service markets for promoting user participation in the network regulation) and the uncertainty over the sharing of costs and benefits among different stakeholders in new smart grid applications (e.g. active demand market), which creates uncertainty over new business models and might be hindering investments. In many instances, this might be the most significant obstacle to the large-scale implementation of the applications tested in the smart grid projects surveyed.

Finally, a number of project coordinators report that another major obstacle to project implementation was the difficulty of approaching and recruiting consumers willing to participate in the trials. These were all projects in demonstration phase actively involved in trials mainly connected to the demand response application. This was the case, for example, for projects like *Address*, *EDRP* and *Isernia*. It is no coincidence that studying effective ways of involving consumers is one of the key concerns in the smart grid community (see Chapter 5).

4 SMART METERING

Directive 2009/72/EC requires Member States to proceed with the roll-out of at least 80 % of smart meters in their territory by 2020, if the CBA is positive [EC 2012, EU 2009]. The Directive has been a great stimulus to the deployment of smart metering systems.

Our smart metering project database includes around 90 projects dealing with smart metering. In most cases, smart metering installations are led by DSOs/utilities, except for those in the UK (led by energy retailers) and Bulgaria (led by a telecom company). The size of the pilots varies widely from a few hundred to a few tens of thousands of meters. In a growing number of projects, smart metering installations are part of a wider smart grid project, typically in combination with new automation and control systems on the grid side or with demand response and energy management applications in the smart home (e.g. *Smart City Malaga*, *Grid4EU*, *Inovgrid*, *Low Carbon London*, *Price*).

Despite the high number of smart metering projects that have been surveyed and included in our smart metering database, we cannot reliably ensure an accurate and comprehensive mapping of all smart metering initiatives. The number of such initiatives that have been conducted in Member States is considerable. Often several local utilities have been involved in the implementation of a number small projects. For example, the roll-out in Sweden consisted of some 150 different smart metering projects.

More accurate information is available at aggregated national level, however. Therefore, in the following we will discuss smart metering developments in Member States at national aggregated level and will use information from individual smart metering projects only to support the analysis with concrete field information.

4.1 Smart metering progress across Europe

Significant investments have already been mobilised and a few countries have already proceeded to full smart metering roll-out. A conservative estimate is that at least € 5 billion have been spent to date on smart metering pilots and roll-outs.

In the years 2001-08, Italy installed around 36 million smart meters for a total investment of € 2.1 billion.

In the years 2003-09, Sweden completed a full roll-out, installing 5.2 million smart meters for a total investment of around € 1.5 billion.

Malta and Finland will complete their smart metering roll-out by 2013. Finland is installing 5.1 million meters for a total investment in the range of € 600-900 million. Malta is about to complete the installation of around 250 thousand meters for a total investment of € 86.5 million.

Other countries have given the go-ahead for smart metering roll-outs. For example, France will install 35 million meters by 2017, the UK will install 29 million by 2019, Spain will install 28 million by 2018.

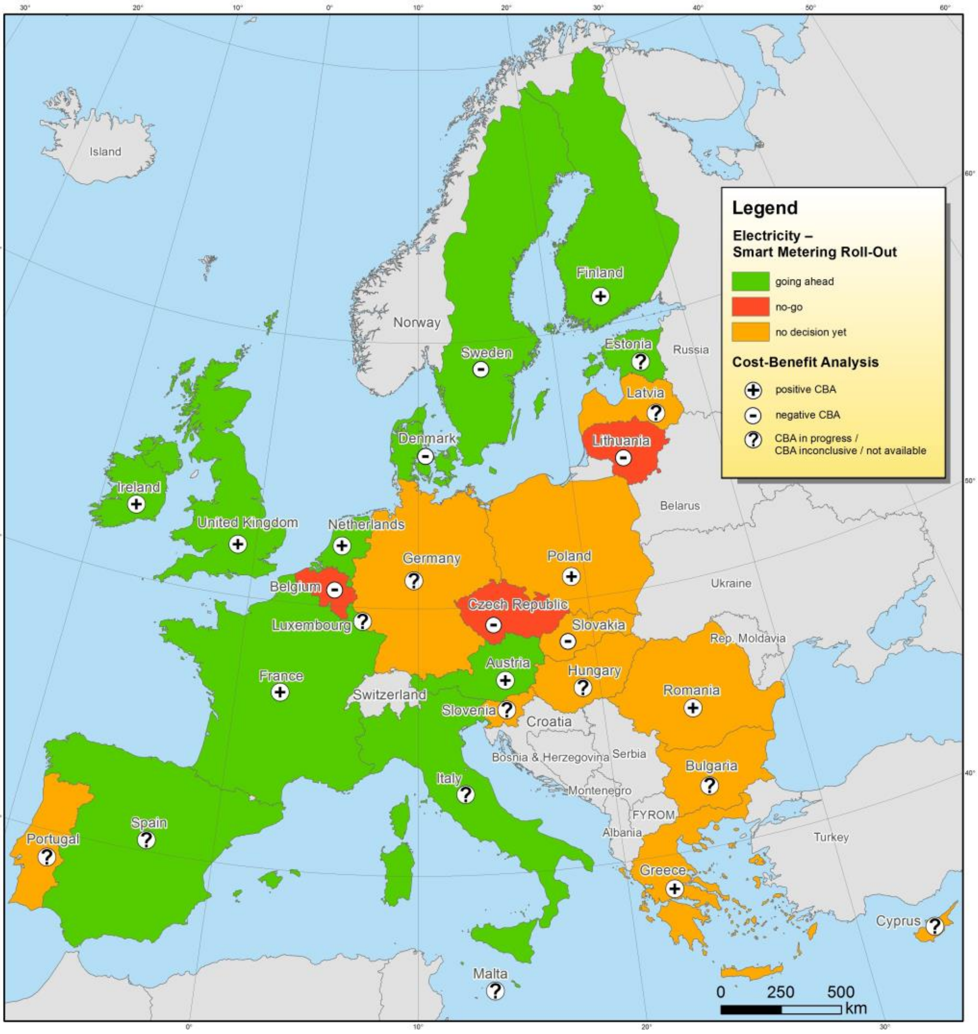

Figure 38 — Snapshot of CBA outcomes for electricity smart meters in Member States, based on data available in JANUARY 2013

Overall, according to currently available information (referring to January 2013), 13 Member States have decided to go ahead with a national roll-out or have already completed it (e.g. Italy and Sweden). Three countries (Belgium, Czech Republic and Lithuania) have decided not to proceed with a national roll-out based on a negative CBA, whereas the remaining 11 Member States have not yet reached an official decision (Figure 38). We stress that the map of figure 38 represents just a snapshot of smart metering CBAs in Europe based on information available at January 2013. Maps will be updated with latest information from Member States and will be provided in future publications by the JRC.

Considering the Member States which, at this date, have already committed themselves to, or shown strong interest in, a full smart metering roll-out, we can estimate that the total investment in smart metering will be at least €30 billion by 2020, for a total of at least 170-180 million smart meters installed. The level of investment and the number of installed meters is bound to grow as other Member States take official steps.

SMART METERING PROGRESS
Around 250 million smart meters in Europe as a potential number. Target (80 %) is 200 million smart meters by 2020 Based on present available information, we estimate **Investments of at least € 30 billion by 2020** **At least 170-180 million smart meters by 2020 –> 70 % of penetration**

Communication infrastructure

The projects surveyed highlight that three communication infrastructure options are typically available for smart metering: communication via the electricity grid (power line carrier), communication via telephone lines and the cable infrastructure (ADSL, TV distribution cable) and wireless communication (mobile telephony, Radio Frequency -RF).

The analysis of the projects surveyed shows clearly that the choice of a particular communication option depends strongly on the local conditions. However, according to available information, the most widespread communication option is the combined use of PLC for the smart meter-concentrator connection in the secondary substation and the use of GSM/GPRS for the concentrator-meter data management system connection.

Another element that emerges from the analysis of the projects surveyed is that, given the different choices in terms of communication infrastructure, functionalities of the smart meters and local conditions (e.g. urban vs rural installations, economies of scale), we expect that the cost per smart meter could vary widely across countries and regions. According to available data, the costs of the smart metering infrastructure range from less than € 100 to as much as around € 400 per metering point. Quite consistently across projects, smart meters are assumed to have an average lifetime of 15 years.

Multi-utility configuration

Our catalogue also includes pilots testing the installation of a multi-utility smart metering configuration, where metering for electricity, gas and water shared a common communication infrastructure. A multi-utility communication interface is required to collect the data from all the meters (see e.g. [KEMA 2012b]).

However, the available data indicate that the diffusion of multi-utility installation is lagging behind. Most of the projects concentrate on the installation of smart electricity meters only. There still appears to be uncertainty as to the profitability of a multi-utility configuration, particularly whether the additional costs of water and gas meters are compensated by additional benefits.

4.2 Smart metering and consumers

Based on an analysis of all projects in the catalogue involving smart metering, the main (expected) benefits for consumers from the installation of smart meters can be summarised as follows:

a) Energy savings: smart meters demonstrably help consumers reduce their consumption and save energy

The Smart Metering Customer Behaviour Trials in Ireland demonstrated that smart meters helped 82 % of participants to make some change in the way they use electricity.

Thanks to the British Gas and First Utility smart meters in the UK, 64 % of the consumers participating in the programme acknowledged improved energy efficiency.

In many Member States, energy savings are the main benefits resulting from smart metering. Typically, it is conservatively assumed that smart metering will bring energy savings in the order of 2-3 %.

The use of in-home displays can provide a useful complement to smart meters to provide further incentives for energy savings and peak load shifting. For example, in the UK, in-home displays are installed together with smart meters. Available data show that the installation of in-home displays is worthwhile in terms of energy savings if the device has a limited cost (in the order of few tens of euros€).

b) Enabling demand response: through the actual data retrieved from the meter and dynamic tariffs

Pilot studies have shown that the demand response and dynamic tariffs made possible by smart meters can in turn strengthen the business case of smart meters. A growing number of projects are testing the installation of smart meters together with in-home displays, home energy controllers and smart appliances to implement dynamic rates and demand response.

Smart meters mean that several new services can be offered in the marketplace.

First of all, they open the door to new time-variable, dynamic rates. The E-Energy projects in Germany, for example, have tested new energy rates, ranging from time-variable rates to dynamic rates and event rates (extremely high or low prices per kWh are charged in response to external events). The projects have shown that tariffs more reflective of grid and market conditions can bring a noticeable level of flexibility on the demand and on the supply side.

Automated, market-based negotiating systems with several decentralised participants work in real demonstrations. Marketing flexibilities in primary and secondary reserves are not yet possible but they can be offered for near real-time balancing energy and for providing ancillary services (voltage control, frequency control, reactive power compensation).

c) Innovative services for consumers: smart meters open the door to smart home solutions and innovative home automation services

Thanks to the innovative services enabled by smart meters (such as home energy management and demand response), smart appliances, micro-generation and EVs can become an economically attractive proposition for consumers, contributing to lower energy bills and increased comfort.

One point of concern is that most projects where smart metering is linked with consumer involvement are still limited in scope. In the JRC catalogue, smart metering pilots with direct consumer participation typically involve around 2 000 consumers or less. Also, consumers typically volunteer to participate in the project and are therefore not necessarily representative of the larger population when it comes to motivation and behavioural flexibility.

d) Consumer empowerment: smart meters will improve competition in retail markets

Smart meters can improve competition and support active consumer participation in retail markets by:

- ✓ facilitating the supplier switching process (e.g. in the AMR project (SE), lead time for exporting meter readings to suppliers was shortened from 30 days to five);
- ✓ enabling consumers to choose from different offers and different suppliers that better adapt to their consumption patterns;
- ✓ enabling consumers to receive more transparent and accurate billing (e.g. in the Storstad Smart Metering project, the period for settlement of balance power was reduced from 13 months to two. Over a two-year period, the number of calls for meter-reading and invoice-related issues dropped by 56 %).

SMART METERING BENEFITS FOR CONSUMERS
1) Energy savings: smart meters demonstrably help consumers reduce their consumption and save energy;
2) Enabling demand response: through the actual data retrieved from the meter and dynamic tariffs;
3) Innovative services for consumers: smart meters open the door to smart home solutions and innovative home automation services;
4) Consumer empowerment: smart meters will improve competition in retail markets.

5 CONSUMER INVOLVEMENT AND SOCIAL IMPLICATIONS IN SMART GRIDS

5.1 The role of the consumer

Thanks to the widespread use of information and communication technologies, the smart grid will enable two-way communication and power exchange between suppliers and consumers, transforming the traditionally passive end-users into active players.

At this early stage, it is important to understand and involve consumers in order for them to successfully assume their new role as active participants in the electric power system. As most services are produced and consumed at the same time, it is essential for energy providers to develop closeness to their consumers as new services are developed in order to ensure good performance. Consumers, their daily routines and the social context in which they operate, should be more central in the smart grid community, where the focus is still mainly on technological issues and economic incentives [Verbong et al, 2013]. Many recent studies have involved interviews and surveys to assess consumer's perceptions, understanding and willingness to pay for the development of smart grid technologies [Diaz-Rainey et al, 2008; Ngar-yin Mah et al., 2012; Krishnamurti et al, 2012]. These studies detect a positive attitude towards smart grid technologies, but also recognise the need to address erroneous beliefs and misconceptions that still exist about them and to strive for trust, transparency and feedback to gain consumer involvement and acceptance.

The role of involving consumers in sustainable consumption is clearly acknowledged by the EC Task Force for Smart Grids: 'the *engagement* and *education* of the consumer is a key task in the process as there will be fundamental changes to the energy retail market. To deliver the wider goals of energy efficiency and security of supply there will need to be a significant change in the nature of customers' energy consumption (…). A lack of *consumer confidence* or choice in the new systems will result in a failure to capture all of the potential benefits of Smart Meters and Smart Grids' [EC Smart Grid Task Force, 2010]. The European Communication on smart grids [EC, 2011] further underlines the importance of consumer awareness and emphasises how 'developing smart grids in a competitive retail market should encourage consumers to change behaviour, become more active and adapt to new 'smart' energy consumption patterns' [EC 2011, p10]. However, the Communication also recognises the uncertainty linked to this new technology: 'Neither is there clarity on how to integrate the complex smart grid systems, how to choose cost-effective technologies, which technical standards should apply to smart grids in the future, and whether *consumers will embrace the new technology*' [EC, 2011, p.4]. Finally, it is worth mentioning the CEER (Council of European Energy Regulators) discussion paper *2020 vision for Europe's energy customers* [CEER, 2012]. The paper acknowledges the low level of customer involvement with the energy market and underlines how decisions made today on rules and conditions in the energy markets will affect how markets operate and will therefore have an impact on customers for years to come. Therefore *understanding what energy customers want and how they behave* is fundamental to designing Europe's energy markets.

In this context, the aim of the present section is to shed some light on current developments in consumer involvement strategies in Smart Grid projects in Europe. The analysis includes only those smart grid projects that have provided information in section 5 - Consumer engagement- of our questionnaire. We exclude all other projects, even though some may involve consumer participation.

Of the total of 281 smart grid projects (R&D and demonstration), **65 projects** replied to the section on 'consumer engagement'. Below we highlight the most important findings that emerged from the analysis of these projects.

5.1.1 Increasing number of projects with focus on consumer involvement

The number of consumer involvement projects has grown since 2005 (see Figure 39). In particular, many projects started in 2011 and 2012. The catalogue, as mentioned earlier, includes a relative small number of projects which started in 2012. This circumstance might be related to the deadline set for filling in the questionnaire (September 2012) and not necessarily to a decrease in the number of projects on consumer engagement starting in 2012.

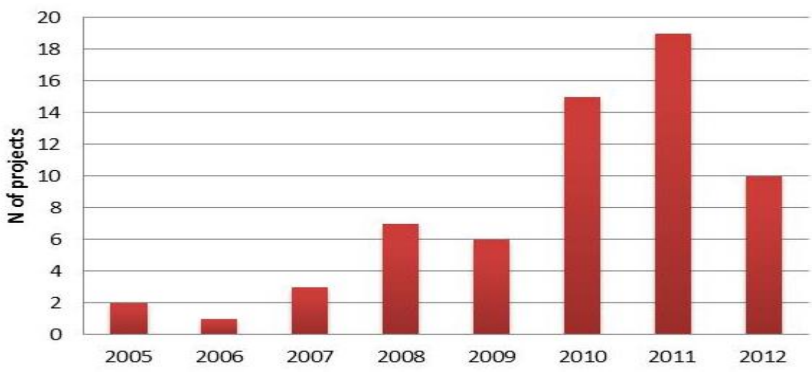

Figure 39: Number of projects with focus on consumer involvement

Most of the projects surveyed indicate a focus on the residential sector. This can be explained by the need for energy providers to target household consumers. Indeed, residential consumers represent a huge potential for energy savings that energy providers can tap into.

5.1.2 Lead organisations and stage of innovation

DSOs, challenged by the need to integrate increasing shares of renewable and distributed energy sources while ensuring security of system supply, are inherently interested in enhancing flexibility through energy efficiency and dynamic pricing so as to enable consumer responsiveness. Indeed, the survey shows that DSOs have started developing projects aimed at getting to know consumers' preferences and behaviour and the impact of their choices on system operators. DSOs, as Figure 40 shows, are acting as one of the key enablers for consumer's integration in the distribution network. Most of the consumer involvement projects in our survey (43 %) are led by DSOs. Figure 40 also indicates more limited participation by aggregators and retailers (service providers), who should have the commercial role of interacting with consumers.

Consumer involvement projects are predominantly in the demonstration phase (see Figure 41).

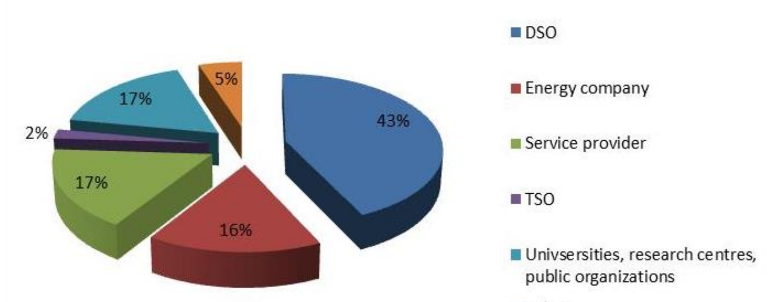

Figure 40: Lead organisation in consumer involvement projects

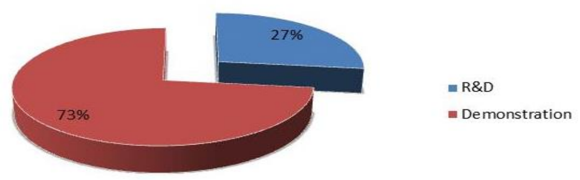

Figure 41: Distribution of projects along the stages of the innovation chain

5.1.3 Geographical distribution in Europe

Figure 42 shows the distribution of consumer involvement projects in Europe. It shows the overall number of projects in each country. Projects are not uniformly distributed across Europe: the majority are in EU15 Member States and, of those, mostly concentrated in a few countries; Denmark, Germany and France together account for approximately half of the total number of projects.

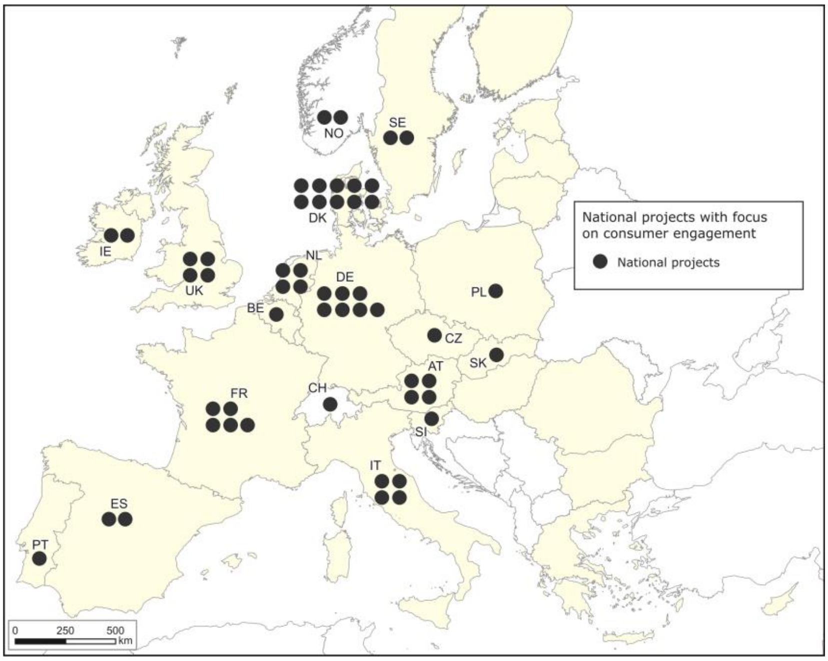

Figure 42: Geographical distribution of national projects

Figure 43 shows the number of multinational projects. Spain is the top participant, followed by Italy, Germany and Sweden. The number of multinational projects has increased since 2008, when Address was the first multinational project to clearly include consumer involvement as a research topic. In 2010, Integris (INTelligent Electrical GRId Sensor communication), 3e-House, BeAware, Web2Energy, and Nobel started, followed by G4V, Green motion, Internet of Energy for Electric Vehicle (IOE) in 2011 and in 2012 by Meter On and Integrating Households in the Smart Grid (IHSMAG).

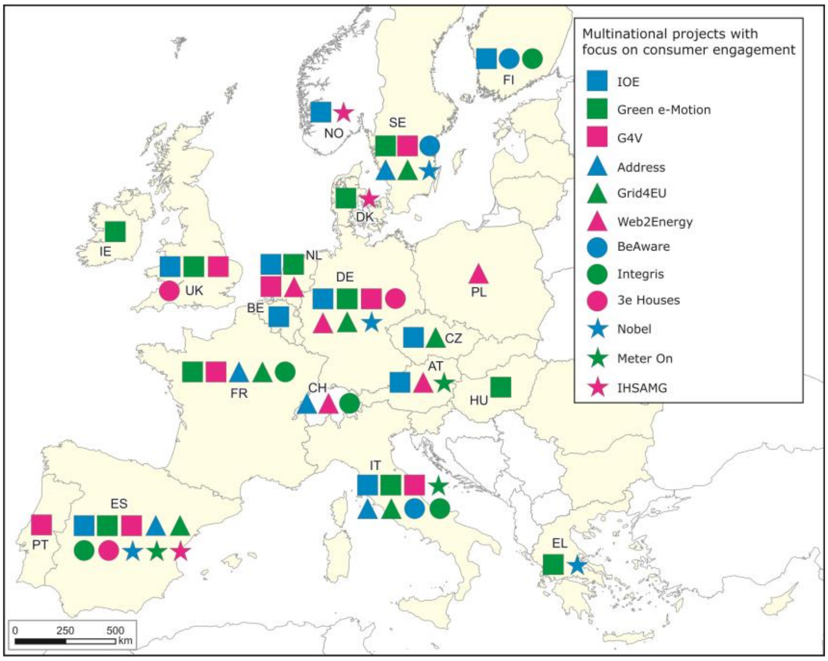

Figure 43: Geographical distribution of multinational projects

5.2. Challenges and success strategies

Two points most frequently referred to as critical are (i) lack of trust by consumers and (ii) uncertainties regarding the use of different motivational factors.

5.2.1 Motivational factors

Understanding the values that influence consumer choice is of crucial importance in segmenting consumers on the basis of non-traditional factors, like attitudes and motivation as regards energy usage. These factors play a fundamental role in actually triggering behavioural change and are increasingly being used by energy providers as motivational incentives to stimulate consumer involvement and promote smart grid projects.

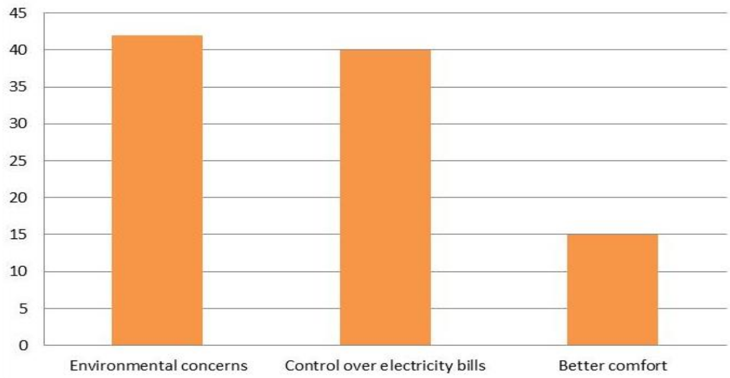

Figure 44: Motivational factors

Our inventory shows that the motivational factors commonly used by smart grid projects in Europe are: (i) environmental concerns, (ii) reduction of/control over electricity bills and (iii) better comfort (Figure 44). Most of the projects use more than one factor, usually combining environmental concerns with cost reduction. This indicates that electricity providers are not yet targeting specific customer segments, but dealing with consumers *en masse*, trying to appeal to them with a combination of motivational factors.

Environmental concerns

From our inventory, it emerges that environmental concerns are the motivational factor used most in the projects. Several studies have highlighted that environmental considerations are becoming an important variable in consumers' choices. A consumer survey by IBM, for example, found that 70 % of consumers surveyed cited environmental considerations as an important factor in their choice of energy and other products [Valocchi et al., 2009]. Another recent survey confirms that, while consumers consider reliability of supply and tariffs important, they place equally high value on broader environmental and social issues [Ngar-yin Mah et al., 2012]. Nevertheless, some studies emphasise that environmental concerns alone are not enough to get untargeted consumers involved. A recent survey by Accenture [Accenture, 2010b] reveals that, when deciding to adopt an electricity management programme, the average consumer ascribes relatively less importance to environmental impact as compared with other motivational incentives. These studies are not specific to the European market and the extent to which their conclusions can be applied to European customers is unclear. Our inventory shows that electricity providers leading consumer involvement projects in Europe consider e*nvironmental concerns* to be an appealing motivational factor very often used in combination with r*eduction of/control over electricity bills*, indicating a certain lack of confidence in its effectiveness when used alone in untargeted initiatives.

Reduction of/control over electricity bills

'Reduction of/control over electricity bills' is the second most commonly used motivational factor. However, a number of project coordinators have pointed out a difficulty due to uncertainty as to whether consumers will actually be able to experience those benefits. The danger here is that consumers who do not make the savings expected from their behavioural change might consider the whole experience disappointing and frustrating [Hargreaves et al., 2010]. This reaction would constitute a major blow to the consumer involvement process and could severely damage any sort of trust that may have already been established.

Better comfort

The motivational factor least referred to by our projects was 'better comfort', i.e. the provision of technological solutions allowing enhanced comfort and more control over one's own energy use. The consumer segment which this factor could most appeal to is that of technology enthusiasts, i.e. consumers who have an interest in the technology itself, either for professional reasons or because it represents 'another gadget'].

5.2.2 Successful strategies

Consumer response and consumption patterns

The observation of consumer responses to newly introduced mechanisms and technical solutions is essential to exploring their viability and their impact on the energy system. Some of the projects in our inventory explore consumers' responses to dynamic pricing and other incentive programmes.

EcoGrid EU: consumers participate with flexible demand response to real-time price signals. The participants are equipped with residential demand-response devices/appliances using gateways and smart controllers. Consumers can see real-time prices and pre-programme their automatic demand-response preferences, e.g. through different electricity contracts. Automation and customer choice are key elements in the project.

Address: two recruitment and involvement strategies were used to involve consumers in an active demand programme: 1. fixed incentives to participate (20 % bill reduction for the duration of the field test); 2. variable incentives based on consumers' participation during the field test. The results show that the second strategy was far more effective in involving the consumer as an active player in the active demand programme.

Mini Berlin: the project involves 50 EVs (Mini E) on the street with public access to charging points. It tests the interaction of electric vehicles in everyday conditions and explores the performance of EVs not only from the technical point of view but also by observing users' patterns of behaviour and preferences.

Consumer involvement strategies

The installation of the enabling infrastructure (smart meters, in-home displays) and provision of detailed information alone will not be sufficient to involve consumers.

Project developers in our catalogue have started to develop diversified strategies to find the best way of presenting information to consumers, and possibly different consumer segments, fine-tuning the strategies in the light of the reactions.

Ewz-Studie Smart Metering, Zurich aims simultaneously to assess the response of consumers to different ways of involving them, including in-home displays, expert advice, social competition and social comparison. Individual surveys are conducted before, during and after the trial to assess consumer response and satisfaction.

The *Consumer to Grid* project aims to test and measure behavioural change induced by different feedback means, monthly bills, a smart-phone-optimised website, in-home displays and an ad-hoc feedback gadget. Behavioural change is assessed by means of data verification (smart meters), questionnaires and interviews.

Many projects focus on one feedback solution only, typically in-home displays, but investigate the importance of using complementary means to involve the consumer.

In the *ESB Smart Meter* project, in-home displays are coupled with visual recalls such as stickers, magnets and energy consumption indicators, which proved to be effective involvement tools. For example, results showed that fridge magnets and stickers achieved 80 % recall, with 75 % of users finding the magnet useful and 63 % the sticker.

Other projects investigate the role of games in promoting awareness and involving consumers.

The *BeAware — Boosting Energy AWAREness* project involves energy consumers as active players by means of the EnergyLife system, which uses wireless sensors and a smart phone. The system is based on awareness tips and consumption feedback. The former aims to increase consumers' knowledge of the consequences of their electricity consumption, while the latter displays actual energy consumption in terms of the distance to the selected savings target. In order to involve the consumer, the system operates like a game: awareness and consumption are expressed in scores, goals are divided into sub-goals and consumption is expressed in scores linked to different levels of the game, so that achieving a goal on one level gives access to a higher level; higher levels have a greater degree of difficulty and richer functionalities. Lastly, knowledge is tested through quizzes and improved through tips, thus further enhancing awareness [Jacucci et al., 2009]. Energy-saving activity can be discussed with others participating in the same programme. Comparative feedback may lead to a sense of competition, social comparison and social pressure that may be especially effective when relevant others are used as a reference group [Abrahamse et al., 2005].

The *Ecoffices* project is based on an ‘Energy challenge within offices’, encouraging employees in a fun and interactive way to use energy more intelligently. Employees are challenged to participate in a collective effort to ‘green’ their company through a competition based on real-time energy usage data. There is a reward for the winning team. Employees are regularly informed of their ecological behaviour and how to improve. One of the conclusions is that it would be beneficial to add a ‘push information’ system, such as a weekly e-mail to the participants summarising the main information from the web interface.

How to gain trust

Many project coordinators reported a high level of consumer's scepticism. Customers tend to seek relationships with more mutual trust and commitment and are less sceptical when trusted organisations or figures, perceived as neutral, are involved in the project. Some projects have started making direct and personal contact with the consumer, using a combination of means ranging from information letters to one-on-one scheduled appointments; other projects have started approaching customers with an organisation or person of trust (‘door opener’) and this has proved to be a successful strategy.

Examples from our inventory include the involvement of representatives of housing associations (*Pilot Project Märkisches Viertel)*, consumer associations (*EcoGrid EU*) and local authorities (*Address, eTelligence*). This approach has also been shown to be successful in other projects outside Europe. The Smart Grid Consumer Collaborative study highlights that very positive results were achieved by those projects that partnered trusted community groups and persons able to promote messages and programmes to large networks [SmartGrid Consumer Collaborative, 2011].

5.3 Social implications of smart grids

The development of smart grids presents uncertainty as well as risk, particularly in relation to social and cultural factors. For the future smart grids to be successful, social and cultural views and viewpoints need to be incorporated as critical requirements at an early stage.

The 2011 JRC inventory found a lack of specific attention to the social implications of smart grids. However, the report, which was based on a thorough literature review, highlighted several social aspects that were relevant to smart grids' success (jobs, internal mobility, ageing workforce and shortage of new skills and competencies, privacy, vulnerable consumers, safety). These aspects were included in the 2012 questionnaire, section 6 – Social impact.

Some projects reported participants' concerns on health effects of wireless emissions from the sensors / meters installed for the project (*ECOFFICE).* Some other projects reported to have addressed transparency and openness providing information and presentations to the local residents involved in the project (*PREMIO, Electric mobility pilot region of Berlin-Potsdam, 'BeMobility 2.0').*

However, we have to acknowledge a low rate of response on this specific section. This confirms that there is still insufficient consideration given to social and cultural implications in smart grid projects in Europe.

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- ABBREVIATIONS AND ACRONYMS

AEEG	Autorità per l'Energia Elettrica e il Gas (IT)
AMI	Advanced Metering Infrastructure
CBA	Cost-benefit analysis
CHP	Combined Heat and Power
CO_2	Carbon Dioxide
COTS	Commercial off-the-shelf
DEMS	Distributed Energy Management System
DER	Distributed Energy Resources
DG ENER	Directorate-General for Energy
DG	Distributed Generation
DMS	Distribution Management System
DR	Demand Response
DSO	Distribution System Operator
EC	European Commission
EEGI	European Electricity Grid Initiative
EU	European Union
EV	Electric Vehicle
FP6	Sixth Framework Programme
FP7	Seventh Framework Programme
GHG	Greenhouse Gas
ICT	Information and Communication Technologies
IEA	International Energy Agency
IP	Internet Protocol
IT	Information Technologies
JRC	Joint Research Centre
KPI	Key Performance Indicator
KWh	Kilowatt-Hour
MSP	Multi-Sided Platform
OFGEM	Office of the Gas and Electricity Markets (UK)
PV	Photovoltaics
R&D	Research and Development
RES	Renewable Energy Sources
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SCADA	Supervisory Control and Data Acquisition
SET-Plan	Strategic Energy Technology Plan
SMEs	Small and Medium Enterprises
TSO	Transmission System Operator
V2G	Vehicle to Grid
VPP	Virtual Power Plant

Country Codes

AT	Austria
BE	Belgium
BG	Bulgaria
CH	Switzerland, Helvetia
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
FI	Finland, Suomi
FR	France
HR	Croatia
HU	Hungary
IE	Ireland
IT	Italy
LI	Liechtenstein
LT	Lithuania
LU	Luxemburg
LV	Latvia
MK	Macedonia
MT	Malta
NL	Netherlands, The
NO	Norway
PL	Poland
PT	Portugal
RO	Romania
SE	Sweden
SI	Slovenia
SK	Slovakia
UK	United Kingdom
USA	United States of America

ANNEX I DATA COLLECTION TEMPLATE

JRC-IET REPORTING TEMPLATE
FOR THE SURVEY OF SMART GRID PROJECTS IN EUROPE

Why an inventory of smart grid projects?

Intelligent electricity networks — smart grids — are a key component in the EU energy strategy. In the last few years, smart grid projects have been growing in number, size and scope throughout Europe. Where are they taking place? What are they about? Who is leading them? What progresses have we made?

To answer some of these questions, last year the JRC launched the first comprehensive inventory of smart grid projects in Europe. The response was overwhelmingly positive: we heard back from over 200 smart grid projects scattered across Europe.

Project results provide an encouraging indication of how smart grids can help integrate more renewables, accommodate electric vehicles, give more control to consumers over their energy consumption, avoid blackouts and restore power quickly when outages occur.

How can you contribute to this Europe-wide effort?

Project data and results are invaluable to share knowledge, lessons learned and best practices and speed up the implementation of smart grid projects throughout Europe.

We know that many more projects have just started or about to start so the inventory keeps going.

You have an excellent opportunity to disseminate the results of your project and contribute to this Europe-wide effort to promote smart grids. Just complete the new on-line form below, filling all data entry relevant to your project.

We will perform consistency check and include the project in our European smart grid project database. We will treat all financial/economic information confidentially and publish only aggregated data.

We also invite project coordinators that participated to last year's survey to fill in the new-on-line form to provide more updated and detailed info.

How can you keep track of your projects?

At any time you are welcome to provide us with updates and new available information as the project progresses.

Regularly, we will publish a new version of the database, available to all main smart grid actors in Europe and beyond. You can track your project on our website (http://ses.jrc.ec.europa.eu/) for a first glance and on a dedicated visualisation platform (www.smartgridsprojects.eu) for an in-depth navigation across smart grid projects in Europe.

<table>
<tr><th colspan="5">1.PROJECT OVERVIEW</th></tr>
<tr><td>1.1 Project name</td><td colspan="4"></td></tr>
<tr><td>1.2 Location/s of the physical implementation</td><td colspan="4"></td></tr>
<tr><td>1.3 Start date and duration of the project</td><td colspan="4"></td></tr>
<tr><td>1.4 Contact person website</td><td colspan="4"></td></tr>
<tr><td>1.5 Lead organisation (Name and Country)</td><td colspan="4"></td></tr>
<tr><td rowspan="11">1.6 Lead organisation type</td><td>☐</td><td colspan="3">Distribution system operator</td></tr>
<tr><td>☐</td><td colspan="3">Transmission system operator</td></tr>
<tr><td>☐</td><td colspan="3">Retailer</td></tr>
<tr><td>☐</td><td colspan="3">Generation company</td></tr>
<tr><td>☐</td><td colspan="3">Utility/Energy company</td></tr>
<tr><td>☐</td><td colspan="3">Aggregator</td></tr>
<tr><td>☐</td><td colspan="3">Manufacturer</td></tr>
<tr><td>☐</td><td colspan="3">Telecom company</td></tr>
<tr><td>☐</td><td colspan="3">IT company</td></tr>
<tr><td>☐</td><td colspan="3">University/research centre/consultancy</td></tr>
<tr><td>☐</td><td colspan="3">Other (please specify):</td></tr>
<tr><td>1.7 Other Participants (Names, Countries and Organisation Type)</td><td colspan="4"></td></tr>
<tr><td rowspan="7">1.8 Project main application (If more than one category applies, please express the relevance of the category with a number between 0 and 1)</td><td colspan="2">Smart Network Management</td><td>☐</td><td>Relevance:</td></tr>
<tr><td colspan="2">Integration of DER</td><td>☐</td><td>Relevance:</td></tr>
<tr><td colspan="2">Integration of large scale RES</td><td>☐</td><td>Relevance:</td></tr>
<tr><td colspan="2">Aggregation (Demand Response, VPP)</td><td>☐</td><td>Relevance:</td></tr>
<tr><td colspan="2">Smart Customer and Smart Home</td><td>☐</td><td>Relevance:</td></tr>
<tr><td colspan="2">Electric Vehicles and Vehicle2Grid applications</td><td>☐</td><td>Relevance:</td></tr>
<tr><td colspan="2">Other (please specify)</td><td>☐</td><td>Relevance:</td></tr>
<tr><td>1.9 Technical parameters</td><td colspan="3">Voltage level(s) (kV):
Number of users involved (producers, consumers and prosumers):
Consumption level in the project area (MWh/year):
% of energy supplied by non-dispatchable resources:
Other (please specify)</td><td></td></tr>
<tr><td rowspan="3">1.10 Prevailing stage of development (R&D, Demonstration or Deployment/roll-out) (if the project includes different stages -e.g. R&D and demonstration phases- please express their relevance in</td><td>R&D</td><td>☐ 25%</td><td>☐ 50%</td><td>☐ 75% ☐ 100%</td></tr>
<tr><td>Demonstration</td><td>☐ 25%</td><td>☐ 50%</td><td>☐ 75% ☐ 100%</td></tr>
<tr><td>Deployment</td><td>☐ 25%</td><td>☐ 50%</td><td>☐ 75% ☐ 100%</td></tr>
</table>

percentage terms)		
1.11 Budget and time allocated to each stage of development in the project	R&D	Budget (%) Time (%)
	Demonstration	Budget (%) Time (%)
	Deployment	Budget (%) Time (%)
1.12 Brief project description, specifying goals and main areas of innovation [Max 200 words]		
1.13 Main project results and outcomes [Max 200 words]		
1.14 Brief description of how project results can be scaled-up and/or replicated in other regions of Europe [Max 200 words]		
1.15 What are the main obstacles/challenges encountered during the project? What are the lessons learned? [Max 200 words]		
1.16 What are the future new applications/services and third-party market entries that may be enabled by the project? [Max 200 words]		
1.17 Main regulatory issues and recommendations if any [Max 200 words]		

2. PROJECT FINANCIAL INFORMATION (this information will be treated as CONFIDENTIAL and only aggregated data will be published)			
2.1 Total budget [€]			
2.2 Contributing organisations and share of contribution [€]			
2.3 Budget of individual demos [€] (for projects composed of different demos)			
2.4 Sources of project financing/funding and shares	Tariffs	☐	Please provide details: Budget Share:
	Regulatory incentives (please specify)	☐	Please provide details: Budget Share:
	Public funding (please specify)	☐	Please provide details: Budget Share:
	EC funding (please specify)	☐	Please provide details: Budget Share:
	Own resources/private capitals (please specify)	☐	Please provide details: Budget Share:
	Other (*please specify*):	☐	Please provide details: Budget Share:
2.5 Has the project tracked costs and benefits? If yes, please provide details of the deployment scenario considered (max 200 words)			
2.6 Estimated costs for deployment scenario	CAPEX	☐	Please provide details: Amount €:
	OPEX	☐	Please provide details: Amount €:
	Other (*please specify*):	☐	Please provide details: Amount €:
2.7 Estimated benefits for deployment scenario	Energy savings	☐	Please provide details: Amount €:
	Reduced energy technical and non-technical losses	☐	Please provide details: Amount €:
	Reduced operational and maintenance costs	☐	Please provide details: Amount €:
	Reduced outages (including value of lost load)	☐	Please provide details: Amount €:
	Deferred investments (transmission, distribution, generation)	☐	Please provide details: Amount €:
	Reduced system management costs	☐	Please provide details: Amount €:
	Other (*please specify*):	☐	Please provide details: Amount €:

3 SMART GRID AREAS OF FOCUS and DEPLOYED TECHNOLOGIES (according to EEGI)			
TRANSMISSION LEVEL			
3.1 Pan EU grid architecture	A toolbox for network architecture assessment for the pan EU transmission system	☐	Specify type, number and function of assets and technologies deployed
	Tools to analyse pan EU transmission systems expansion	☐	Specify type, number and function of assets and technologies deployed
	Methodology for public acceptance	☐	Specify type, number and function of assets and technologies deployed
3.2 Power Technologies	Demonstration of power technologies for more network flexibility	☐	Specify type, number and function of assets and technologies deployed:
	Demonstration of power technologies for power architecture	☐	Specify type, number and function of assets and technologies deployed
	Demonstration of renewable integration	☐	Specify type, number and function of assets and technologies deployed
3.3 Network management and control	Tools for pan EU network observability	☐	Specify type, number and function of assets and technologies deployed
	Innovative tools for coordinated operation	☐	Specify type, number and function of assets and technologies deployed
	Improved training tools for improved coordination	☐	Specify type, number and function of assets and technologies deployed
	Innovative tools for pan EU network reliability assessment	☐	Specify type, number and function of assets and technologies deployed
3.4 Market rules — market simulation techniques to develop a single EU el market	Tools for pan EU balancing markets	☐	Specify type, number and function of assets and technologies deployed
	Advanced tools for congestion management	☐	Specify type, number and function of assets and technologies deployed
	Tools for renewable market integration	☐	Specify type, number and function of assets and technologies deployed
	Tools to study market integration of active demand	☐	Specify type, number and function of assets and technologies deployed
T&D INTERFACE			
3.5 Coordination between T&D	Tools for improved system observability and network interactions	☐	Specify type, number and function of assets and technologies deployed

	Integration of DSM in TSO operation	☐	Specify type, number and function of assets and technologies deployed
	Ancillary services by DSOs	☐	Specify type, number and function of assets and technologies deployed
	Improved defence and restoration plans	☐	Specify type, number and function of assets and technologies deployed
	Joint task force on IT system protocol and standards	☐	Specify type, number and function of assets and technologies deployed
DISTRIBUTION LEVEL			
3.6 Smart Customers	Active demand response	☐	Specify type, number and function of assets and technologies deployed (e.g. aggregation services, dynamic tariffs, web portals etc.)
	Energy efficiency from integration with Smart Homes	☐	Specify type, number and function of assets and technologies deployed
3.7 Smart Energy Management	Smart metering infrastructure	☐	Specify type, number and function of assets and technologies deployed
	Smart metering data processing	☐	Specify type, number and function of assets and technologies deployed
3.8 Smart Integration	DER hosting capacity of low voltage networks — Integration of small renewable in the distribution network	☐	Specify type, number. and function of assets and technologies deployed Specify DER hosting capacity (kW):
	DER hosting capacity of medium voltage networks — System Integration of medium size renewables in the distribution network	☐	Specify type, number. and function of assets and technologies deployed (e.g. aggregation services) Specify DER hosting capacity (kW):
	Integration of storage in distribution networks (medium and low voltage level) –Integration of storage in network management	☐	Specify type, number. power (kW) and function of assets and technologies deployed (e.g. aggregation services)

			Specify storage hosting capacity (kW):
	Integration of electric vehicles (EV) and plug in hybrid electric vehicles (PHEV) in distribution networks (medium and low voltage level) — Infrastructure to host electric vehicles	☐	Specify type, number and function of assets and technologies deployed (e.g. aggregation services)
3.9 Smart Distribution Network	Monitoring and control of low voltage networks — Integration of automation and local power production in the LV distribution network	☐	Specify type, number and function of assets deployed:
	Automation and control of medium voltage networks — Integration of advanced automation solution with local power production and two-way of power flow in the MV distribution network	☐	Specify type, number and function Specify type, number and function of assets deployed:
	Integration of Methods and system support (medium and low voltage level) — Integration of state estimation, maintenance, planning and asset management in network management	☐	Specify type, number and function of assets deployed:
	Integration of Integrated communication solutions in distribution networks — Widespread communication solutions, standardised	☐	Specify type, number and function of assets deployed:

4. PROJECT CONTRIBUTION TO POLICY GOALS			
4.1 Sustainability and integration ☐	*Estimated reductions of CO_2 (via reduced energy losses, energy savings, integration of RES)*	☐	Details: Value [Mt]:
	Additional RES[23] hosting power in the grid /maximum power load	☐	Details: Value [%]:
	Additional DER[24] hosting power input in the grid (incl. EV and storage)/ maximum power load	☐	Details: Value [%]:
	Additional Demand Side Management power managed in the grid/maximum power load	☐	Details: Value [%]:
	Increased number of consumers participating in electricity markets and in energy efficiency measures	☐	Details: Value [number;%]
	Other (please specify): ...	☐	Details: Value []:
4.2 Security and Quality of Supply ☐	*Duration and frequency of interruptions (e.g. SAIDI, SAIFI , CAIDIetc)*	☐	Details: Value []:
	Other (please specify):	☐	Details: Value []:
4.3 Energy Efficiency and Savings ☐	*Energy savings*	☐	Details: Value [%]:
	Percentage reduction of electricity losses	☐	Details: Value [%]:
	Reduced peak load	☐	Details: Value [%]:
	Other (please specify):	☐	Details: Value []:
4.4 Coordination and Interconnection ☐	*Additional interconnection capacity (specify HVDC and HVAC)*	☐	Details: Value [MW]
	Increased internal transfer capacity between TSOs or DSOs	☐	Details: Value [MW]
	Other (please specify):	☐	Details: Value []:

5. CONSUMER ENGAGEMENT		
5.1 Which of the following aspects of consumer engagement has the project	☐ ☐	Identifying consumer segments Collecting information on consumption patterns, needs and user experiences (please, specify the means)

[23] Renewable energy sources.
[24] Distributed energy resources.

mainly aimed for/addressed/focused on?	☐ Exploring customer response to innovative regulatory, market and technical solutions (e.g. response to dynamic tariffs, automatic load control schemes, etc.) ☐ Providing information to consumers about newly introduced smart technologies or mechanisms (please specify the means): … ☐ Providing information to customers about their energy consumption/usage through different means (please, specify the means): … ☐ Investigating different ways of presenting information to consumers in order to engage him/her in an energy related project ☐ Other (please specify):
5.2 Target Sector	☐ Industrial ☐ Commercial/public services ☐ Residential
5.3 What are the main motivational factors used by the project to engage the consumer?	☐ Environmental concerns ☐ Control over/reduction of electricity bills ☐ Better comfort (e.g. home automation) ☐ Other (please specify): …
5.4 Consumers involved in the engagement programme	Number: Details:
5.5 Consumers participating in demand response	Number: Details:
5.6 Consumers with in-home visualisation tools (e.g. webportal, displays)	Number: Details:
5.7 Consumers with smart appliances	Number: Details:
5.8 How do you rate the participation of the consumers involved in your project?	☐ Very good ☐ Good ☐ Fair ☐ Poor ☐ Very poor
5.9 Brief description of the consumer observation/engagement strategy and main project findings:	
5.10 What are the main benefits for consumers and the main obstacles to consumer engagement observed in the project? (please explain)	
5.11 Which innovative business models has the project proposed that might contribute to consumer engagement? (please explain)	
5.12 According to project's results, which regulatory aspects can/should be considered and improved to facilitate consumer engagement? (please explain)	

6. SOCIAL IMPACT			
6.1 Has the project addressed/quantified the following social aspects?	Job creation	☐	Details:
	Job losses	☐	Details:
	Internal job mobility — Personnel retrained for other roles following smart grid programmes (e.g. meter reading)	☐	Details:
	Ageing workforce and shortage of new skills and competencies	☐	Details:
	Vulnerable consumers (e.g. low-income, pensioners, disabled, technology unsavvy)	☐	Details:
	Safety (reduction of hazard exposure)	☐	Details:
	Other (please specify)	☐	Details:
SOCIAL/PUBLIC ACCEPTANCE			
6.2 Has the project dealt with issues hindering its social acceptance? How did the project address them?	Not applicable/not relevant	☐	
	Concerned over transparency	☐	Details:
	Lack of trust	☐	Details:
	Concerns over fair benefit sharing	☐	Details:
	Concerns over social equity (e.g. considering the needs of vulnerable segments of the community)	☐	Details:
	Other (please specify)	☐	Details:

7. DATA PRIVACY, SECURITY AND INTEROPERABILITY			
7.1 Has the project assessed the risks related to the data processed by the system?	Measures to ensure cybersecurity	☐	Details:
	Security risk assessment (methodology)	☐	Details:
	Security policy (risk mitigation measures)	☐	Details:
	Measures to ensure privacy and protection of personal data	☐	Details:
	Consultation of Data Protection Authority, involvement of Data Protection Officer if applicable.	☐	Details:
	Privacy Impact Assessment	☐	Details:
	Other (please specify)	☐	Details:
7.2 Has the project addressed issues of interoperability?	Specific measures to ensure interoperability	☐	Details:
	Use of devices from different manufactures/vendors	☐	Details:
	Challenges/problems encountered due to lack of standards	☐	Details:
	Other (please specify)	☐	Details:

ANNEX II PROJECT CATALOGUE

AUSTRIA	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
	DG Demonetz Validierung	2006	2013	VKW-Netz AG	*www.smartgridssalzburg.at*	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. Especially a solution for the interaction of grid components by means of communication will be developed. The project objective is to solve above challenges with acceptable costs regarding investment, maintenance and operation.
	Smart Web Grid	2011	2013	Salzburg AG	*n/a*	Smart Web Grid analyses user interaction, technology, cost effectiveness and data security of such a data exchange by means of three concrete examples in the Smart Grid Model Region Salzburg. The goal is the conceptual design of a comprehensive information model for web-service-based access to smart grids data sources, providing a more efficient integration of different applications as well as additional benefits through information aggregation. At the same time, it will be made sure on a conceptual level that privacy and security are guaranteed.
AUSTRIA	More PV2Grid	2010	2013	Fronius International GmbH	*n/a*	The project aims at developing and validating 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 superordinate system and communication technology. These concepts shall ultimately allow the cost-effective integration of a large number of photovoltaic generators.
	DG Demonet Smart LV Grid	2011	2014	Austrian Institute of Technology	*www.ait.ac.at/departments/energy/research-areas/electric-energy-infrastructure/smart-grids/dg-demonet-smart-lv-grid/*	The project aims to enable an efficient and cost-effective use of existing grid infrastructures based on a three-step approach: intelligent planning, on-line monitoring, and active grid management. Communication-based systems for automatic control concepts for low voltage networks will be developed and evaluated in operation.
	Isolves PSSA-M	2009	2012	Austrian Institute of Technology	*n/a*	The objective of the project is to define and develop the required technical foundations to enable an increasing number of distributed energy feed-in opportunities in LV networks. For this purpose a method is developed to take an instantaneous image of the network (the 'Power Snap-Shot Analysis by Meters') and is applied together with adapted smart meters.
	EMPORA 1 + 2 — E-Mobile Power Austria	2010	2014	Verbund AG	*n/a*	The EMPORA projects aims to achieve a complete system for electric mobility in a user-oriented and international coordinated way. Within the framework of the project, an integrated system solution for electric mobility will be developed and implemented for the first time.

AUSTRIA	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
	HiT	2011	2013	Salzburg AG	*http://www.smartgridssalzburg.at/forschungsfelder/kunden-und-gebaeude/hit/*	A demonstration building is to be planned and constructed as flagship project, in order to investigate the possibilities and benefits of Smart grids in connection with buildings, which should then be brought to the attention of the broad public to make this topic visible and concrete.
	Building to Grid (B2G)-Smart Grids Modell region Salzburg	2010	2012	Salzburg AG		The goal of the project is to close that gap and 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.
	Consumer to Grid (C2G)	2010	2012	Salzburg AG	*http://energyit.ict.tuwien.ac.at/index.php/en/projects/c2g*	This study investigates the way in which information about potential energy savings is best presented to the consumer in order to reduce energy consumption in the smart-grid. C2G aims at conducting basic research regarding if, how, when and what kind of energy feedback occupants need regarding a socio-demographic and cultural background. Various established and new forms of communication, combined with smart metering allow for investigating the impact, the sustainability and the handling of smart-grid enabled consumers. The expected results shall shed light on the most resource effective energy feedback methods for the human-in-the-loop in the smart grid.
	Smart Heat Networks-Smart Grids region Salzburg	2010	2013	Salzburg AG		The objective of the project SGMS-Smart Heat Net is to analyse and evaluate the potential of smart grid concepts for district heating systems in the model region of Salzburg. Reducing peak loads improves the energetic, environmental and economic efficiency of district heating systems. The utilisation of peak load boilers running on oil and gas can be reduced significantly, which in turn reduces CO2 emissions.
	Smart Synergy Potentials-Smart Grids model region Salzburg	2010	2012	Salzburg AG		For smart grid and e-mobility applications different data and information have to be recorded and distributed with different technical requirements (e.g. amount of data, real-time capability, data security, availability and redundancy, etc.), which also fundamentally affects the construction costs of ICT infrastructure. The synergistic use of the ICT infrastructure for multiple applications including the validation of the actual realisable synergies is key objective in the project.
	Vehicle to Grid — Interfaces	2010	2011	Salzburg AG		This feasibility study evaluates necessary technical parameters (for hard- and software applications) which enable the implementation of Vehicle to Grid driven visualisation processes within the Salzburg AG to create e.g. new billing services or other business processes. These visualisation concepts will be derived for costumer's daily needs incorporating adequate software layouts for perfect handling.
	Vehicle to Grid — Strategies	2010	2012	Vienna University of Technology		Technical, economic and ecological impacts for Austria's energy system (until 2050) due to massive e-mobility penetrations are examined. The options of system related e-mobility integration in urban and rural case studies are analysed developing active grid integration as well as new business models for Grid to Vehicle and Vehicle to Grid concepts. As key results a tailor made guideline and action plan for Austrian decision makers are derived.

Austria	Project Name	Period		Lead Organisation	Website	Project Description
	ZUQDE	2010	2012	Salzburg Netz GmbH	*www.smartgridssalzburg.at*	Field test Lungau: medium voltage grid including a transformer station and 4 hydro power plants included in the control loop. 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.
	ProAktivNetz	2011	2013	Kelag Netz		ProActivNetz project objectives are: 1) To extend an existing tool, which provide plans for grid operators for optimal operation of the distribution network through precise monitoring of the distribution network and reduces outage times. 2) To consider and integrate decentralised generation (including their forecast) placed in medium voltage and low voltage network, as well as parallel planed outages or unplanned disturbances within optimal network operation schedules.
	GAVE-Großschönau as virtual energy storage	2010	2012	Sonnenplatz Großschönau GmbH	*http://energyit.ict.tuwien.ac.at/index.php/en/projects/gave*	GAVE is the first project to analyse the effectiveness and the user acceptance of automated demand response in Austria. Private, public and commercial electricity customers in a municipality in Lower Austria are equipped with demand response technology and join a municipality-wide experiment. The project aims to show that effective demand response is possible without compromising the customer comfort.

Belgium	Project Name	Period		Lead Organisation	Website	Project Description
Belgium	Belgium east loop active network management	2010	2011	Elia		The project aims at designing an active network solution based on the power systems analysis. It will define principles of access for generators to perform a curtailment assessment that will help to estimate how often limits are threatened. This will lead to the generators modulation necessary to keep power flows within limits. The project will provide guidelines for the active network solution deployment and cost estimation as well.
	Electrical vehicles impacts on the grids	2010	2011	Ores		Measurements and models of impact of electrical vehicles slow and fast charging on the Ores grid. In particular project is going to explore customers' behaviour and the application of grid automation distribution.
	Network design & management in a smart city	2010	n/a	Ores		The project aims at integrating all smart technologies on the distribution grid of a given city and at defining new network design rules and management principles definition.

BELGIUM	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
	with large deployment of DER					
	Linear	2011	2014	VITO	*http://www.linear-smartgrid.be/?q=en*	The main objective of the Linear project is a demonstration of the smart grids philosophy in an existing typical Belgian residential area. This pilot study will be operational in 2012. Active demand management of more than 100 buildings will be realised within the project where many non-predictable energy resources will be part of, as well as (µ) CHP, heat-pumps, thermal and electrical energy storage concepts.
	Meta-PV	2009	2014	3E N.V	*http://www.metapv.eu/introduction*	Meta-PV is the first project world-wide that will demonstrate the provision of electrical benefits from photovoltaic (PV) on a large scale. Additional benefits for active grid support from PV will be demonstrated at two sites: a residential area of 128 households with 4 kWp each, and an industrial zone of 31 PV systems with 200 kWp each. The enhanced control capacities to be implemented into PV inverters and demonstrated are active voltage control, fault ride-through capability, autonomous grid operation, and interaction of distribution system control with PV systems
	Volt-Air: Where energy meets mobility	2011	2014	Siemens	*http://www.livinglab-ev.be/platformen/volt-air-platform*	Volt-Air is mainly focused on the integration of electric vehicles in vehicle fleets and the integration of these fleets in the micro grid companies. The Volt-Air platform consists of three sub labs which are connected via a common data platform for data exchange.

	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
CZECH REPUBLIC	Smart Region	2011	2014	CEZ Distribuce a.s	*http://www.futuremotion.cz/smartgrids/cs/index.html*	Fully automated and monitored LV and MV grid. Balanced distribution grid which can easily switch between island and normal operation mode.
	SMART GRID Prague	2012	2015	PREdistribuce	*http://www.siemens.com/press/en/pressrelease/?press=/en/pressrelease/2012/infrastructure-cities/smart-grid/icsg201202013.htm*	To build a network control system for Prague's power grid in order to support all aspects of the operations of the Czech distribution network operator. The new network control system, which will replace the old SCADA systems of the Czech grid operator, will manage the voltage levels of 110 kV, 22 kV and 0.4 kV. As part of the installation process, the 200000 remotely monitored data points from the high-voltage and medium-voltage network will be extended to the 400-Volt level, for a total of 2.5 million data points, all of which will be mapped in the system.

Denmark	Project name	Period		Lead organisation	Website	Project description
Denmark	Activation of 200 MW refuse-generated CHP upward regulation effect	2009	2010	EMD International A/S.	*http://www.danskenergi.dk/AndreSider/Smart_Grid_Oversigt/1002.aspx*	Waste CHP plants can be used in the electricity market for upward regulation by bypassing the steam turbine. The technical design for this purpose must ensure that factors such as response and activation time do not result in more expensive turbine maintenance.
	Opportunities to use Compressed air for storage of electricity	2005	2010	DTU Mechanical Engineering	*http://www.danskenergi.dk/AndreSider/Smart_Grid_Oversigt/1003.aspx*	The project objective is to determine whether Compressed Air Energy Storage (CAES) will be a sound alternative in financial and energy terms to other types of electricity storage (hydrogen. battery. pumped storage power stations abroad) and regulation methods in connection with electricity overflow and other regulation needs in the electricity system of the future.
	Increased energy supply flexibility and efficiency by using decentralised heat pumps in CHP stations	2007	2010	Danish Technological Institute (DTU)	*http://www.danskenergi.dk/AndreSider/Smart_Grid_Oversigt/1004.aspx*	The project is a continuation of the research results from EFP 2003 (j.no.: 1373/03-0007) and demonstrates the newly developed heat pump technology in full scale at two decentralised CHP stations. Furthermore. a number of ideas concerning the integration of compression heat pumps in the energy system will be tested via simulation models and also in practice. Finally heat pumps will be investigated in connection with reduction of grid loss in district heating (20-40%) via ultra-cold district heating.
	Demand response medium sized industry consumers	2009	2011	Danish Technological Institute (DTU)	*http://www.stateofgreen.com/en/Profiles/Energy-2008---ForskEL/Solutions/Demand-response-medium-sized-industry-consumers*	To investigate the possibility of introducing flexible electricity demand and regulation power in Danish Industry consumers via a price- and control signal from the supplier of electricity. The aim is to develop a valuable solution for the industry consumers giving them various benefits and afterwards to test the system.
	Electricity storage for short term power system service	2010	2010	Materials Research Division at Risø DTU	*http://www.stateofgreen.com/en/Profiles/Energy-2008---ForskEL/Solutions/Electricity-Storage-for-Short-Term-Power-System-Se*	To evaluate and compare – technically and economically – the available options for using dedicated electricity storage units to provide short term system services at transmission system level in the Danish power system.
	Flex power – indirect power system control through dynamic power price	2010	2013	EA energianalyse	*http://www.danskenergi.dk/AndreSider/Smart_Grid_Oversigt/1013.aspx*	This project will investigate a possible extension of the current market for regulating power. The core idea is to design and test a real-time market with minimal administrative overheads that can make it possible for electricity demand and micro generation to deliver regulating power.
	Price elastic electricity consumption as reserve power – a demonstration project in the horticultural sector	2006	2010	DEG Green Team	*http://www.danskenergi.dk/AndreSider/Smart_Grid_Oversigt/1016.aspx*	The project objective is charting the scale of the realisable potential for price-elastic electricity consumption within the horticultural sector. and demonstration of the technical opportunities and the financial incentive for the individual market gardens to participate in the markets for regulated and reserve power via price-elastic electricity consumption.

DENMARK

PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
Price elastic electricity consumption and electricity production in industry	2006	2010	Dansk Energi Analyse a/s	*http://www.danskenergi.dk/AndreSider/Smart_Grid_Oversigt/1017.aspx*	The project aims at promoting industry's access to price-elastic electricity consumption by creating interest among companies in the opportunity to maximise gains and making it easier for them to assess their potential with dependence on e.g. the activation payment and by developing the contractual conditions in the electricity markets.
Second1 – Security concept for DER	2010	2011	EURISCO ApS	*http://www.stateofgreen.com/en/Profiles/Energy-2008ForskEL/Solutions/SECOND1---Security-Concept-for-DER*	The project objective is to analyse and implement a security concept that can be used in a power system with a high degree of decentralised production and with many actors in an unbundled market. It will also investigate various forms of role based access control (RBAC).
Control and regulation of modern distribution system	2006	2010	Department of Energy Technology- Aalborg University. Denmark		The project's objective is to study the effects of load management systems and online real time electricity pricing systems in modern distribution systems and to develop the models, operation and control strategies for such distribution systems and finally to establish the control approach for the systems in contingency situations. i.e. island operation.
Generic VPP for optimised micro CHP operation and integration	2007	2010	CET-DTU		The project develops tests, validates and evaluates novel control architecture for optimised operation and seamless integration of micro CHP based on a generic virtual power plant (VPP) concept. The concept shall provide a foundation for future operation and integration of micro CHP
Dynamic tariffs	2010	2010	Danish Energy Agency	*http://www.danskenergi.dk/AndreSider/Smart_Grid_Oversigt/1504.aspx*	To investigate the opportunities for and effects of changed tariffs for electricity with the special objective of better integration of renewable energy from, among other things ever-increasing wind power production.
The cell controller pilot project	2004	2011	Energinet.dk	*n/a*	Via a full-scale SmartGrid development and demonstration project in a 60 kV distribution grid it is sought to achieve sufficient knowledge and a basis for a long-term re-design process. in order to turn the traditional passive distribution grids into active grids that can optimally utilise the growing volume of decentralised production.
EcoGrid EU	2011	2014	Energinet.dk	*http://www.eu-ecogrid.net/*	To build and demonstrate a complete prototype of the future power system with more than 50% renewable energy.
Development of Early Warning Systems	2006	2012	Energinet.dk		The purpose is to develop systems that can monitor the overall power system state and alert system operators and other protection systems about forthcoming critical situations in the power system.
Power pit	2007	2009	DONG Energy	*http://www.danskenergi.dk/AndreSider/Smart_Grid_Oversigt/2001.aspx*	The purpose of the Power Pit project is state estimation in 10 kV network and visualisation of results
SACSe	2008	2010	DONG Energy		The objective of the SACSe project was automatic conversion in the 10 kV grid in order to improve supply quality in connection with 10 kV faults – the so called 'self-healing' grid.
eFlex	2010	2011	DONG Energy	*http://www.alexandra.dk/uk/Projects/Pages/eFlex.aspx*	The purpose of eFlex project is to gain experience with mobilisation of private customers' flexible energy consumption, especially from electric cars, electric heating and heat pumps.
Regulated power. OUH	2009	2009	Energi Fyn Produktion	*http://www.danskenergi.dk/AndreSider/Smart_Grid_Oversigt/2015.aspx*	The project's mission is to contribute to the development of a sustainable energy system by being available to regulate out the varying services that wind turbines contribute to in the various weather conditions.

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Charge stands	2010	n/a	SydEnergi	*http://www.danskenergi.dk/AndreSider/Smart_Grid_Oversigt/2032.aspx*	Gain knowledge of whether it is technically possible and financially/environmentally advantageous for the customer and the electricity system to offer owners of electrical vehicles an intelligent charging facility comprising possible use of spot electricity agreements, and the choice of charging most cheaply or most greenly. The objective is during 2010 to establish minimum 70 charge stands, whereby experience is gained of charging electrical vehicles based on hourly price and production mix and of the financial/environmental advantages for the end user.
Trials with heat pumps on spot agreements	2010	2011	SydEnergi	*http://www.danskenergi.dk/AndreSider/Smart_Grid_Oversigt/2034.aspx*	The objective of the project is to gain knowledge of the technical challenges of establishing a heat pump solution in private households in order to plan the heat pumps' electricity consumption for when electricity production is highest/greenest.
Automatic receipt of short circuiting indicators	2009	2010	Tre-For El-net A/S	*http://www.danskenergi.dk/AndreSider/Smart_Grid_Oversigt/2037.aspx*	DSO-Pilot project – Automatic receipt of short-circuiting indicators from the 10 kV grids ensures rapid information to the duty officer in the event of high-voltage faults.
0.4 kV remote control	2011	2013	Verdo Renewables DK	*http://www.danskenergi.dk/AndreSider/Smart_Grid_Oversigt/2038.aspx*	Opportunities to establish remote control/DNM of the 0.4 kV grids have been analysed. The opportunities for integrations from the cable registration to the remote control have been investigated and pilot projects have been performed with integrations of sections of the low-voltage grid. Verdo has analysed the possibilities of establishing remote / DNM of 0.4 kV network.
Automation and security of Supply	2010	n/a	Verdo Renewables DK	*http://www.danskenergi.dk/AndreSider/Smart_Grid_Oversigt/2039.aspx*	The company in focus has established DSO – Distribution – Control – Surveillance at individual stations. On these 10/0.4 kV stations there is full remote control, with commands, reports, metering and alarms, which in a fault situation makes it possible to quickly gain an overview of the grid status for the medium-voltage grid.
Information from the electricity grid – remote reading	2010	n/a	Verdo Renewables DK	*http://sitecore.danskenergi.dk/AndreSider/Smart_Grid_Oversigt/2040.aspx*	The remote reading project in addition to consumption data also makes it possible to retrieve information on consumption patterns, loads, voltage variations. These are all related initiatives to achieve smart grid solutions on the low-voltage grid.
Consumer web	2010	2011	Vestforsyning A/S	*http://www.danskenergi.dk/AndreSider/Smart_Grid_Oversigt/2042.aspx*	Make consumption data available to consumers in a way that: helps them to understand their own consumption, their consumption pattern and energy consumption in general; motivates them to optimise their consumption; and enables them to achieve energy savings. Gives stronger communication with customers in order to achieve better and faster customer service and more services.
Service optimisation of the distribution network	2009	2010	DEFU – Dansk Energi	*http://sitecore.danskenergi.dk/AndreSider/Smart_Grid_Oversigt/3001.aspx*	To investigate different parameters which can optimise the operation of the distribution network on the basis of The Danish Energy Regulatory Authority's regulation of the distribution network companies in the form of financial regulation and regulation of the security of supply.
3002 EDISON	2009	2011	Danish Energy Association	*http://www.edison-net.dk/*	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.
Automation systems for Demand Response	2006	2009	Danish Energy Industries Federation		More than 500 households with electric heating participated in a demonstration project about demand response. Participants paid for electricity based on spot prices. The groups notified of the next day's prices by E-mail and/or SMS did not change their

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PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
					demand pattern
Agent based control of power systems	2006	2010	CET-DTU		The purpose is to explore the possibilities of using agent technology to dynamic breakdown of electrical power supply system for example. 'Islanding' of subsystems and to study how agents can be used for implementation of flexible control strategies.
Electricity demand as frequency controlled re-serve	2006	2008	CET-DTU	*http://www.danskenergi.dk/AndreSider/Smart_Grid_Oversigt/1009.aspx*	The project developed technology for demand frequency controlled reserve (DFR) implementation, a system that automatically stops or starts electricity consumption in response to system frequency variations. The developed technology is able to supply reserve electricity and to improve electricity system frequency control.
Interactive meters, activating price flexible power consumption	2006	2009	DONG Energy A/S		It is technically possible to manage and activate the potential for flexible electricity consumption in the segment of large office blocks and public buildings. Practical experiments have shown that it is somewhat more expensive to achieve flexibility in power consumption for old buildings than for newly built properties
Integration and management of wind power in The Danish electricity system	2007	2009	Department of Energy Technology- Aalborg University		The project establishes a new model of the Danish electricity system in the form of two buses, to which new models of load and production units are connected in the form of centralised and local power plants, onshore and offshore wind turbines and grid connections to Norway, Sweden and Germany.
Energy Forecast	2007	2010	Rambøll		The purpose of this project is to address the following barriers: 1. Lack of suitable power supply agreements, meeting both the clients' demand for cost stability and – at the same time – encourages a demand response. 2. Lack of information and awareness about the possibilities and opportunities of demand response.
EcoGrid Denmark	2007	2009	Danish Technological Institute (DTU)		To develop new long term technologies and market solutions for power systems with increased share of distributed generation and renewable energy sources while maintaining the reliability of supply.
Flexcom	2008	2010	Risø DTU		The project aims at producing a conceptual framework for the unified and extensible representation and exchange of power system information and data. The aim is not to produce a new communication standard; it will instead focus on concept design and proof-of-concept testing (to provide input to the existing standardisation effort).
Remote Services for CHP	2009	2010	Eurisco		The main purpose of the project is to analyse and develop a concept for remote supervision of Combined Heat and Power plants.
Proactive participation. of wind in electricity markets	2009	2010	EMD International		This project wants to demonstrate that wind turbines themselves may deliver an important part of the balancing tasks needed, thus reducing high unbalance prices and promoting the development of wind energy in Europe.
Intelligent Remote Control for Heat Pumps	2010	2011	Nordjysk Elhandel A/S		The project will develop and demonstrate an intelligent remote control system for individual heating pumps by enabling the balance responsible party to plan consumption and deliver regulatory power and by internal balancing and possibly primary reserves.
Heat Pumps as an active tool in the energy	2010	2012	Danish Technological Institute.		Heat pumps will provide flexibility due to the possibility to either increase, decrease or interrupt the power consumption. The project will deal with the ability of heat pumps to operate in so-called Virtual

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supply system					Power Plants to deliver regulating power and to react on spot-market electricity prices.
PV-Island Bornholm	2010	2012	EnergiMidt A/S		The 'PV Island Bornholm' (PVIB) project aims at establishing 5 MWp PV on the island of Born-holm. App. 1MWp of them will be installed during this phase. PVIB will focus on demonstration and further utilisation of PV and as such provide unique facilities to test how PV as a fluctuating energy source can be implemented in a future intelligent power system
Information and education of the future power consumer.	2011	2014	Østkraft Holding A/S		This project focuses on customer behaviour and what actions are needed to inform the customer so that he actually changes his behaviour. The project will result in brochures, a new energy consultancy service and education of teenagers following a youth education programmes.
SmartGrid Fuel Call CHP on Bornholm	2011	2011	Dantherm Power A/S		The project will introduce power producing elements to the SmartGrid implemented in the 'Ec-oGrid.EU' project executed on Bornholm. The power producing elements will be based on fuel cell technology and will produce both electricity and heat for e.g. central/district heating. FCCHP units
Marina power dist. hub with smart-grid functionality.	2011	2012	Danish Technological Institute (DTU)		Pilot project will analyse the need for and potential of a marina power distribution hub with smart-grid functionality for the expected increasing share of electrical tour- and pleasure boats in Denmark
Plug n' play-koncept for intelligent indeklimastyring	2011	2013	Neogrid Technologies		A concept for energy efficient control of air-air heat pumps and electric storage water heaters with focus on indoor climate. energy savings and demand response is developed
Distribution System planning for Smart Grids	2011	2012	Risø DTU		The purpose of the project is to identify limitations of existing simulation and planning tools for distribution grids. with a particular focus on the challenges imposed by the introduction of smart grid technologies
Large-scale demonstration of charging of electric vehicles	2011	2013	ChoosEV A/S		Developing of ChoosCOM for intelligent charging and communication with electric cars and is test it by 2400 families in 300 EVs. Main investigation is whether it is possible to move the charge of EVs to a more production and environmental friendly time – and is the EV owner interested in it.
Smart neighbouring heat supply based on ground heat pumps	2011	2012	Solrød Municipality		The proposed projects is to develop and demonstrate the concept of 'neighbouring heating' (i.e. heat supply to a cluster of 10-20 individual houses from a central plant) based on smart control of a heat pump in a combination with a hot water storage. Where the possibilities of 'tapping' cheap electricity from the grid in periods with low electricity demand or/and high wind production are analysed and demonstrated.
Application of smart grid in photovoltaic power systems	2011	2014	Danfoss Solar Inverters	*http://pvnet.dk/*	The target of the proposed project is to study how to integrate large amount of RES into the network without having to reinforce the network. This is done by examining different types of grid voltage control. applying smart grid functionalities and introducing other ancillary services integrated into the RES
Electricity demand as frequency controlled	2009	2012	CET-DTU	*http://www.dtu.dk/centre/cet/English/research/projects/26_Demand_as_frequency_controlled_reserve.asp*	This project focuses on investigating the appropriate use of demands as frequency reserve (DFR) with strong focus on hardware development and demonstration in a practical power system based on our previous research. The project will have as objectives to:

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	reserves				x	a)Practical hardware development of the technology for frequency controlled demand b)Validate and evaluate the technology's field performance of reserve provision c)Evaluate the technology's actual impacts on appliance operation through large-scale demonstration of hundreds of such devices. d) Test and further develop monitoring methods for DFR appliances concerning the needs of the transmission system operator (TSO) e) Obtain first-hand experience and feedbacks, and evaluate customer's acceptance of the technology. f) Further develop DFR control logics to fulfil specific rules of UCTE and Nordel.
	Real-time demonstration of Bornholm electricity network with high wind power penetration	2009	2012	CET-DTU		Create a research platform where elements of future the energy system can be tested. Testing can be performed from the laboratory level and up to full scale demonstration on Bornholm.
	Prøv1Elbil	2009	2012	Danish Technological Institute (DTU)	*http://www.teknologisk.dk/26116*	The project is collaboration between Danish Technological Institute. Region Midtjylland Energi Horsens and NRGi. The purpose is to collect information on driving patterns needs and user experiences, charging times and patterns and loads on the network.
	Development of a Secure, Economic and Environmentally friendly Modern Power System	2010	2014	Department of Energy Technology- Aalborg University		The project develops a number of new concepts and intelligent approaches for a modern power system which includes renewable energy, storage units, distributed generation, plug-in hybrid electric vehicles etc.
	Systems with High Level Integration of Renewable Generation Units	2007	2009	Department of Energy Technology- Aalborg University		The project developed probabilistic methods for optimum operation and planning of contemporary distribution systems including probabilistic models for wind power, small-scale CHP plants and load.
	iPower	2011	2016	Risø DTU	*http://www.ipower-net.dk/*	The goal of the platform is to contribute to the development of an intelligent and flexible electricity system capable of handling a large part of sustainable electricity production in areas where production varies due to weather conditions (sun. wind etc.).
	Self-organising control of a distrib.energy system with a high penetration of renewable energy	2007	2010	DTU Informatics		The project studied aspects of the basis for distributed resources such as wind turbines, photovoltaic and not least consumers participating in power system control, including the aspect of how build-up of such control can be automated.
	From wind power to heat pumps	2009	2011	Energinet.dk	*http://www.energinet.dk/EN/FORSKNING/Energinet-dks-forskning-og-*	The idea is to control 300 intelligent heat pumps as if they were one big energy storage facility capable of storing electricity as heat. The house owners will thus be involved in developing the intelligent power system of the future, using wind power to replace

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Project name	Period		Lead organisation	Website	Project description
				udvikling/Sider/Fra-vindkraft-til-varmepumper.aspx	fossil fuels for heating purposes.
EVCOM	2008	2010	Energinet.dk		The primary purpose is to establish a concept for electric vehicles and their communication with the power system. The concept disseminated to the standardisation work and to relevant stakeholders.
Concept for Management of the Future Electricity System	2009	2011	Energinet.dk		To develop and describe a concept for the necessary and sufficient management of the future power system in 2025. The concept description should be at a level that allows a subsequent breakdown in specific projects to an early-stage phased rollout.
Smart Grid Task Force project	2009	2010	Energinet.dk		To describe and calculate a ‘Danish business case for full smart grid dissemination’ from a socio economical perspective.
NextGen	2006	2010	CET-DTU		To contribute to the development of next generation communication system for system integration of distributed generation (NextGen) based on the new international IEC61850-family of open standards developed in these years.
DataHub project	2009	2012	Energinet.dk	*http://www.energinet.dk/EN/El/Datahub/Sider/DataHub.aspx*	A more free competition in the Danish electricity market, easier access to information and more transparency for consumers who choose to switch supplier. A desire for more standardised communication between players on the Danish electricity market
Project ‘Intelligent home’	2009	2011	SEAS-NVE		The aim is through information to customers to achieve energy-saving behaviour change by making visible the biggest energy consumers. The project also include the management of individual components based on defined conditions
Electricity for road transport. flexible power systems and wind power	2008	2011	Risø DTU		The project aims to analyse the interaction between the electricity/CHP industry and the trans-port industry in a situation of increased use of electric cars and plug-in hybrid cars. The project focuses on all the technical aspects in the chain: the status of the electric car, testing of hybrid cars in a local electricity grid, connection points as well as the load and capacity requirements of the electricity grid.
System services from small-scale distributed energy resources	2011	2014	DTU Centre for Electric Technology		This project will through experimental testing develop methods and procedures for the validation of the ability of DER to deliver system services to the electric power system satisfying the needs and requirements of the Transmission (TSO) and Distribution (DSO) System Operators. To achieve the overall energy policy targets an increased integration and coordination of distributed (mainly renewable) energy production facilities into the Danish energy systems is required. This integration shall comprise a large number of distributed, renewable energy sources.
PowerLabDK	2012	2015	DTU Centre for Electric Technology		PowerLabDK is a collation of internationally world-class research facilities for electric power and energy, ranging from flexible laboratories over large-scale experimental facilities to a complete full-scale electric power system at Bornholm.
SOSPO – Secure Operation of Sustainable Power Systems	2012	2015	DTU Centre for Electric Technology		SOSPO, focus is on how control of the power system, at transmission level, needs to be changed to meet the needs of stable and uninterrupted power, despite the fluctuating energy sources in the grid of the future.
EDGE – Efficient	2012	2016	University of Aalborg		The mission of the Efficient Distribution of Green Energy (EDGE) project is to radically improve integration of wind energy in the power grid through effective coordination of

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	Distribution of Green Energy					both electricity generation and consumption. Specifically, the project aims at developing rigorous methods for managing the flow of energy among actors – consumers and producers – connected to the power grid.
	INCAP	2012	2016	University of Copenhagen	*http://dev.energiforskning.omega.oitudv.dk/en/projects/detail?page=9*	INCAP: Inducing consumer adoption of automated reaction technology for dynamic power pricing tariffs. Can consumers be induced to adopt varying tariffs and automatic response technology for common household appliances at costs that make this socially attractive? The project implements a large scale field experiment using an automatic response application for a common appliance (e.g. refrigerators).
	DREAM – Danish Renewable Energy Aligned Markets-phase 1	2012	2013	Danish Technological Institute		DREAM phase 1 provides the necessary analysis and design of end user solutions in order to make a reliable and financial accountable full scale demonstration in succeeding projects with large amount of heat pumps, electric vehicles and smart grid technology.
	ESWA – Energy Smart Water Utilities	2012	2014	Aarhus Vand A/S		The purpose of the project is to map and assess the potential for a water utility to adapt current operating practices to respond to the needs of a the electricity system through a flexible demand driven by a market signal for electricity; and by extrapolation to estimate the potential for the entire Danish water utility sector.
	Smart Grid in agriculture – Demonstration Samsø	2012	2014	Danish Technological Institute	*n/a*	This project is focusing on the electricity consumption of the agriculture on Samsø. The agricultures/farms are going to be active players in smart grids together with other manufacturing industries. In the future, the farms will have their own production of renewable energy which is of great importance for the success of the future smart grid.
	READY – Smart Grid ready VPP controller for heat pumps	2012	2014	Nordjysk Elhandel	*n/a*	The aim is analysing, developing and demonstrating a smart grid ready Virtual Power Plant controller that includes the complex challenges of large scale demonstration with demand flexibility, balancing possibilities, grid constraints, optimising across a pool of heat pumps, house models, user comfort, acceptability and business models.
	SmartGrid ready Battery Energy Storage System	2012	2014	Danish Technological Institute, Denmark	*n/a*	The purpose of the project is to generate hands-on experience of developing and operating a battery energy storage system in the renewable energy based power system of the future. During the project an efficient project team will develop and test a 600 kW/1.2 MWh energy storage, which will provide high value grid services.
	TotalFlex	2012	2015	Neogrid Technologies, Denmark	*http://www.totalflex.dk/In%20English/*	TotalFlex is a demonstration project that intelligently manages flexible consumption and production. This is done by flex-offers from a technical and commercial VPP, which are traded on a marketplace. Thereby the full flexibility is utilised in an optimum way, while power-balance-liability and network capacity is taken into account.
	Consumer acceptance of intelligent charging	2012	2015	DTU Transport		Batteries of electric vehicles are a potential storage for excess power supply. The project investigates the users of EVs' willingness to participate in intelligent charging and the consequences of actual driving patterns for the recharging infrastructure.

FINLAND	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
FINLAND	Sustainable urban living	2009	2013	Fortum Electricity solutions and distribution	*http://www.abb.com/cawp/seitp202/38b6123726551d78c12579920037911e.aspx*	'Sustainable Urban Living' develops a new building concept for urban residential construction aiming to minimise the energy consumption and enable customers to make intelligent choice for conserving energy.
	Smart grids and energy markets (SGEM)	2009	2014	Cleen Oy	*http://www.cleen.fi/en/sgem*	The aim of the Smart Grids and Energy Markets (SGEM) research programme is to develop international smart grid solutions that can be demonstrated in a real environment utilising Finnish R&D infrastructure. At the same time, the benefits of an interactive international research environment will accumulate the know-how of world-leading ICT and smart grid providers.
	Zone concept and smart protection pilot	2010	2013	Fortum Sahkonsiirto Oy.	*n/a*	The pilot aims to test a smart protection concept which should reduce the outage times and automation investment needs. The system consists of central unit in the primary substation which analyses the network status and faults
	HEMS-Pilot project Home Energy Management Systems	2011	2012	Vattenfall Verkko Oy	*http://www.therecorporation.com/se/node/130*	The goal of the project is to develop new energy efficiency services for households and to offer opportunities for the electricity market to develop new services. The aim of the project is also to create household services that meet the energy efficiency goals of the European Union concerning more efficient household energy usage.
	HEAT 07	2007	2008	SYKE-Finnish Environment Institute	*http://kirjasto.ymparisto.fi/lib4/src?PBFORMTYPE=01002&TITLEID=22390&SQS=1:SYEN:1:0:5:15::HTML&PL=0*	The HEAT'07 project was designed to test improvement of the means available for consumers to get information on their energy consumption and to collect the consumers' experiences related to the possibilities of following the consumption at run-time. Another purpose was to test BaseN platform developed for a real-time measurement and results visualisation.
	MPC:Mobile Power Connections	2011	2012	Aidon Oy	*http://www.tekes.fi/programmes/EVE/Projects?id=10435024*	Mobile Power Connection -project aims to develop a service concept, which enables electricity consumers to secure the amount of used electricity power independent from the point of delivery. The goal of the project is to create intelligent metering system, which enables reliable remote electricity power metering, telecommunication and customer invoicing from mobile loading points. Project is mainly focusing to create overall solution for PHEV/EV slow charging with existing infrastructure and develop business model for the concept.

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FRANCE	PREMIO- 'Production Répartie, Enr et MDE, Intégrées	2008	2012	CAPENERGIE	*http://www.projetpremio.fr/*	PREMIO is primarily a technical proposal created to address multiple goals. PREMIO combines the control of installed Distributed Resources for optimal use with an awareness campaign promoting Demand Side Management (DSM). The PREMIO platform includes a Virtual Power Plant (VPP) which integrates approximately fifty Distributed

FRANCE	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
	et Optimisées'					Resources, all of which are Distributed Generation, storage technologies and customers' curtail able loads. The limited number of installations suggests that project results will be qualitative rather than quantitative.
	ECOFFICES – Energy Challenge within OFFICES	2011	2011	CSTB – Centre Scientifique et Technique du Bâtiment	*www.ecoffices.com*	The idea of ECOFFICES is to achieve an 'Energy challenge within offices' by inciting employees to an intelligent use of energy in a fun and interactive way. The competition is based on real-time energy usage data of the employees within the offices.
	EnR-Pool	2012	2015	Enel Distribuzione SpA		The 'EnR-Pool' project is aiming to provide solutions to the problem of balance between renewable production and consumption of electricity, based on active participation of consumers. The aim is to validate the technical feasibility and to develop systems and business models for operating and enhancing the efforts of all parties (consumer, producer, actor and manager of network equilibrium) for a better integration of renewable energy in the electrical system.
	Greenlys	2012	2016	ERDF	*http://www.greenlys.fr/*	GreenLys is a systemic smart grid project which includes: – DER – Consumption – Networks (DSO & TSO) Main Goals: – decrease of greenhouse gases – control of energy bill – introduction and control of DER on LV networks – behaviour of consumers, with incentive and innovative new offers – aggregator functions Innovations: – Smart management of grid (seal-healing, smart metering using Linky infrastructure,...) – Demand Side Management, Demand/Response, energy saving and new offers (using boxes linked to Linky Infrastructure, tariffs, dynamic prices policy...) – Investments, Impact on studies and development of networks (especially for DSOs)
	VENTEEA	2012	2015	ERDF	*www.venteea.fr*	The demonstrator is focused on the integration of large wind energy in distribution networks. More precisely the project will study observability and controllability of wind-farms, voltage regulation and centralised local protection plan and power quality. If the costs benefits analysis is validated by all involved stakeholders, a battery storage system offering a full service package would be implemented on 20 kV level.
	MYRTE	2009	2015	Université de Corse		The aim of the platform is to develop MYRTLE system and a control strategy to improve the management and the stabilisation of the electrical network. Hydrogen produced and stored to manage fluctuations in power energy intermittent renewable integrated in the network. It will examine the system's ability to meet a goal of clipping the tip called by the grid and smoothing of the photovoltaic power produced.
	GRIDTEAMS	2010	2012	GRIDPOCKET, FRANCE		The aim of this project is to help people to handle their own load curve. With home installation of a smart meter, provide and support by the WIT inc., the Web platform empowered by Gridpocket use both an energy analysis lead by scientists from Mines ParisTech and a behavioural overview by sociologist from Telecom ParisTech to provide a scope of consumption with two points, a starting one: the actual consumption and a target: the lowest consumption reachable. The effort for a better behaviour is nudged with little rewards.
	REFLEXE: Electric Flexibility Response for Smart Grids	2010	2013	Veolia Environnement	*http://www.veolia.com/en/medias/press-releases/reflexe.htm*	The Réflexe project consists in implementing a smart grid pilot in France's Provence-Alpes-Côte d'Azur region. The new electric grid will integrate many diverse and widespread sources of decentralised generation, storage and consumption. It will therefore have to manage considerable amounts of information in real time using a communication network in parallel. As the link between electricity producers and

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					consumers, ‘energy aggregators’ will have the role of monitoring in real time all local installations in order to produce locally, store power and supply it to the grid as required.
MODELEC: optimiser la gestion des usages électriques résidentiels	2012	2014	Direct Energie		This is a pilot project on the behavioural adoption of Energy Efficiency services and Demand Response programmes over 1 000 homes in France. The project proposes to examine customers’ behaviour in situations of peak demand where additional fossil fuel generation sources used. The interest is to shift some consumers use during peak periods to limit the use of carbon sources of energy. Precise knowledge of the customer’s consumption, accompaniment through tools and tips to automatically control some equipment and to change their behaviour, give them the means to minimise their overall annual consumption.
MILLENER: control demand of individuals and improve the integration of renewable energies in the islands.	2012	2016	EDF	*http://investissement-avenir.gouvernement.fr/content/l%E2%80%99etat-engage-28-m%E2%82%AC-pour-des-projets-r%C3%A9seaux-electriques-intelligents-smartgrids*	The research project MILLENER aims to reduce the electricity consumption of customers and to better integrate intermittent renewables into distribution networks in order to ensure real-time the balance between electricity demand and production. It takes into account the specificities of a non-isolated network interconnected, such as islands, and the need to educate users to control their consumption. These experiments will consist of facilities photovoltaic panels, energy storage systems and control of electrical consumers.
SMART ZAE	2010	2013	SCLE SFE		Smart ZAE(démontrer qu’une Zone d’Activité Economique peut être une brique élémentaire intelligente du réseau électrique) project aims to show that by means of renewable energy production, storage, low environmental impact and Management System (BMS), an area of economic activity (AEZ) may constitute a ‘building block ‘a smart electricity grid. The project will reduce consumption called on the distribution network to support the network in case of need, and increase the production of renewable electricity in creating value. The project will be deployed in the region of Toulouse, on a site that already has 125 kW and 15 kW photovoltaic and wind power. A solution of electricity storage by flywheel 10 kW will be developed so as to fit the site of a 100 kW inertial storage in addition to an electrochemical storage.
OMERE (GE & IPERD): Optimisation et Maîtrise des Energies renouvelables et du Réseau Electrique	2011	2014	General Electric		The project OMERE (Optimisation and Control of Renewable Energy and Electricity Network) aims to implement a full range of solutions for the optimisation of electrical networks and improving reliability. It is based on the use and combination of interdependent technologies on renewable energy, storage, distribution and demand management. OMERE combines the scientific and sociological studies to validate the relevance of communication technologies on the network and their applications at all levels (producers, distributors, manufacturers, users and communities).

 Germany	Project name	Period		Lead organisation	Website	Project description
Germany	Model City Mannheim	2008	2012	MVV Energie	*http://www.modellstadt-mannheim.de/moma/web/de/home/index.html*	Within the framework of the E-Energy project a representative large-scale trial is being conducted both in Mannheim 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.
	eTelligence	2009	2012	EWE AG	*www.etelligence.de*	The idea behind eTelligence is the intelligent system integration of electricity generation and consumption. To this aim the project will develop and field-tests: • a regional market place for electricity; • feedback systems. tariffs and incentive programmes; • power generation and demand side control systems;
	Mini E-Berlin	2008	2010	Vattenfall Europe Innovation GmbH	*http://www.vattenfall.com/en/mini-e-berlin-powered-by-vatt_107362.htm*	The functional demonstration MINI E Berlin powered by Vattenfall is a cooperation between Vattenfall and BMW. There are 50 MINI E (35 kWh. range ~ 180-200 km. max speed 152 km/h) mostly used by Berlin residents but also in fleet applications. Vattenfall delivers the required intelligent charging applications, the hardware for charging in private and public environments, and the electricity from RES keeping the whole project CO2-neutral. The EVs (MINI E) should function as energy storage capacity to help balancing the grid during periods of high energy feed-ins by RES.
	ADELE Project AA-CAES	2009	2013	RWE Power AG	*http://www.rwe.com/web/cms/mediablob/en/391748/data/364260/1/rwe-power-ag/innovations/adele/Brochure-ADELE.pdf*	COMPRESSED-AIR ENERGY STORAGE (CAES) as buffer for electricity from wind and sun. The aim of the new joint project is to develop an adiabatic CAES power station up to bidding maturity for a first demonstration plant.
	E-Energy Project 'MeRegio' (Minimum Emission Regions)	2008	2012	EnBW Energie Baden-Württemberg AG (EnBW)	*http://www.meregio.de*	The Project MeRegio aims to demonstrate that a shift from the present-day power supply system to 'minimum emission regions' is possible by intelligently combining technical energy management and innovative ICT.
	Regenerative Modellregion Harz (RegModHarz)	2008	2012	Fraunhofer IWES	*www.regmodharz.de*	The objective of this project is the technical and economic development and integration of renewable energy sources (RES) by deploying modern information and communication technology (ICT). The project deals with the creation of an efficient energy infrastructure with a maximum share of regional renewable energies as well as with their organisation and operation under market conditions.
	Netze der Stromversorgung der Zukunft	2008	2011	RWE DAG	*http://www.rwe.com/web/cms/de/683570/smart-country/*	One of the most promising investigated grid structures will be demonstrated in a typical rural MV grid, which has to cope a massive implementation of RES. Several technologies like electronic sub-stations, automatic tap changer, the usage of the flexibility of a biogas plant etc. will be tested and demonstrated. Three components are tested in the course of the model project: newly developed voltage regulators for protecting against voltage fluctuations, recording and

GERMANY

Project name	Period		Lead organisation	Website	Project description
					communicating real-time production and consumption data, and using biogas storage to compensate for peaks in supply and demand.
E-DeMa	2009	2014	RWE RWN	*www.e-dema.de*	The goal of E-DeMa is to reach more energy benefits and efficiency for electricity generators, municipal utilities, device manufacturers and customers.
Virtual Power Plant	2008	2010	RWE DAG	*http://www.rwe.com/*	The aim of this pilot project is the demonstration of the technical and economic feasibility of the VPP concept-Within the project duration further decentralised power producer like CHP, Biomass or Wind turbines will be included into the VPP.
Smart Watts	2008	2012	Utilicount GmbH & Co. KG. Aachen	*www.smartwatts.de; www.utilicount.com*	The Smart Watts projects implements the concept of the ‚smart watt‘. i.e. the intelligent kWh: an open system, which enables new services, value added and increased efficiency for utility companies, device manufacturers, service providers and consumers.
IRIN: Innovative Regulierung für intelligente Netze	2009	2011	Verein zur Förderung der wissenschaftlichen Forschung in der Freien Hansestadt Bremen e.V. (VFwF)’	*http://www.bremer-energie-institut.de/irin/*	The research project aims to develop the institutional framework that guides efficient and effective network development towards smart grids
NET-ELAN	2008	2011	Forschungszentrum Jülich GmbH	*http://www.net-elan.de/*	This project aims to answer the question of whether and how it can be in terms of a multi-sector system solution. a number of vehicles with electrified drive components used both useful as a distributed energy storage in the electric network and the consumer side demand management. Conclusions will be drawn to the technical feasibility and potential barriers.
Harz.EE-Mobility	2009	2011	University Magdeburg	*https://www.harzee-mobility.de/*	The Harz.EE-mobility project aims to harness as much of this renewable energy as possible to enhance passenger mobility. By doing so, the project also aims to ensure the stability of energy networks, to boost economic performance and to foster energy security and climate protection.
Grid Integration of Offshore Windparks	2008	2011	Fraunhofer-Institut für Windenergie und Energiesystemtechnik (IWES)		‘With the WCMS the scattered wind farms have been combined in a cluster and the control room of the relevant network operator controlled centrally. While the wind farm cluster management system, the frequency and the voltage of power in the electric grid stable holding and secure network operation, provides calculates the forecasting software wind power management system using artificial neural networks based on weather forecasts, the expected wind power.
Grid-integration of Electricity Storage	2009	2011	Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. (FhG)		Not available
Yello Sparzähler online	2008	2009	Cisco	*http://newsroom.cisco.com/dlls/2009/prod_100509e.html*	Project aim is to create an intelligent energy system that allows customers to measure and control the power consumption of their electrical appliances, enabling them to reduce their monthly bills. In the current pilot, 70 homes and businesses have been selected to communicate intelligently with the local power grid and power sources over an Internet Protocol network. Customers can use Yello Sparzähler online to receive information about their electricity consumption in real time while, a home

GERMANY	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
						energy management system also allows them to set appliances to operate during off-peak periods.
	Electric mobility pilot region of Berlin-Potsdam, Project ‘BeMobility 2.0’, Subproject ‘Micro Smart Grid’	2011	2015	InnoZ GmbH	*http://www.now-gmbh.de/en/mobilitaet/stationary-applications/modellregionen-elektromobilitaet/berlinpotsdam.html*	• Integration of electric mobility with grid. • Smart- Charging to shave peaks and increase amount of renewable energy in consumption. • Integration of decentralised and volatile renewable energy production into mostly centrally administered grid feeding. • Research if it is feasible to use of Vehicle-2-Grid to support peak hour consumption. • To maximise the fleet charging with renewable energy sources and to reduce the CO_2 emissions of each car. • Development of new business-models to incorporate renewables, storage devices and electric fleets within the electricity market. • To research the effects of different storage devices and their interactions with each other and to determine what storage device is most feasible to be incorporated into electric vehicles and fleets and local grids. • To make the local micro smart grid independent and galvanised off the main grid.
	DESI — (Pervasive Energy-Sensitive ICT Production)	2011	2013	Deutsche Telekom AG	*http://www.desi-it2green.de/*	DESI aims at introducing load-adaptive mode into Telco network operation. In utility lingo, this turns a Telco network into a large consumer with demand-response capabilities. Furthermore, the UPS systems integrated into the network contain considerable energy storage capacity which is rendered accessible to smart grid use cases. A unified control framework as it is developed within DESI provides the communication infrastructure to impose complex optimisation algorithms onto load and storage management.
	Smart Nord: Smart Grids for Northern Germany	2012	2015	University of Oldenburg	*http://smartnord.de/projekt/*	In order to reliably substitute large-scale power plants that mainly rely on finite fossil fuels with distributed energy re-sources, system-stabilising tasks have to be shifted from the transmission system level to the distribution system level. In future, coalitions of distributed consumers, producers and storages providing active power by following concerted schedules or providing system services for frequency and voltage control therefore will have to comply with the same technical requirements as conventional power plants. Therefore, an agent-based concept for the coordinated and distributed provision of active power, reactive power and balancing power on the distribution system level will be developed.

GREECE	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
GREECE	Hybrid Energy project of Ikaria: Energy Sustainable	2007	2012	CEZ Distribuce a.s	*ftp://ftp.cordis.europa.eu/pub/eesd/docs/ev260901_poster_iren.pdf*	An integrated renewable energy network shall be built on Ikaria Island (Greece), allowing renewables to become the backbone of public power supplies. The system consists of: a) Small — Hydro Station: 4.1 MW hydro turbines which will be installed in conjunction with the existing water reservoir. b) Grid Master Control System: The

GREECE	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
	island for real life community					different types of generating machines to be installed in conjunction with the existing diesel and their parallel operation, will be controlled, coordinated and maximised by a ‘smart’ system (intelligent power dispatcher) regulating the availability of energy, frequency, voltage regulation, fuel economy, emission reduction and noise reduction. c) New wind turbines which will result to a total installed capacity of 2.7 MW. The reversal (pump storage) of the system and the return of the water at the high level reservoirs will be secured with the installation of pumps (2MW) that will utilise energy the hours of low demand produced by the wind turbines.

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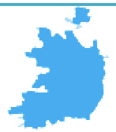
HUNGARY	E-mobility	2011	2011	ELMŰ-ÉMÁSZ Nyrt	*http://www.e-autozas.hu/e-mobility-network*	To get feedback about customer’s expectations for e-vehicles and charging infrastructure. To get information about charging behaviour and load profiles. Analysis of requirements of charging infrastructure. Defining home charging infrastructure and developing new tariffs.
	ETM (Distribution Network Automation on 10 kV cable line stations)	2009	2013	ELMŰ Hálózati Kft		Nearly 760 pieces of 10 kV switching stations (on cable networks) will be equipped by RTUs to provide remote observability and remote control. The communication (connection) is established via GSM network.

IRELAND	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
IRELAND	Smart green circuits. ESB Networks – Smart grid demonstration project	2010	2012	ESB Networks	*http://inventory.sei.ie/project/view/id/1304*	This project aims to enable the creation of smart green circuits, through the implementation of technology to reduce distribution losses, improve continuity with self-healing loops, optimally use distribution connected generation, evaluate and optimise system voltages and power factors and investigate optimal system sectionalisation and power flows.
	EV Network integration	2009	2013	ESB Networks	*http://inventory.sei.ie/project/view/id/1303*	This project will take two typical LV (220V) circuits, one urban and one rural and will examine in detail through modelling and through demonstration. the impact of EV’s on



IRELAND	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
						the network. The specific objectives of this project are: • Assess amount of Electric Vehicle Charging allowable on existing network; • Identification of low cost investments required to increase network EV capacity; • Assess impact on power quality of EV and how this can be kept within standard without unduly limiting use of EV; • Assess scope for use of EV in DSM through HAN control via Smart Meter; • Assess scope for future use of Electric Vehicle to Grid (V2G) operations; and • Assess (by simulation) the interaction between plugged-in vehicles and variable electricity (wind generated)
	Distributed connected wind farms	2010	2012	ESB Networks	*http://inventory.sei.ie/project/view/id/1302*	This project comprises three independent strands, all with the goal of enabling maximum wind generation penetration on the distribution system.
	Context Aware Electric Vehicle Charging Based on Real Time Energy Prices	2011	2012	Intel Corp U.K.	*http://virtualshowfloor.com/#/technology/power/context-aware-electric-vehicle-charging*	Manage EV charge scheduling based on predicted user needs, to avoid peak load charging, optimise the use or excess renewable generation, extend the vehicles usable battery life and reduce the cost of charging for the end user.

ITALY	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
ITALY	E-mobility	2008	2013	Enel	*http://www.e-mobilityitaly.it/*	E-mobility Italy enables the diffusion and the use of electric vehicles with state of the art recharging technologies, thanks to ad-hoc development of recharging infrastructure offering intelligent and secure services and respecting the environment. Smart® Electric vehicles will be provided to 140 customers and 400 recharging stations will be installed by Enel in Rome, Milan and Pisa. The new charging points will leverage Enel's technology, including the Enel smart meter as a kernel for providing all certified metering functionalities and guaranteeing uniformity with regard to data acquisition and final customer billing management. One of project's main applications is the Smart recharging of electric vehicles.
	Energy @ home	2009	2013	Enel Distribuzione SpA	*www.energy-home.it*	'Energy@Home' project aims to develop a system in which 'smart appliances' can manage themselves by adjusting power consumption depending on power supply and prices or in order to avoid overloads within the house. In addition Energy@Home provides information to the user such as power consumption of appliances, hourly cost of energy, green level of the energy being supplied; this information are made available on the user's PC, mobile or on the display of the appliance. Installation in residential homes of Energy@home system (Enel Smart Info, Telecom Gateway, Smart washing machine, Smart plugs, Application tools). It allows continuous real-time bidirectional information exchange between on one side utility,

ITALY

PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
					retailer, telecom and manufactures and on the other side appliances and energy generation plant in the houses.
STAmi: Advanced Metering Interface	2010	2011	Enel Distribuzione SpA	*http://www.enel.com/en-GB/innovation/smart_grids/development/stami/*	The project aims at developing a dedicated application for LV network management and business purposes which leverages the existing metering infrastructure. STAmi provides network operators with a dedicated web interface to collect on demand and real-time, specific high quality and accurate data stored in smart meters without additional load for the AMM system. Both the operators in the control room, in the back office and on field work operators (via tablet PC) are provided with a dedicated suite of functionalities and tools based on web interfaces.
ESTER. Enel integrated System for TEsts on stoRage	2009	2013	Enel		Not available
ASSM Tolentino	2011	2014	ASSM SPA		Not available
Isernia Project	2011	2014	Enel Distribuzione SpA	*http://www.enel.com/en-GB/innovation/smart_grids/development/isernia_project/*	Objective of the project is the implementation of innovative solutions under real operating conditions aiming at optimally regulating the bi-directional energy flow on the MV distribution networks while integrating DERs and assuring high system reliability and security. Advanced regulation of input flows is provided by optimising power exchanges between the nodes and the feeder.
POI Energie Rinnovabili e Risparmio Energetico 2007-2013	2009	2013	Enel Distribuzione SpA	*http://www.enel.com/en-GB/innovation/smart_grids/development/poi/*	'POI' is composed of 4 regional projects (Progetto Campania, Progetto Puglia, Progetto Calabria, Progetto Sicilia) aiming at 'increasing the share of renewable energy in the overall consumption, increasing the level of energy efficiency, promoting local development'. In this framework, the projects aim at facilitating the integration of Distributed Generation (DG) testing on pilot sites the evolution of the network management options towards an active/passive system, to maximise the integration of all energy sources in the network. The project focuses on the transformation of the network structure to allow the inclusion of PV plants ranging from 100 kW to 1MW.
PRIME – Progetto di Ricarica Intelligente per la Mobilità Elettrica	2011	2014	Enel Ingegneria Innovazione S.p.A.	*http://www.enel.it/it-IT/media_investor/comunicati/release.aspx?iddoc=1648204*	The Smart Charging for Electric Mobility project will analyse the tools required for the growth of electric mobility, identifying the most appropriate incentives to promote the diffusion of electric vehicles in Italy. The research includes a study of the behaviour of customers who choose the electric car and the quantification of the benefits deriving from 'green' mobility. The project analyses the impacts of charging stations for electric vehicles on the stability of the electric grid and contributes to the definition of the most appropriate regulatory measures in favour of the renewal of the car fleet in Italy. The project will support electric mobility pilot projects and study the regulatory measures necessary to promote the massive diffusion of electric vehicles in Italy.
SCHEMA – Innovative criteria for management and operation of a MV meshed network	2011	2014	Enel Distribuzione SpA		The intent of the project is to experiment, in a real MV distribution grid, a meshed network operation by adopting an advanced control system that will be realised through: • use of sensors and fault detectors along the relevant points of the network; • a communication infrastructure based on optical fibres combined with MV overhead cables of the distribution line itself. The basic element of the project will be a MV junction (i.e. two facing feeders connected together, starting from the same MV busbar) that will be operated as a meshed scheme.
INGRID- High-capacity	2012	2016	Engineering Ingegneria Informatica	*http://www.eng.it*	To effectively integrate larger yet decentralised, fluctuating renewable energy sources (within the 30-50% penetration level) without compromising grid reliability and

ITALY	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
	hydrogen-based green-energy storage solutions for grid balancing					security, based on effective rapid and safe hydrogen-based energy storage/deliver solutions capable to timely and instantaneously accept and manage any RES fluctuation and variability the main objectives of the INGRID project are (i) To effectively integrate larger yet decentralised, fluctuating renewable energy sources (within the 30-50% penetration level) without compromising grid reliability and security, based on effective rapid and safe hydrogen-based energy storage/deliver solutions capable to timely and instantaneously accept and manage any RES fluctuation and variability (ii) to design and make available advanced ICT monitoring and control tools aimed at simulating, managing, monitoring, controlling power dispatching in compliance with the power request of the grid, allowing a correct balance between variable energy supply and demand and simulate.
	Acea Distribuzione Smart Grid Pilot Project	2011	2013	Acea Distribuzione	*http://www.landisgyr.com/na/en/pub/about/news/news2010.cfm?news_ID=4847*	This project is characterised by six different actions: 1. Advanced auto-selection faulty section with the help of 'fast' hiperlan network; 2. Acquisition of electrical and environmental values for the MV and LV grids using TETRA/GPRS network; 3. New Criteria For Managing The MV Grid; 4. Photovoltaic plant + storage system + smart inverter + electric charge devices 5. Diagnostics for primary station; 6. Identification of transient fault point.
	A2A CP Lambrate	2011	2014	A2A		
	ASM Terni	2011	2014	ASM		A smart grid project by ASM (Terni Multi-utilities Municipal Company, around 65.000 customers, among the first 10 DSOs nationwide), awarded of the second place at national level by the Italian Energy & Gas Authority, will provide the fundamental infrastructure to implement proper services for increasing energy efficiency, use of renewables and e-mobility.
	A2A Gavardo	2011	2014	A2A		
	Smart Info	2010	2015	Enel Distribuzione SpA	*http://www.enel.com/en-GB/innovation/smart_grids/smart_homes/smart_info/*	Enel Smart Info provides information on electricity consumption and informs customers on off-peak time slots in order to guide them towards more sustainable consumption behaviours. Enel Smart Info is the key element of future smart homes, where the information displayed by the electronic meter through Enel Smart Info is transmitted to domestic appliances to make them work when consuming energy costs less.
	Deval PS Villeneuve	2011	2014	Deval PS		
	Assem San Severino Marche	2011	2014	Assem SPA		

NETHER LANDS	PROJECT NAME	PERIOD	LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION

NETHERLANDS	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
	DA (Distribution Automation)	2007	2010	Enexis		Building an integrated architecture (i.c.: interaction between business-processes. information-architecture and primary network layout) to maximise Enexis' MV-grid performance (10-20 kV)
	Fieldtrail Mobile Smart Grid	2010	2011	Enexis	*http://www.mobilesmartgrid.eu/index.php?id=9*	Demonstrate an earlier tested proof-of-concept (PoC) for demand response with one EV on multiple EVs and charge spots in one location based on individual driver demands.
	Demonstration project Smart Charging	2010	2011	Enexis	*http://jurjendejong.wordpress.com/smart-charging-project-in-the-netherlands/*	Test and demonstrate an environment in which commercial market parties are enabled to provide charge services to EV customers in cooperation with EV infrastructure parties and grid operators. This taking into account roaming of customers and demand side management based. The project, which will initially involve 15 charge spots and 15-20 drivers, is designed to simulate how in the future large numbers of consumers will be able to make easy and affordable use of their electric vehicles.
	Jouw Energie Moment (Easy Street & Meulenspie)	2011	2014	Enexis	*www.jouwenergiemoment.nl*	Insight into the workings of technology incentives and interaction in order to mobilise flexibility from customer's electricity usage in the city of Breda (Easy Street & Meulenspie). Participants will be provided with products and services to enable them to choose their preferred times to use electricity. Equipped with a special display and a smart washing machine, users will be able to choose whether they want to run their washing machine during times when their local sustainable electricity is produced by PV panels or at those when the cost of electricity is low on the wholesale market.
NETHERLANDS	Smart Energy Collective	2010	2013	KEMA Netherlands	*www.smartenergycollective.com*	The Smart Energy Collective seeks to secure an affordable and reliable energy supply in the changing situation of electricity system and enable the end-users to control their own (renewable) energy management in a comfortable way. The project includes five large-scale sites where advanced technologies and new services (smart grids and energy services) are tested in close collaboration with industries and end-users.
	Smart Power System – First trial	2006	2007	ECN. Energy research Centre of the Netherlands		The main goal of the field test was to demonstrate the ability of such a VPP to reduce the local peak load on the single low-voltage grid segment the micro-CHP units were connected to.
	Jouw Energie Moment (Muziekwijk Zwolle)	2012	2015	Enexis	*www.jouwenergiemoment.nl*	Insight into the workings of technology incentives and interaction in order to mobilise flexibility from customer's electricity usage in the city of Zwolle. Participants will be provided with products and services to enable them to choose their preferred times to use electricity. Equipped with a special display and a smart washing machine, users will be able to choose whether they want to run their washing machine during times when their local sustainable electricity is produced by PV panels or at those when the cost of electricity is low on the wholesale market.
	PowerMatching City II	2011	2014	RWE/Essent	*https://www.rwe.com/web/cms/en/453894/rwe/innovation/projects-technologies/energy-application/powermatching-city/*	In the PowerMatching City II pilot in Hoogkerk, the Netherlands, advanced smart grid technology is being tested and developed. This technology optimises the energy use of consumers by automatically shifting local energy production of micro CHP's as well as energy demand of various devices like electric vehicles, washing machines and heat pumps. Hoogkerk II is about exploring this new role of the energy supplier. The project will be expanded with more smart homes and electric vehicles, but the main part of the project is about the interaction with the prosumers and the energy market. Build on the infrastructure of Hoogkerk, new services and products will be tested
	Intelligent E-Transport Management	2008	2010	KEMA	*http://www.itm-project.nl/info.html*	The purpose of the project is to reduce the large difference in demand during the day and night project and to make it possible to fit in 6.000 MWe wind energy in the Netherlands in the grid and continue reliable electricity supply

Country	Project name	Period		Lead organisation	Website	Project description
Netherlands	(ITM)					
	Smart Substation (IntDS)	2007	2010	ECN. Energy research Centre of the Netherlands	*http://www.smartsubstation.eu/contact/*	The aim of this project is to design an intelligent 400 kVA. MV/LV distribution station (IntDS) that will allow power flow fluctuations to be managed while maintaining power quality, reliability and security of supply. A full-scale prototype was assembled and extensively tested at the Flex Power Grid Lab (FPG Lab). It was then installed in a live test grid as a pilot.

Country	Project name	Period		Lead organisation	Website	Project description
Poland	The metering data processing and central repository concept	2010	2011	PSE Operator S.A	*www.piio.pl*	The goal of the project is to prepare cost benefit analysis of smart metering implementation in Poland and to develop the legal and organisational framework to implement metering data processing and central repository concept.
	Introduction of emergency Demand Side Response (DSR) programmes	2011	2012	PSE Operator S.A	*www.piio.pl*	The main goal of the pilot project is to gain practical experience of the functioning of emergency DSR programmes in smart grid/smart meters environment. This experience will be used to develop the target DSR programmes
	The Smart Peninsula- pilot project of smart grid deployment at ENERGA-OPERATOR SA	2011	2012	ENERGA-OPERATOR SA Poland		The main objective of the smart grid pilot project in the Hel Peninsula is to check its basic elements and to develop an implementation concept for similar projects across ENERGA-OPERATOR SA. It has been assumed that the scope of the project should include medium and low voltage grids. Subject to checking – by way of practical implementation – are project elements such as: ● central part – IT system integrated with SCADA at the Regional Power Dispatch level, ● telecommunication infrastructure, ● automation, control, and measuring equipment in MV and LV grids, ● installation in LV grid of distributed generation such as photovoltaic cells, wind turbines, as well as heat pumps, smart street lighting, and electric vehicle charging stations.

Country	Project name	Period		Lead organisation	Website	Project description
Portugal	Inovgrid	2008	2013	EDP Distribucao SA	*http://www.inovcity.pt/en/Pages/inovgrid.aspx*	Inovgrid aims to realistically demonstrate smart grid concepts for a significant number of users, by means of novel integrated management tools that will: • Improve service quality; • Promote Distribution Network Remote management; • Reduce operating costs; • Promote a more active role for customers/producers; • Support new

	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
						commercial services; • Increase energy efficiency; • Exploit the potential of DG; • Enables the integration of Electric Vehicles Charging Network.

	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
SLOVENIA	Advanced Systems of Efficient Use of Electrical Energy – SURE	2011	2014	Teces	*http://www.teces.si/prikazi.asp?vsebina=predstavitev%2Freference_skupno.asp&jezik=1033*	The main purpose of the project is to build active network concepts based on new technological solutions and to test these solutions in actual power networks. In the frame of the project a number of demonstration projects in the field of active networks will be carried out. These demonstrations will include systems for increasing power system energy efficiency, implementations of virtual power plant, upgrade of the distribution remote control centre and automatic demand response of domestic consumers.
	Supermen	2009	2011	Iskra MIS d.d.	*http://www.projekt-supermen.si/*	Optimisation of the operation of distribution assets and improve the efficiency of the network through enhanced automation, monitoring protection and real time operation. Faster fault identification/resolution will help improve continuity of supply levels.
	Kybernet	2009	2011	INEA d.o.o.		The project objective is the development of a system prototype for control of industrial loads and dispersed electrical power plants on a distribution electrical grid
	SUMO	2011	2014	Elektro-Slovenija		Dynamic thermal rating will be incorporated in SCADA/EMS environment. Network analyses will use near real time system capabilities. Calculation of element ratings will use ambient parameters from relevant geographical areas
	WAMPAC	2011	2014	Elektro-Slovenija		Existing wide area measurement system will be upgraded with protection and control functions. Relevant critical operation scenarios will be investigated in due course.
	Tertiary reserve power with zero CO2 emission	2011	2014	Elektro-Slovenija		Demand side management and renewable producers will be integrated in TSO's ancillary services as additional tertiary reserve power for load frequency control.
	DCN4TSO	2004	2013	Elektro-Slovenija		DCN (data communication network) IP/MPLS data communication system for smart grid TSO operations and management. DCN system will enable smart protection, metering, energy management, automation and data exchange with other European TSO using standard protocols.

SPAIN	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
SPAIN	Smartcity Malaga	2009	2013	Endesa	*www.smartcitymalaga.com*	The goals of SmartCity Málaga can be summarised as follows: a) Test and deployment of the new energy management model; b) Implementation and integration of Distributed Energy Resources, energy Storage facilities. electric vehicles charging processes and intelligent public lighting devices into the new operation grid systems

SPAIN

PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
GAD Gestión Activa de la demanda	2007	2010	Iberdrola Distribucion	*http://www.proyectogad.com/*	The first aim of the GAD Demand Side Management Project is to optimise electrical energy consumption and the its associated costs at domestic level. while meeting consumer needs and maintaining quality standards
DER-IREC 22@Microgrid	2009	2011	GTD Sistemas de Informacion SA	*http://der-microgrid.gtd.es/home*	DER – IREC 22 @ MICROGRID is a research project focused to create products and services around Distributed Energy Resources (DER) and EV. The main goal is to build a platform where research could be done in order to integrate all those components into a new system of energy supply.
Sotavento H2 management system	2005	2012	Gas Natural Fenosa	*www.gasnaturalfenosa.com*	This facility is the highest electrolysis power installed at the European level. It consists of an electrolyser of 300 kW, a piston compressor, a 1 725 Nm3 H2 storage system and an engine of 55 kW. This pilot plant is being operated by Gas Natural Fenosa in order to extrapolate its behaviour to that of an industrial facility capable of managing all the production of Sotavento wind farm following different strategies: balancing, peak-shaving and increasing the capacity factor of the wind farm. The main goal of this facility is to achieve the management of the wind power produced by Sotavento wind farm, allowing that wind power can be a manageable source.
A complete and normalised 61850 substation	2009	2015	Red Eléctrica de España		Use the standard IEC61850 as a means to improve the design. maintenance and operation of the substation automation systems. Design a standard substation considering the existing and new solutions developed by the vendors collaborating in the project. Build and set-up in operation a IEC61850 HV substation.
Almacena	2009	2013	Red Eléctrica de España		Installation and testing of 1 MW electrochemical battery in a substation of the transmission grid
220 kV SSSC device for power flow control.	2009	2014	Red Eléctrica de España	*www.redes2025.es*	Design, construct, set up in operation and test a FACTS (SSSC) to prevent overload situations in the 220 kV transmission grid and reduce the measures that the System Operator has to make for solving overloads like reduce the meshing of the network or curtail wind production.
PRICE	2011	2014	GasNatural Fenosa/ Iberdrola	*http://www.priceproject.es/en*	PRICE will not only help to improve the operation and maintenance of the network, optimising the progressive integration of renewable energy and distributed generation and facilitate the mainstreaming of electric vehicles, but also it will allow marketers to offer new services to its customers

SWEDEN

	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
SWEDEN	Charging Infrastructure for Electric	2008	2010	Goteborg Energy AB		The project built and tested approximately 50 charging points, all of them equipped with smart meters enabling sub-metering at user specific level and remote on-off functionality. A one-stop-shop charging offer was tested on the market and further

Sweden	Project name	Period		Lead organisation	Website	Project description
	Vehicles					developed within the project. An internal development plan for charging of electrical vehicles was produced.
	Customer Value Proposition Smart Grid	2008	2012	Goteborg Energy AB		The company is undergoing an extensive change process going from partly manual to fully automated processes for energy consumption measurement on hourly basis and invoicing based on this. The project concerns the launching of hourly measuring and new hourly based tariffs.
	Smart Grid Gotland	2011	2016	GEAB	*www.smartgridgotland.com*	The Smart Grid Gotland R&D demonstration project intends to develop strategies for the planning, construction and operation of a fully developed, large-scale smart grid, including a large share of intermittent production, primarily from wind power in the distribution network. New market models and services will be developed to pave the way for new market players.
	Stockholm Royal seaport pre-study phase	2010	2011	Fortum Distribution AB	*http://stockholmroyalseaport.com/innovation/rd-projects/*	The pre-study for Stockholm Royal Seaport – an urban smart grid area, will deliver a concept description including market models and description of technical solutions ready for implementation and testing as a new project phase.
	Elforsk Smart grid programme	2011	2014	Elforsk AB		Elforsk Smart Grid Programme is driven as a national programmer for four years with financing and participating from Swedish utilities and other companies (e.g. ABB and Ericson). A common steering group takes decision for each project/sub project in the programme. The normal delivery from a project will be an open report available for all participants and normally also put on internet as a public document. The programme will also interact with other large pilot projects as Stockholm Royal Seaport with Fortum and ABB and Gotland Smart Grid project with Vattenfall and ABB.
	Smart Grid Hyllie	2012	2015	E.ON	*http://www.eib.org/attachments/general/events/malmo_290312_berne_karlsberg.pdf*	Hyllie – A test bed for developing solutions for a future transformed energy in the city of Malme. The project includes: a) Customer control of heat and electricity consumption b) Smart home and Smart building solutions c) Distributed generation – electricity and heat d) Smart grid solutions – DH and electricity e) Sustainable mobility solutions – gas and e-mobility f)CO2 and resource efficient energy supply g)Distributed energy storage

UK	Project name	Period		Lead organisation	Website	Project description
United Kingdom	Low Carbon London – A Learning Journey	2011	2014	UK Power Networks	*http://lowcarbonlondon.ukpowernetworks.co.uk/*	An integrated large-scale trial of the end-to-end electricity supply chain. Cumulative CO2 savings of 0.6 billion tonnes between 2011 and 2050. The Low Carbon London programme will create and evaluate innovative ways to deliver sustainable electricity to businesses and communities in a low carbon future.

UK

PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
Customer Led Network Revolution	2011	2013	CE Electric	*http://www.networkrevolution.co.uk/*	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.
Low Carbon Hub Lincolnshire	2011	2014	Central Networks	*http://www.westernpowerinnovation.co.uk/Lincolnshire-Low-Carbon-Hub.aspx*	Optimising renewable energy resources in Lincolnshire The low Carbon Hub will demonstrate how substantial levels of renewable generation can be connected to a primary distribution network.
LV Network Templates for a Low carbon` future	2011	2013	Western Power Distribution	*http://www.westernpower.co.uk/Renewable-Generation-and-Innovation/Low-Carbon-Networks-Project*	Assist in the design and planning of national networks in the future. in order to accommodate large-scale renewable generation and changes in customer utilisation.
Smart Grid Demonstration System	2010	2011	Arqiva		Arqiva will use its dedicated UHF spectrum combined with Sensus' purpose designed security measures, to provide a bespoke communications network for independent use by the UK's water, gas and electric utilities.
Cryogenic Storage	2010	2011	Highview Power Storage		The project is being run in two phases: Phase 1: the CryoGenset pilot demonstrator has been commissioned for six months and runs on a regular basis exporting electricity to the National Grid. Phase 2: the fully integrated CryoEnergy System. We are currently integrating the liquefier and aim to be running a fully integrated pilot plant during early 2011.
Clyde Gateway	2010	2015	Scottish Power Energy Networks	*http://www.spenergynetworks.co.uk/innovation/*	The proposals will demonstrate the integration of a number of smart grid components within an established infrastructure and will facilitate the development of solutions in a number of areas including power quality, HV/LV automation, auto-sectionalising / load-transfer etc. The application of the latest technologies on various smart grid components on a relatively small network will: • assist with the development of efficient and effective solutions; • provide learning outcomes not only on the smart aspects of the grid infrastructure but on design standards, network voltages and utilisation of assets; and • inform industry and the supply chain on smart grid challenges and solutions.
Data Exchange	2010	2011	National Grid		The Data Exchange was established to identify an enduring solution to the interaction between the STC and Grid Code regarding the exchange of User data.
Energy Demand Research Project (EDRP)	2007	2011	Department for Energy and Climate Change and Ofgem	*http://www.decc.gov.uk/en/content/cms/tackling/smart_meters/sup_res/gb_evidence/gb_evidence.aspx*	The Energy Demand Research Project (EDRP) was a major and unique suite of trials carried out in Great Britain. They investigated over 60 000 households' responses to improved feedback on their energy use. It was a government initiative test responses to feedback on energy use and smart metering.
Ashton Hayes Smart Village	2011	2013	Scottish Power Energy Networks	*http://www.spenergynetworks.com/innovation/ashton_hayes.asp?NavID=3&SubNavID=1*	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.

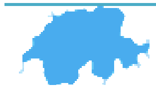
UK

PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
					• To improve the accuracy and granularity of total electricity consumption measurement by installing additional metering on the network at secondary substation feeder level and at renewable energy source(s) providing measurement of the gross generation embedded within the community. • 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.
Implementation of Real-Time Thermal Ratings (RTTR)	2010	2013	Scottish Power Energy Networks	*http://www.spenergynetworks.com/innovation/dynamic_thermal_rating.asp?NavID=3&SubNavID=3*	Renewable generation is often located in rural locations where there is little spare capacity of the distribution networks. This project aims to unlock extra capacity in the networks thus reducing reinforcement requirements and connection costs for wind generators. The scope of this project is to implement a dynamic real-time thermal rating (RTTR) system for overhead lines that gives the control room operators greater visibility of the actual thermal operating status of their network. The objective is to deliver the first active distribution network based implementation of this technology across a wide area of the network. The implementation will involve the installation of meteorological stations and monitoring equipment, the data from which will be processed to display real-time thermal ratings and conductor operating temperatures on a graphical user interface within the distribution network control room. Through open-loop analysis of the RTTR system, and confidence-building in the technology adoption, the system will then feed into an 'Active Network Management' project, which will facilitate and manage the connection of the wind farms on congested networks.
Hydro Active Network Management	2012	2014	Scottish Power Energy Networks	*http://www.sppowersystems.co.uk/innovation/*	The objective of this proposal is to prove the concept of a novel Active Network Management (ANM) approach as applied to a rural 11kV network area which contains several embedded generators (typically small hydro, with some wind). The intention is to develop an operational generation constraint scheme capable of facilitating the connection and management of additional Distributed Generation (DG) onto the SPEN network.
Flexible networks for a Low Carbon Future	2012	2015	Scottish Power Energy Networks	*http://www.spenergynetworks.com/innovation/*	Our solution will provide a 20% increase in network capacity through a number of innovative measures. This will create customer benefits enabling more customers to make the transition to new generation and demand technologies. The project involves enhanced monitoring and analysis to precisely determine existing performance, and the deployment of novel technology for improved network operation – including flexible control and dynamic rating. To ensure representative and replicable outputs, the project involves three carefully selected trial areas across SP Distribution and SP Manweb, covering various network topology and customer demographics: St Andrews in Scotland, Wrexham in Wales and Whitchurch in England.
Flexible Plug and Play Low Carbon Networks (FPP)	2012	2014	UK Power Networks	*http://www.ukpowernetworks.co.uk/internet/en/innovation/fpp/partners/*	Flexible Plug and Play aims to enable faster and cheaper integration of renewable generation, such as wind power, into the electricity distribution network. The project will achieve the faster and cheaper renewable generation connections by trialling innovative technical and commercial solutions with real customers). Specifically, the project will: • Deploy smart devices and systems on to the network that will make best use of the existing electricity network and allow real-time management of any network constraints.

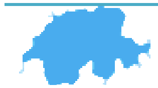
UK

PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
					• Deploy the first ‘Quadrature-booster’ onto the distribution network; the Quadrature-booster will balance the load on parallel circuits by forcing the power away from the weaker circuit. • Develop a new commercial framework for providing flexible connections to generator developers • Develop an investment modelling tool that will determine the optimum network investment from both an economic and carbon emission perspective
Orkney Smart Grid	2004	2009	Scottish and Southern Energy	*http://www.ssepd.co.uk/OrkneySmartGrid/*	An innovative new Active Network Management (ANM) approach was devised to make better use of the existing network by instructing generators to control their output, in real time, to match the available network capacity. It allows the power flows at several points on the network to be monitored, and power flows from multiple new renewable generators to be controlled. The technology is based around a central controller, which collects data from ‘pinch points’ geographically distributed around the network. The central controller identifies when power flows are approaching the limits of the network power rating and sends instructions to generators to reduce their output in time before problems occur. The system is designed to be failsafe to protect the network if generators do not respond correctly to control signals within specified time limits.
Capacity to Customers (C2C)	2012	2014	Electricity North West	*http://www.enwl.co.uk/c2c#*	A project that trials new operational techniques to release latent capacity within the existing high voltage (HV) network. This capacity is provided to ensure security of supply when network outages occur. The project will utilise this capacity by combining network automation and ‘interruptible’ contracts with large customers.
FALCON:Flexible Approaches for Low Carbon Optimised Networks	2011	2015	Western Power Distribution	*http://www.westernpowerinnovation.co.uk/Falcon.aspx*	A project deploying smart interventions on the HV network and novel commercial arrangements with customers. Data from these trials will be used to develop an investment tool to model where these techniques can be deployed efficiently across the whole HV network.
Buildings, Renewables and Integrated Storage, with Tariffs to Overcome network Limitations	2011	2015	Western Power Distribution	*http://www.westernpowerinnovation.co.uk/So-La-Bristol.aspx*	BRISTOL A small project investigating the potential for battery storage in conjunction with PV solar generation to be used within homes, schools and an office to provide network and customer benefits. A variable tariff will be trialled to incentivise customers to use the battery to reduce electricity consumption at peak times.
New Thames Valley Vision	2012	2017	Scottish and Southern Power Distribution		A large project which is primarily focused on developing a tool to help forecast where low carbon technologies might connect to the network. The project also trials network monitoring, energy storage and novel commercial arrangements with large customers.

NORWAY	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
NORWAY	Optimal Power Network design and Operation	2011	2014	Norwegian University of Science and Technology		Improved power system stability. planning and operation Training of PhD's Improved understanding of electricity market design to minimise operational losses
	Manage Smart in SmartGrid	2010	2012	Tieto Energy AS		The project aims to establish understanding and models for efficient energy management for private and public end-users based on AMI/AMS and a smarter power grid.
	Market Based Demand Response	2005	2008	SINTEF Energy Research	*http://www.energy.sintef.no/prosjekt/mabfot/*	The main objectives of the pilot study were to achieve daily load shifting and to explore customer acceptance and load curve impacts of hourly based tariffs and automatic load control schemes
	Smart Grid Pilot for aktiv regulering av spenning og reaktiv effekt i nett med lokal produksjon	2011	2013	SINTEF Energy Research	*http://www.energinorge.no/skjulte-prosjektforslag-2011/smart-grid-pilot-for-aktiv-regulering-av-spenning-og-reaktiv-effekt-i-nett-med-lokal-produksjon-article8310-561.html*	The project's main goal is to develop and demonstrate different strategies for control of voltage and reactive power in distribution network with local production. The strategies will be physically tested in the NTNU / SINTEF Smart Grid & Renewable Energy Laboratory and Helgelandskraft.



SWITZER LAND	PROJECT NAME	PERIOD		LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
SWITZER LAND	Decentralised customer-level under frequency load shed-ding in Switzerland	2010	2012	University of Applied Sciences. Northwestern Switzerland Swiss Federal Institute of Technology	*www.lokales-lastmanagement.ch*	The project focuses on a smart demand side management of household consumers. Modern communication technology enables the management of large groups of distributed loads under a single innovative control schemes to use the flexibility of electrical loads for power system purposes.
	ewz-Studie Smart Metering	2010	2012	ewz – Elektrizitätswerk der Stadt Zürich	*www.ewz.ch/smartmetering*	Conducting a field experiment to provide basic data for decision making whether or not to roll out home applications.
	Swiss2G	2010	2013	Kraftwerke Oberhasli (KWO)	*http://www.s2g.ch/it/home.html*	The project is divided into 2 parts, covers a total period of three years and is based in Mendrisio. In the first part of the project 20 candidates that will be selected and measurement tools will be installed to monitor the current situation of energy consumption of each. At the same time begin the installation work of the photovoltaic system, which will be equipped with every home. Once installed decentralised plants for the production of electricity, will continue with the monitoring of energy flows S2G with the algorithm to optimise the management of the local network. In the second part of the project (from the beginning of 2012) will instead be developed bidirectional battery charger, which will be equipped with electric vehicles of future. Candidates who may however buy an EV of last generation: this will further



SWITZERLAND	PROJECT NAME	PERIOD	LEAD ORGANISATION	WEBSITE	PROJECT DESCRIPTION
					investigate the concept of smart-grid, with a further option is represented by a battery (either an EV or as static application) that can not only be loaded but also store energy and return it to the network at times when demand requires it.
	FlexLast	2012 2013	IBM	*https://www.zurich.ibm.com/news/12/flexlast.html*	Migros, the Swiss supermarket, is part of a project involving electricity utility BKW and national grid operator Swissgrid, which aims to use the warehouses as a buffer to cope with the unpredictability of renewable energy sources. The firms have formed a consortium, called Flexlast, which is working on developing analytical models that predict the energy needs of a warehouse, and allow the electricity provider to divert resources elsewhere at times of lower consumption. In simple terms, when the wind blows and the sun shines, there will be abundant energy that Migros can use. When the weather changes, the utility firm can direct resources elsewhere, knowing that one of its biggest customers will continue to operate with a reduced supply.

Multinational	PROJECT NAME	PERIOD	LEAD ORGANISATION	PART.	WEBSITE	PROJECT DESCRIPTION
	Grid4EU	2011 2015	ERDF	CZ, FR, DE, IT, ES, SE	*http://www.grid4eu.eu/*	Grid4EU is led by a group of European DSOs and aims at testing in real size some innovative system concepts and technologies in order to highlight and help to remove some of the barriers to the smart grids deployment (technical. economic. societal. environmental or regulatory). It focuses on how DSOs can dynamically manage electricity supply and demand, which is crucial for integration of large amounts of renewable energy, and empowers consumers to become active participants in their energy choices.
MULTINATIONAL PROJECTS	Open Node	2010 2012	Atos Origin Sae	AT, FR, DE, NL, PT, ES	*http://www.opennode.eu/*	OpenNode project is focused on the electrical distribution grid operation and explores answers on the three challenges introduced: • How to improve the distribution grid monitoring to cope with volatile states in the grid • How to integrate the 'smart' substation automation devices to increase the efficiency of the distribution grid • How to interoperate with the different roles e.g. operation of the smart meters. power and grid operation
	EU-DEEP	2004 2009	GDF Suez	AT, BE, CY,CZ, FI, FR, DE, EL, HU, IT,LV, PL, ES, SE, UK, TR	*http://eudeep.com/*	The project brings together eight European energy utilities and aims at removing most of the technical and non-technical barriers that prevent a massive deployment of distributed energy resources (DER) in Europe. Project participants implemented a demand-pull rather than technology-push approach. This new approach provided three tentative 'fast-tracks options' to speed up the large-scale implementation of DER in Europe, by defining three client portfolios in various market segments which could benefit from DER solutions and by fostering the R&D required to adapt DER technologies to the demands of these segments.

Multinational

Project name	Period	Lead organisation	Part.	Website	Project description
E-price	2010 2013	Eindhoven University of Technology	IT, NL, HR, CH	*www.e-price-project.eu*	This project proposes an advanced ICT and control framework for ancillary services (reserve capacity) which allows a more intelligent solution by giving consumers and producers clear, real-time financial incentives to adapt their consumption/production according to the actual needs of the power system. This demand-side management is being made possible by the large scale introduction of Smart meters.
Fenix	2005 2009	Iberdrola Distribucion	AT, FR, DE, NL, RO, SI, ES, UK	*http://www.fenix-project.org/*	The objective of FENIX is to boost DER (Distributed Energy Resources) by maximising their contribution to the electric power system through aggregation into Large Scale Virtual Power Plants (LSVPP) and decentralised management. The project is organised in three phases: • Analysis of the DER contribution to the electrical system, assessed in two future scenarios (Northern and Southern) with realistic DER penetration; •Development of a layered communication and control solution validated for a comprehensive set of network use cases, including normal and abnormal operation, as well as recommendations to adapt international power standards; • Validation through 2 large field deployments, one focused on domestic CHP aggregation and the second aggregating large DER in LSVPPs (wind farms. industrial cogeneration), integrated with global network management and markets.
Open meter	2009 2011	Iberdrola Distribucion	BE, FR, DE, IT, NL, ES, CH	*http://www.openmeter.com/*	The main objective of the OPEN meter project is to specify a comprehensive set of open and public standards for Advanced Metering Infrastructure (AMI) supporting multi commodities (Electricity, Gas, Water and Heat), based on the agreement of the most relevant stakeholders in the area.
Address	2008 2013	Enel Distribuzione SpA	FR, IT, ES, SE, CH	*http://www.addressfp7.org/*	The project aims at delivering a comprehensive commercial and technical framework for the development of 'Active Demand' in the smart grids of the future. ADDRESS investigates how to effectively activate participation of domestic and small commercial customers in power system markets and in the provision of services to the different power system participants.
DLC+VIT4IP	2010 2013	Kema Nederland BV	AT, BE, DE, IT, NL, UK ,IL	*http://www.dlc-vit4ip.org/*	DLC+VIT4IP will develop, verify and test a high-speed narrow-band power line communications infrastructure using the Internet Protocol (IP) which is capable of supporting existing and extending new and multiple communication applications. These shall include the existing power distribution network for novel services in smart electricity distribution networks such as demand side management, control of distributed generation and customer integration.
More Microgrids	2006 2009	ICCS/National Technical University of Athens	DK, DE, EL, IT, NL, PT, ES, MK	*http://www.microgrids.eu/index.php*	The aims of this Test Facility is to: • Test centralised and decentralised control strategies in grid interconnected mode; • Test communication protocols and components including aspects related to energy trading; • A control and monitoring system built around IEC 61850 standard designed and prototyped; • Control strategies resulting from agent software to make use of these control and monitoring functions; • Development of intelligent modules embedding the required functions to allow a full integration of each generating/load unit into the system.

Multinational

PROJECT NAME	PERIOD	LEAD ORGANISATION	PART.	WEBSITE	PROJECT DESCRIPTION
MIRACLE	2010 2013	SAP AG	DK, FR, DE, EL, NL, SI	*http://cordis.europa.eu/search/index.cfm?fuseaction=proj.document&PJ_RCN=11157904*	MIRACLE (Micro-Request-Based Aggregation, Forecasting and Scheduling of Energy Demand, Supply and Distribution) main goal is to develop a concept for flex-offers that specify electricity demand and supply which is flexible in time and amount and an infrastructural approach to process lots of these flex-offers issued by small consumers and producers in near real-time. The possibility to shift demand within the mass of households developed within the MIRACLE project will allow for a higher share of fluctuating renewable energy sources in the energy mix on the grid and reduce the peak demand.
HiperDNO	2010 2013	Brunel University	FR, DE, SI, ES, UK, IL	*http://dea.brunel.ac.uk/hiperdno/*	The aim of this research project is to develop a new generation of distribution network management systems that exploits novel near to real-time HPC solutions with inherent security and intelligent communications for smart distribution network operation and management. Cost effective scalable HPC solutions will be developed and initially demonstrated for realistic distribution network data traffic and management scenarios via off-line field trials involving several distribution network owners and operators.
TWENTIES	2010 2013	Red Eléctrica de España	BE, DK, FR, ES	*http://www.twenties-project.eu/node/1*	TWENTIES Project aims to demonstrate through real-life, large-scale demonstrations, the benefits and impact of several critical types of technology required to improve the European transmission network, thus giving Europe the ability to increase the share of renewables in its energy mix by 2020 and beyond, while keeping its present reliability.
SAFEWIND	2008 2012	RTE	DK, FR, DE, EL, IE, ES, UK	*http://www.safewind.eu/*	The project will develop: New forecasting methods for wind generation focusing on uncertainty and challenging situations/extremes. — Models for 'alarming': providing information for the level of predictability in the (very) short-term. — Models for 'warning': providing information for the level of predictability in the medium-term.
GROW-DERS Demonstration of Grid Connected Electricity Systems	2009 2011	KEMA	FRDE, NL, ES	*http://growders.eu/*	The GROW-DERS project (Grid Reliability and Operability with Distributed Generation using Flexible Storage) investigates the implementation of (transportable) distributed storage systems in the networks.
AFTER — A Framework for electrical power sysTems vulnerability identification. dEfense and Restoration	2011 2014	RSE SpA- Ricerca sul Sistema Energetico	BE, CZ, FR, DE, IE, IT, UK, NO	*http://www.rse-web.it/*	AFTER addresses vulnerability evaluation and contingency planning of the energy grids and energy plants considering also the ICT systems used in protection and control. Main addressed problems concern high impact, wide spread, multiple contingencies and cascading.

Multinational

Project name	Period	Lead organisation	Part.	Website	Project description
OPTIMATE	2009 2012	TECHNOFI	BE, DK, FR, DE, IT, ES, UK	*http://www.optimate-platform.eu/*	The project aims at developing a numerical test platform to analyse and to validate new market designs which may allow integrating massive flexible generation dispersed in several regional power markets
IMPROSUME – The Impact of Prosumers in a Smart Grid based Energy Market	2010 2011	Inkubator Halden, Norwegian Center of Expertise for Energy and Emission Trading	DK, NO, CH	*http://www.ncesmart.com/Pages/Inprosume.aspx*	IMPROSUME will establish a better understanding of the prosumers' role in the future power market supported by a smart grid and associated technologies. The project will address stimuli that are likely to motion consumers to take an active role in the market also as suppliers.
Internet of Energy for Electric Mobility (IoE)	2011 2014	SINTEF	AT, BE, CZ, FI, DE, IT, NL, ES, UK, NO,	*http://www.artemis-ioe.eu/*	The objective of Internet of Energy (IoE) is to develop hardware, software and middleware for seamless, secure connectivity and interoperability achieved by connecting the Internet with the energy grids. The project will evaluate and develop the needed ICT for the efficient implementation in future smart grid structures. RWE will consider -as a WP leader- several business models from the perspective of a grid operator.
web2energy	2010 2012	HSE AG	AT, DE, NL, PL, CH	*https://www.web2energy.com/*	The Web2Energy project is directed to implement and approve all three pillars of 'Smart Distribution'. Smart Metering – the consumer participates in the energy market Smart Energy Management – Clustering of small power producers. Smart Distribution Automation – higher reliability of supply.
INTEGRAL: ICT-platform based Distributed Control in Electricity Grids	2009 2011	ECN. Energy research Centre of the Netherlands	FR, NL, ES	*http://www.integral-eu.com/*	The INTEGRAL project aims to build and demonstrate an industry-quality reference solution for DER aggregation-level control and coordination based on commonly available ICT components, standards and platforms. During the project, three field demonstrations have been developed, that demonstrated the practical validity of the Integrated Distributed Control solutions that have being developed. Each pilots was set up in a different country and each pilot targets a different aspect.
SmartGen	2010 2013	Sweco Norge AS	DK, LV, NO, CH	*n/a*	Demonstrate and quantify the benefits of combining SGT with DG and LM and share this knowledge with stakeholders and decision makers in private and public sector. Develop the 'SmartGen Models' which illustrates both energy resources and grid information visually by combining SGT scenarios with input from GIS and NIS.
EWIS – European wind integration study	2007 2009	ELIA SYSTEM OPERATOR SA	AT, BE, CZ, DK, FR, DE, EL, IE, NL, PL, PT, ES, UK	*http://www.wind-integration.eu/*	The project aims to work with all the relevant stakeholders especially representatives of wind generation developers. The study will use results from detailed network and market models of the European transmission system for scenarios representing immediate and longer-term needs. The recommendations will be aimed at developing, where possible and appropriate, common European solutions to wind integration challenges.

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WINDGRID	2006 2009	RED ELECTRICA DE ESPAÑA. S.A.	CZ, DK, DE, IT, PT, SI, ES	*http://windgrid.eu/*	Wind on the Grid is a project focused on preparation of the European electricity network for the large-scale integration of wind farms through the design, development and validation of new tools and devices for its planning, control and operation in a competitive market.
NIGHT WIND	2006 2008	NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK	BG, DK, NL, ES	*http://www.nightwind.eu*	The Night Wind project proposes to design grid architectures for Wind Power Production combined with Energy Storage means of load management of Refrigerated Warehouses (Cold Stores). Refrigerated Warehouses are constant power users. day and night.
G4V – Grid for Vehicles	2010 2011	RWE RHEINLAND WESTFALEN NETZ AG	FR, DE, IT, NL, PT, ES, SE, UK	*http://www.g4v.eu/*	The project of the G4V consortium will generate fast and openly available results: an analytical framework to evaluate the impact of a large scale introduction on the grid infrastructure and a visionary 'road map' for the year 2020 and beyond.
MERGE – Mobile Energy Resources in Grids of Electricity	2010 2011	PUBLIC POWER CORPORATION S.A.	BE, DE, EL, IE, PT, ES, UK, NO	*http://www.ev-merge.eu/*	Electric power systems are facing major new challenges: future massive integration in the electric grid of electric plug-in vehicles (EV). The project will address comprehensively the impact of electric plug-in vehicles (EV) presence regarding steady state operation, intermittent RES integration, system stability and dynamic behaviour system restoration, regulatory aspects and market arrangements.
ICOEUR	2009 2011	TECHNISCHE UNIVERSITAET DORTMUND	BE, EE, DE, IT, LV, SI, SE, UK, CH, RU, TR	*http://icoeur.eu/*	The development and prototypically implementation of new methods and tools is the major goal of the ICOEUR project. New technologies like Wide Area Monitoring, Control and Protection as well as advanced network controllers (FACTS) and HVDC systems will be considered. Envisioned ICOEUR goals can be achieved only in close cooperative work of experts, with extensive knowledge of EU and Russian power systems as well as manufacturers and network operators.
REALISEGRID	2008 2011	CESI RICERCA SPA	AT, BE, FR, DE, IT, NL, SI, UK, RU	*http://realisegrid.rse-web.it/*	The objective of REALISEGRID is to develop a set of criteria. Metrics, methods and tools to assess how the transmission infrastructure should be optimally developed to support the achievement of reliable, competitive and sustainable electricity supply in the European Union (EU).
SUSPLAN	2008 2011	SINTEF ENERGIFORSKNING A/S	AT, BG, CZ, DE, IT, NL, PL, RO, ES, UK, NO, RS	*http://www.susplan.eu/*	The overall impact from SUSPLAN is contribution to a substantially increased share of renewable energy sources (RES) in Europe at an acceptable level of cost, thereby increasing security of supply and competitiveness of RES industry. The main objective is to develop guidelines for more efficient integration of RES into future infrastructures as a support for decision makers at regional as well as Pan-European level. The guidelines shall consist of strategies, recommendations, criteria and benchmarks for political, infrastructure and network decision makers and power distributors with a time perspective 2030-2050.

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	PEGASE – Pan European Grid Advanced Simulation and state Estimation	2008 2012	TRACTEBEL ENGINEERING S.A.	BE, FR, DE, LV, LT, NL, PT, RO, ES, UK, HR, BA, RU, TR	*http://www.fp7-pegase.eu/*	PEGASE is a four year project dealing with the High and Extra High Voltage transmission and sub-transmission networks in Europe (designated as ETN) and implemented by a Consortium composed of 20 Partners including TSOs, expert companies and leading research centres in power system analysis and applied mathematics. Its overall objectives are to define the most appropriate state estimation, optimisation and simulation frameworks, their performance and dataflow requirements to achieve an integrated security analysis and control of the ETN.
	LASTBEG – Large Scale Tool for Power Balancing in Electric Grid	2009 2009	NANOTECH SAS AIX EN PROVENCE	FR, DE, HU, LT, ES, UK		This project will demonstrate an optimisation of renewable energy supplies (RES), primarily wind energy sourced onshore and offshore, with an existing pumped storage power plant (PSPP). It will integrate smart meters with power demand and supply forecasting to enable consistency of power supply in a small European country (Lithuania). The lessons learnt from this demonstration project will be disseminated directly to the participants in this project and indirectly through them to major global Transmission System Operators (TSOs). This work will therefore enable a greater penetration of RES as part of the drive to meet the EC's 20:20:20 objectives.
	SmartHouse/ SmartGrid	2008 2011	SAP Research	DE, EL, NL	*http://www.smarthouse-smartgrid.eu/*	The SmartHouse/SmartGrid project sets out to validate and test how ICT-enabled collaborative technical-commercial aggregations of Smart Houses provide an essential step to achieve the needed radically higher levels of energy efficiency in Europe.
	BeyWatch	2008 2011	Telefonica Investigacion y Desarrollo SA.	FR, EL, IT, SI, ES, UK	*http://www.beywatch.eu/*	BeyWatch will develop an energy-aware and user-centric solution, able to provide intelligent energy monitoring/control and power demand balancing at home/building & neighbourhood level.
	BeAware	2010 2013	Teknillinen Korkeakoulu	FI, IT, SE	*http://www.energyawareness.eu/beaware/*	BeAware studies how ubiquitous information can turn energy consumers into active players by developing: -An open and capillary infrastructure sensing wirelessly energy consumption at appliance level in the home; -Ambient and mobile interaction to integrate energy use profiles into users' everyday life; -Value added service platforms and models where consumers can act on ubiquitous energy information and energy producers and other stakeholders gain new business opportunities.
	ADINE- EU Demonstration Project of Active Distribution Network	2007 2010	Technology Centre Hermia Ltd	FI, DE, SE	*http://smartgrid.epri.com/doc/11-ADINE_EPRI_workshop_09122008.pdf*	The overall aim of the ADINE-project is to develop, demonstrate and validate a new Active Network Management (ANM) method of distribution network including DG.

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CRISP	2003 2006	ECN. Energy research Centre of the Netherlands	FR, NL, SE	*http://www.ecn.nl/crisp*	The CRISP project aims to investigate, develop and test how latest advanced intelligence by ICT technologies can be exploited in a novel way for cost-effective, fine-grained and reliable monitoring, management and control of power networks that have a high degree of Distributed Generation and RES penetration.
Dispower	2002 2005	FhG-ISE	AT, BE, DK, FR, DE, EL, IT, NL, PL, ES, UK	*http://www.iset.uni-kassel.de/dispower_static/present.html*	Dispower has developed new methodologies, components and tools for planning, operational control, training, forecast and trading for the reliable and cost effective integration of distributed generation and renewable energies.
NOBEL – A Neighbourhood Oriented Brokerage ELectricity and Monitoring System	2010 2012	ETRA I+D	DEEL, ESSE	*http://cordis.europa.eu/search/index.cfm?fuseaction=proj.document&PJ_RCN=11209123*	The NOBEL project is building an energy brokerage system with which individual energy prosumers can communicate their energy needs directly to both large-scale and small-scale energy producers, thereby making energy use more efficient.
SEESGEN-ict	2009 2011	RSE SpA- Ricerca sul Sistema Energetico	AT, BE, DK, FI, FR, DE, EL, IT, NL, PL, RO, ES, SE, UK, NO	*http://seesgen-ict.rse-web.it/*	The main objectives of SEESGEN-ICT consist in producing a harmonised set of priorities to accelerate the introduction of ICT into the Smart Distributed Power Generation Grids, investigating requirements, barriers and proposing solutions. SEESGEN-ICT will produce policy recommendations, identify best practices and draw scenarios and roadmaps for the next generation of electric distribution network.
G(E)OGREEN	2010 2012	VITO	AT, BE, ES, CH	*https://esites.vito.be/sites/geogreen/Pages/home.aspx*	Project aims at bringing another approach to energy balance and overall power system stability. Introducing a concept of mobile consumer, it considers consumption mobility both in terms of time and space. In particular, electric vehicles and Data Centres processing tasks, as typical cases of mobile consumers and their impact on power grid, better energy usage efficiency, grid stability and picks shaving will be considered. Additionally, the project will explore optimal control strategies and scheduling algorithms for mobile consumers, Vehicle to Grid (V2G) applications and analysis of storing energy in big functional buildings.
VSYNC	2007 2010	ECN. Energy research Centre of the Netherlands	BE, DE, NL, RO, ES	*http://www.vsync.eu/*	ELECTRICA is implementing The Virtual Synchronous Generator (GSV). ELECTRICA, together with the Polytechnic University from Bucharest and another eight research and education institutions from Western Europe, are part of a project to implement the virtual synchronous machines stabilising the frequency in the distribution networks where there is a high degree of decentralised power generation (VSYNC project). The VSYNC was installed at Cheia in Prahova county (Romania) within the Power Distribution Branch 'Electrica Distribution North Muntenia'.

Multinational	Project name	Period	Lead organisation	Part.	Website	Project description
	E-Harbours Electric	2010 2013	Municipality of Zaanstad	BE, DE, NL, SE, UK	*http://eharbours.eu/showcases/showcase-zaanstad*	The challenge is to create a more sustainable energy model in harbour regions on the basis of innovative intelligent energy networks (smart grids). e-harbours focuses 3 objectives: •Increase the production and use of renewable energy in harbour cities. Harbour cities have extensive industrial areas with a great potential for development of sustainable energies; from wind, solar PV, tide, waves and the reuse of industrial waste, heat or cooling available. • Increase the use of energy smart grids. Attuning demand and supply of energy by flexible demand management, instantaneous load shedding (both directions), energy labelling, intelligent storage. • Increase the use of electric transport, a perfect partner to connect to large scale renewable energies and leading to a healthier environment
	DEHEMS-Digital Environment Home Energy Management System project	2008 2011	Manchester City Council	BG, UK	*http://www.dehems.eu/*	The problem domain (DEHEMS) is concerned with home energy management. This is multidisciplinary problem, involving electrical technology, sensor networks, Software Engineering, Artificial Intelligence, and Human Machine Interaction etc. DEHEMS's one task is to monitor energy consumption of households in a municipality and store energy consumption data in a central database. The data from central database is used from various purposes ranging from displaying households' current energy consumption and its associated CO_2 footprint to providing intelligent advice on efficient energy use based to historical data.
	iTESLA: Innovative Tools for Electrical System Security within Large Areas	2012 2015	RTE	BE, FR, EL, PT, UK, NO	*http://www.itesla-project.eu/*	The purpose of the iTESLA project is to develop a common toolbox, allowing the different TSOs to increase coordination and harmonise operating procedures. The toolbox will support the future operation of the pan-European electricity transmission network and shall bring forward a major innovation: carry out operational dynamic simulations in the frame of a full probabilistic approach, thus going further that the current 'N-1' approach and optimising the transit capacities of the grid at different spatial (national, regional, Pan-European) and time (real-time, intra-day) scales.
	Smart-A	2007 2009	Oeko-Institut	AT, BE, DE, UK	*http://www.smart-a.org/*	The main objective of the Smart-A project is to identify and evaluate the potential synergies that arise from coordinating energy demand of domestic appliances with local sustainable energy generation but also with the requirements of regional load management in electricity networks.
	IMPONET: Intelligent Monitoring of Power Networks	2010 2012	Indra Software Labs	SI, ES, TR	*http://www.innovationenergy.org/imponet/*	The IMPONET project is scoped to provide essential cornerstones in order to achieve a comprehensive, flexible and configurable information system to support the most complex and advanced requirements in Energy Management. This includes the modelling, design and implementation of the two main targets of IMPONET: power quality monitoring and the remote control and smart metering platform.

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PROJECT NAME	PERIOD	LEAD ORGANISATION	PART.	WEBSITE	PROJECT DESCRIPTION
QUALITY AND SAFETY (Power Quality and Safety Requirements for People and Electrical Equipment in Smart Grid Customer Domain)	2010 2012	Tallinn University of Technology	AT, EE, LV		The project idea focuses on power quality, protection of equipment and safety requirements for people working with smart grid technology.
Green eMotion	2011 2015	Siemens AG	DK, FR, DE, EL, HU, IE, IT, NL, ES, SE, UK	*www.greenemotion-project.eu*	Green eMotion will connect ongoing regional and national electro mobility initiatives leveraging on the results and comparing the different technology approaches to ensure the best solutions prevail for the European market. A virtual marketplace will be created to enable the different actors to interact and to allow for new high value transportation services as well as EV-user convenience in billing (EU Clearing House).
REservices (Economic grid support from variable renewables)	2012 2014	European Wind Energy Association	BE, DK, FI, DE, IE, ES	*http://eaci-projects.eu/iee/page/Page.jsp?op=project_detail&prid=2575*	The RESERVICES project intends to establish a reference basis and policy recommendations for future network codes and market design in the area of ancillary services from variable renewable energy technologies. The outputs will be essential technical insights and economic elements to support the establishment of proper market mechanisms and Grid Code formulations in the EU, as well as to carry out a preliminary assessment to determine whether ancillary services can generate additional value for network operators by involving grid users, notably wind and solar PV generation.
INTEGRIS: INTelligent Electrical GRId Sensor communications	2010 2013	Enel Energy Europe	FI, FR, IT, ES, CH	*www.fp7integris.eu*	INTEGRIS project proposes the development of a novel and flexible ICT infrastructure based on a hybrid Power Line Communication-wireless integrated communications system able to completely and efficiently fulfil the communications requirements foreseen for the Smart Electricity Networks of the future. This includes encompassing applications such as monitoring, operation, customer integration, demand side management, voltage control, quality of service control, control of Distributed Energy Resources and asset management and can enable a variety of improved power system operations, some of which are to be implemented in field trials that must proof the validity of the developed ICT infrastructure. Focus is on interoperability of the PLC, Wireless Sensor Network and Radio Frequency Identification, technologies that together are able to achieve the indicated goal with reasonable cost. The system will require an adequate management system that is also an objective of the project. Such system will be based on beyond the state-of-the-art cognitive techniques to provide the system with the adequate flexibility, scalability, availability, security, enhanced system life-time and self-healing properties as is necessary in complex and dynamic systems.

Multinational	Project name	Period	Lead organisation	Part.	Website	Project description
	Integrating households in the smart grid (IHSMAG)	2012 2015	Danish Building Research Institute, Aalborg University	DK, ES, NO	*www.sbi.dk*	IHSMAG studies the integration of households in the smart grid and develops design recommendations. Based on a number of case studies in the participating countries (Norway, Spain and Denmark), the project contributes with new knowledge on how to develop a comprehensive design of household smart grid solutions that integrates the specific characteristics of the three domains that intersect at the household level: 1) Technologies in households, 2) electricity consuming everyday practices of the household members and 3) the electrical system and the administrative and institutional rules that affect the implementation of new smart grid solutions (e.g. standards for home automation and economic incentives). IHSMAG combines different methods in relation to case studies. Besides interviews and field observations, the project also includes technical studies of challenges related to interoperability, communication standards etc. at the household level. The smart grid solutions studied in the project includes EV's, smart metering and feedback to customers.
	PRO-NET	2011 2014	University of Aalborg	DK, NO		PRO-NET (Protection of power electronically interfaced LV distributed generation networks) aims to develop the communication technology based intelligent protection and post fault control methods for distribution systems. The developed protection and control methods would minimise the possibility of losing power supply in an abnormal situation and restore normal operation as quickly as possible.
	BPES – Balancing power energy system	2012 2015	ETH Zürich/ Power System Lab	DK, NO, CH		BPES's main objectives are: a) to address the problems related to balancing power in a system with a substantial part of fluctuating renewable power sources and b) to develop planning methods and operational strategies for the future European energy system incorporating the needs of balancing power using modelling concepts like Power Node combined with MPC.
	3e-Houses	2010 2013	Gas Natural Fenosa	DE, ES, UK	*www.3eHouses.eu*	3eHouses deals to build the customers into the energy system through ICTs, allowing them to develop or enhance their relationship with the environment by piloting in several social housing buildings the interaction between smart devices and the users. 3e-HOUSES deals with the integration of the most established ICT technologies in social housing in order to provide an innovative service for energy efficiency: real time monitoring and management of the energy consumption; integration of renewable energies; creating the resources to lower energy consumption. The described new services will allow the integration of renewable energy and other sources of distributed energies as well it is expected to achieve a reduction around 20 % in energy consumption in social buildings.
	Meter-ON	2012 2014	EDSO for Smart Grids	AT, IT, ES	*www.edsoforsmartgrids.eu*	Meter-ON project is a coordination and support action which aims to steer the implementation of smart metering solutions throughout Europe by effectively collecting the most successful experiences in the field and highlighting the conditions that enabled their development. The analysis is based on relevant R&D projects, pilot-projects, large-scale demonstrators and full rollouts involving smart-meters, considering also the regulatory framework, applicable incentive schemes and in-force laws, both in the European Union and in the rest of the world.

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	SOL-ION	2008 2012	Saft	FR, DE	*http://www.sol-ion-project.eu/sites/en/sol-ion-project/overview.html*	The Sol-ion kit has been developed to accommodate PV energy production of 5 kWp (peak) with a battery rated from 5 to 15 kWh and a nominal voltage of 170 V to 350 V. Li-ion is the only technology that meets the project's need for 20-year battery life in demanding environmental conditions. The energy conversion and system management systems are designed to handle four system functions: multidirectional energy flows; self-consumption; grid support; back-up. They are also intended to handle requirements for demand side management such as control over storage and loads using smart metering, and integration within future smart grids that will need to handle demand response and dynamic pricing.
	ENCOURAGE – Embedded iNtelligent COntrols for bUildings with Renewable generAtion and storaGE	2011 2014	Aalborg University (AAU)	DK, IT, ES	*www.encourage-project.eu*	ENCOURAGE is an European project aiming to develop embedded intelligence and integration technologies that will directly optimise energy use in buildings and enable active participation in the future smart grid environment. The desired energy savings will be achieved in three complementary ways. Firstly, by developing supervisory control strategies that will be able to coordinate larger subsystems (HVAC, lighting, renewable energy generation, thermal storage) and orchestrate operation of the numerous devices in such systems. Secondly, through an intelligent gateway with embedded logic supporting inter-building energy exchange. And thirdly, by developing novel virtual sub-metering technologies and event-based middleware applications that will support advanced monitoring and diagnostics concepts.

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Abstract

Smart grid projects are playing a key role in shedding light on how to move forward in this challenging transition. In 2011, therefore, the JRC launched the first comprehensive inventory of smart grid projects in Europe to collect lessons learned and assess current developments [EC JRC 2011]. The final catalogue was published in July 2011 and included 219 smart grid and smart metering projects from EU27 Member States, Switzerland and Norway. The overall investment amounted to over € 5 billion.

The participation of project coordinators and the reception of the report by the smart grid community were extremely positive. It was therefore decided that the project inventory would be carried out on a regular basis so as to constantly update the picture of smart grid developments in Europe and keep track of lessons learned and of challenges and opportunities.

A new on-line questionnaire was launched in March 2012 and information on projects was collected until September 2012. The resulting final database is the most updated and comprehensive inventory of smart grid and smart metering projects in Europe for 2012: it includes 281 smart grid projects and around 90 smart metering pilots and roll-outs.

This study is the 2012 update of the inventory carried out in 2011.

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