CEER status review of regulatory approaches to smart electricity grids

Ref: C11-EQS-45-04
6 July 2011

Council of European Energy Regulators ASBL
28 rue le Titien, 1000 Bruxelles
Arrondissement judiciaire de Bruxelles
RPM 0861.035.445

INFORMATION PAGE

Abstract

This document (C11-EQS-45-04) is a CEER status review of regulatory approaches to smart electricity grids.

This document seeks to follow-up the discussion initiated by European Energy Regulators with the ERGEG public consultation on the "position paper on smart grids" in 2010. It examines the scope and definition of smart grids; regulatory challenges affecting smart grids, national roadmaps for their implementation; and recommendations regarding demonstration projects, cost benefit analyses and potential performance indicators and incentive schemes.

Target Audience

Consumer representative groups, network users, policy-makers, electricity industry, distribution system operators, transmission system operators, electric and electronic equipment manufacturers, standardisation organisations, energy suppliers, energy services providers, information and communication technology providers, academics, researchers and other interested parties.

If you have any queries relating to this paper please contact:

Mrs Natalie McCoy
Tel: +32 (0)2 788 73 30
Email: natalie.mccoy@ceer.eu

Related Documents

CEER/ERGEG documents (available at http://www.energy-regulators.eu/):

[1] "European Energy Regulators' 2011 Work Programme", Ref: C10-WPDC-20-07, 6 December 2010

[2] "Position Paper on Smart Grids - An ERGEG Public Consultation Paper", Ref: E09-EQS-30-04, 10 December 2009

[3] "Position Paper on Smart Grids - An ERGEG Conclusions Paper", Ref: E10-EQS-38-05, 10 June 2010

[4] "CEER 4th Benchmarking Report on Quality of Electricity Supply 2008", December 2008

External documents:

[5] European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions “Smart Grids: from innovation to deployment”, COM(2011) 202 final, Brussels, 12 April 2011 http://ec.europa.eu/energy/gas_electricity/smartgrids/smartgrids_en.htm

[6] EU Commission Task Force for Smart Grids, "Expert Group 3: Roles and Responsibilities of Actors involved in the Smart Grids Deployment", 4 April 2011. http://ec.europa.eu/energy/gas_electricity/smartgrids/taskforce_en.htm

[7] European Commission, Directorate General Joint Research Centre, "A view on Smart Grids from Pilot Projects: Lessons learned and current developments", June 2011 http://ses.jrc.ec.europa.eu/images/stories/deliverables/jrc%20report%20-%20smart%20grid%20projects%20in%20europe.pdf

[8] ENTSO-E and EDSO-SG, The European Electricity Grid Initiative (EEGI) Roadmap 2010-18 and Detailed Implementation Plan 2010-12, 25 May 2010 https://www.entsoe.eu/fileadmin/user_upload/_library/news/EEGI_Implementation_plan_May_2010.pdf

Table of Contents

TABLES:

EXECUTIVE SUMMARY

Background

This status review paper is a follow-up to the 2010 ERGEG Position Paper on Smart Grids [2] [3].

Objectives and contents of the document

The objective of this paper is to gather and analyse information about the regulatory approaches to demonstration and deployment of smart electricity networks. Input for the paper was supported by an internal questionnaire to CEER members. The main topics addressed in this paper, are:

1. the definition of smart grids;
2. regulatory challenges currently identified and actions taken at national level;
3. national roadmaps and implementation plans;
4. innovation and demonstration projects in the electricity networks;
5. cost benefit analyses for the demonstration and deployment of smart grids; and
6. potential performance indicators and incentive schemes.

A brief summary of each topic is provided below.

The definition of smart grids

Of the twenty-four national regulatory authorities (NRAs) taking part in the internal questionnaire, four (Austria, Great Britain, Poland, Sweden) indicated that their country has adopted a definition for smart grids. The definitions adopted in these countries do not differ significantly from the ERGEG definition of smart grids.

We also note that the European Commission used the ERGEG definition in its accompanying document (SEC(2011) 463 final) to the European Commission Communication "Smart Grids: from innovation to deployment" [5]. CEER therefore re-confirms this definition, first published in 2009.

The regulatory challenges concerning smart grids

As smart grids become increasingly relevant in Member States, regulators are considering possible challenges to their implementation. This analysis, which is important for regulators in order to take appropriate national actions, has already occurred in many countries. Using an internal questionnaire, CEER analysed a range of possible challenges. Taken overall, the feedback suggests differences in the importance attached to possible challenges at national level. Some challenges have been recognised more than others. The question of dealing with incentives to improve cost-effectiveness was identified (and/or commented on) by most of the countries.
The following three challenges also generated a significant reaction from the NRAs:

- how to encourage network operators to choose innovative solutions;
- the inadequacy of existing standards or lack of standards on smart-grid technology; and
- the need to enhance the definition of national objectives and policies at political level.

National roadmaps and implementation plans

Three countries (Austria, France and Great Britain) have a national roadmap in place. Another eleven countries (Cyprus, Denmark, Estonia, Hungary, Ireland, Lithuania, Poland, Slovenia, Sweden and – to some extent – the Czech Republic and Italy) have plans or concrete proposals for the development of such a national roadmap. In all cases, all major stakeholders are or will be involved in their development.

Encouraging innovative solutions in electricity networks

The 2010 ERGEG Position Paper on Smart Grids [3] included recommendations that relate to smart grid demonstration projects. CEER continues to recommend encouraging the deployment of smart grid solutions where they are a cost-efficient alternative to existing solutions, and as a first step in this direction, finding ways of incentivising network companies to pursue innovative solutions where this can be considered beneficial from the viewpoint of society as a whole. Based on responses to our internal questionnaire, we see various approaches to encouraging innovation through different regulatory regimes and the varying status of smart grids development in different countries. Different incentive mechanisms to encourage network companies to pursue innovation/demonstration projects are already in place or planned. Further, some countries rely on current approaches which do not necessarily contradict innovative solutions especially when focused parameters are implemented and separate funding schemes using public money are in place for demonstration projects.

CEER also recommends ensuring dissemination of the results and lessons learned from the demonstration projects. Seven countries said there are guarantees in place regarding such dissemination, but nine said there are not. In the former ones, there are generally clear rules that ensure dissemination. Still, it is noteworthy that the majority of responses indicated that no requirements are in place to ensure the dissemination of results and lessons learned.

CEER considers that there are very significant benefits to the efficient communication of the results of demonstration projects to all interested stakeholders. We have initiated a dialogue with the European Commission in order to contribute to its assessment of smart grid demonstrations. Consideration will be given to ways of improving the dissemination of learning and the sharing of experiences from demonstration projects.

Cost benefit analyses for the demonstration and deployment of smart grids

European Energy Regulators recommend evaluating the breakdown of the costs and benefits of possible demonstration projects for each network stakeholder and taking decisions or giving advice to decision-makers based on a societal cost benefit assessment. One of the ERGEG priorities for regulation refers to the identification of costs and benefits of smart grid demonstrations and deployed solutions.

Our survey found that three countries (the Danish TSO and energy association, the GB Electricity Networks Strategy Group and a Polish DSO) have undertaken a cost benefit analysis of a full smart grid or specific value streams. However, six countries indicated that a cost benefit analysis is either on-going or planned. Among these, several countries are waiting for the results of on-going demonstration projects, as an instrument to carry out the planned cost benefit analyses.

Potential performance indicators and incentive schemes for regulating network outputs

Regulators are highly aware of the importance of performance indicators within Member States. The move to quality and efficiency in networks, which was encouraged by the European Commission in its Communication [5], is already being applied by many NRAs. A significant number of countries indicated that they use some of the indicators proposed in the ERGEG Smart Grids Conclusions Paper. This can be either for monitoring purposes, as a minimum requirement, or as a revenue driver. In particular, the indicators for continuity of supply (one quality element) and the indicators related to losses (one efficiency element) are used as revenue drivers in more than half of the countries.

However, the experience of CEER members shows differences concerning the calculation of performance indicators and the way they are (or can be) used as a revenue driver. It is important that the indicators, and any associated revenue mechanism, are defined in such a way that they do not favour one technology above another. Other key features, such as the determination of a quantifiable benefit to grid users and society as a whole, the accountability of the indicators in a sufficiently accurate and objective way and the clear possibility to influence the value of the indicators by the network operator(s) or the system operator, have already been identified by European Energy Regulators. This puts high demands on the methods used to calculate or measure the respective indicators. Further work is therefore needed, at national as well as at international level, to develop suitable methods to calculate and measure indicators and to design suitable revenue mechanisms.

Regulators are committed to continuing to work on these issues and to contributing to the efficient (and interoperable) development of smart grids across Europe. To this end, we will continue our analysis, exchange of best practices and engagement in national and European activities in this field.

1 Introduction

The CEER work programme for 2011 envisages a 'CEER Status Review of regulatory approaches to smart grids'. The work programme [1] describes the paper as follows:

> *Progress in smart grid deployment will be a continuous learning process. A Status Review among Member States will support this learning phase. The report will cover the current state of play in "smart" technologies across European grids as well as select and quantify a few promising performance indicators and grid output measures.*

The present report follows the 2010 ERGEG Position Paper on Smart Grids [2] [3], which identified three main priorities for regulators:

1. to concentrate on outputs of the regulated entity, by tailored regulatory mechanisms;
2. to favour cooperation among stakeholders, with emphasis on standardisation, also in order to identify the possible barriers to smart grid deployment; and
3. to encourage an adequate level of innovation, while protecting consumers by the identification of costs and benefits of smart grid demonstrations and deployed solutions.

This status review can be used by NRAs as a sound information base for approaching the deployment of smart grid solutions in the future.

1.1 Objective and main topics of the status review paper

The objective of this paper is to gather and analyse information about the regulatory approaches to demonstration and deployment of smart electricity networks. The main topics addressed in this paper are:

1. the definition of smart grids;
2. regulatory challenges currently identified and actions taken at national level;
3. national roadmaps and implementation plans;
4. innovation and demonstration projects in the electricity networks;
5. cost benefit analyses for the demonstration and deployment of smart grids;
6. potential performance indicators and incentive schemes.

This report was supported by an internal questionnaire among CEER members, with 24 of the 29 members contributing to some or all of the questions. Annexes 3, 4, 5 and 6 include targeted information resulting from this survey.

2 The definition of smart grids

The term "smart grids" is defined in many different ways. The following definition is used in the ERGEG papers on smart grids [2] [3]:

> *Smart grid is an electricity network that can cost-efficiently integrate the behaviour and actions of all users connected to it – generators, consumers and those that do both – in order to ensure economically-efficient, sustainable power systems with*

low losses and high levels of quality and security of supply and safety.

Other definitions are also used, including those that define smart grids by the kind of technology used.

Of the twenty-four national regulatory authorities (NRAs) taking part in the internal questionnaire, four (Austria, Great Britain, Poland, Sweden) indicated that their country has adopted a definition for smart grids. The definitions adopted in these countries do not differ significantly from the ERGEG definition of smart grids.

The definition presented by Austria[1] was adopted by the National Technology Platform Smart Grids Austria in 2008 and is close to the one adopted by the Smart Grids European Technology Platform. The NRA was not involved in the definition process.

The definition from Great Britain[2] has been adopted by the Electricity Networks Strategy Group and is very close to the one adopted by ERGEG. The NRA was involved in the definition process.

Poland adopted in June 2011 the definition from the ERGEG position paper, which is published in an NRA position paper on minimum requirements for AMI Smart Grid Ready.

The Swedish definition[3] has been published by the NRA and contains some of the Smart Grids objectives.

Meanwhile, the European Commission made use of the ERGEG definition in accompanying documents (SEC(2011) 463 final) to the European Commission Communication “Smart Grids: from innovation to deployment” [5].

We do not consider these small differences, or indeed the lack of a definition, to be a barrier to the development of smart grids. That being said, we maintain the definition first published by ERGEG in 2009.

---

[1] Smart grids are power grids, with a coordinated management, based on bi-directional communication, between: grid components, generators, energy storages and consumers; to enable an energy-efficient and cost-efficient system operation that is ready for future challenges of the energy system.

[2] A smart grid as part of an electricity power system can intelligently integrate the actions of all users connected to it - generators, consumers and those that do both - in order to efficiently deliver sustainable, economic and secure electricity supplies.

[3] Intelligent or smart grids is the synthesis of technologies, functions, and regulatory frameworks that in a cost effective manner facilitate the introduction and use of renewable electricity generation, the reduction of overall energy consumption, the reduction of load peaks, and the creation of an environment where electricity consumers can become more active.

3 The regulatory challenges related to smart grids

3.1 Introduction

In its 2010 Conclusions Paper, ERGEG identified the need to address the main barriers by encouraging cooperation amongst stakeholders as one of the main priorities for smart grids. ERGEG agreed that while high-level principles can be applied across Member States, detailed implementation will vary from country to country. Smart grids are at different stages of development in Europe, as is therefore, corresponding regulatory activity in this area.

As smart grids become increasingly relevant in Member States, regulators are considering possible challenges to their implementation. This analysis, which is important for regulators in order to take appropriate national actions, has already occurred in many countries. It is important as well to understand those issues that do not represent major barriers and therefore may not need to be proactively addressed.

Using an internal questionnaire, CEER analysed a range of possible challenges. The questionnaire sought information on a range of issues which could represent challenges or barriers to smart grids, according to the following general categories:

- Terms for taxes, financial inducements and incentives;
- Involvement and role of different stakeholders and interest groups;
- General conditions and framework (e.g. standardisation, regulation elements, implementation mechanisms); and
- Know-how of market participants.

We assessed each specific issue, focussing on the most commented ones. Indeed, some specific issues may well depend on the stage of development of smart grids in a country. Some issues can only be identified once smart grid initiatives are well advanced (which is currently not the case in most countries). As a general comment, we would note that while an issue might not be 'identified' as a possible challenge per se, it may still be of relevance to regulators.

The following sections provide an overview of our findings.

3.2 Review of regulatory issues by category

The aim of the NRA questionnaire was not only to address the individual barriers but also to consider the types of barriers. We have therefore categorised regulatory issues/challenges into groups, based on the subject the challenges primarily relate to. Although some challenges have ambiguous boundaries and could relate to more than one category, the survey was divided into groups investigating four types of barriers.

3.2.1 Terms for taxes, financial inducements and incentives

Three potential challenges relate to incentives which either:

- encourage the network operators to choose investment solutions which offer the most cost-effective solution to all network users;

- encourage the network operators to choose innovative (i.e. having higher risk) solutions; or
- encourage efficient use of electricity and/or renewable electricity production.

Demand for technically feasible and economically affordable solutions in the grid area has been growing continually for years. Governments promote smart grids as a way of addressing the integration of renewable electricity, energy independence and grid flexibility. The introduction of smart grid solutions must, on the one hand, provide a business case for the investment companies and power supplier and, on the other hand, be an economically feasible solution for the public. This part of the questionnaire inquired about three groups of incentives for power suppliers to install smart grid solutions.

It is worth pointing out that most of the comments received from responding NRAs related to these three issues. Furthermore, we would like to underline that in some cases an issue might not be "identified" as a possible challenge, but may still be of relevance to regulators.

3.2.2 Involvement and role of different stakeholders and interest groups

This category concerns the involvement and role of stakeholders across four issues:

- the roles and responsibilities of relevant stakeholders who do not encourage or block the introduction of new services or markets;
- greater active participation in the development of smart grids by the stakeholders;
- greater involvement in network innovation by research and development institutes; and
- lack of involvement of retail suppliers and energy service companies.

Most of the responding NRAs (69%) did not identify any obstacles in this area. The values identified and not identified in this category are rather widespread, with no country focusing on a single value.

However, the countries identifying the most challenges under this category were Great Britain and Lithuania (75% each). Nine countries (Belgium, Estonia, Finland, Greece, Hungary, Ireland, Norway, Portugal and Spain) did not identify any challenges in this area.

3.2.3 General conditions and framework

This third category was the largest, containing eleven topics related to standardisation, regulation elements and implementation mechanisms. Possible challenges in this area include the absence of and unclear or imprecise definition of a framework for utilities, network operators and industry to implement and further develop smart grid solutions. This category includes the following issues:

- existing standards or lack of standards on smart grid technology;
- regulatory mechanisms that encourage network operators to pursue "business as usual" practices;
- the existing regulatory framework which does not allow the integration of new services in the electricity networks;
- elements of regulation which are not technology neutral;
- difficulty for network operators to introduce more advanced structures in their network

tariffs to incentivise more efficient network use;
- the need for improved definition and assignment of roles and responsibilities to stakeholders;
- data security and privacy issues;
- the need to enhance the definition of national objectives and policies at political level,
- ineffective implementation of unbundling;
- lack of a definition of minimum functionalities of smart grid solutions; and
- safety legislation unintentionally constraining innovation.

Belgium, Estonia, Finland, Greece, Hungary and Ireland did not identify any challenges in this area, while Cyprus, Slovenia and Poland were countries where most (55%) challenges were sited.

3.2.4 Know-how

Five topics relate to the know-how of retail suppliers, network users and operators as regards smart grid issues. The aforementioned parties will need to develop proposals and solutions to deal with the changes brought forward by new smart technology. The challenges include:

- The need to enhance the capability of network operators to identify and address the possibilities and limitations of new technologies;
- The need to enhance the understanding of network operators in relation to the challenges faced, e.g. due to introduction of renewable electricity production;
- The need to enhance the understanding of retail suppliers and energy service companies of both the possibilities and limitations of new technologies;
- The need to enhance the understanding of network users (consumers and producers) of both the possibilities and limitations of new technology; and
- The availability of skilled workforce (especially in terms of knowledge of innovative solutions).

While Sweden and Great Britain identified challenges in all five knowledge and feasibility areas, followed by Poland (four), Cyprus and Lithuania (three), most of the responding NRAs labelled specified challenges in this area as not identified.

3.3 Review of specific regulatory issues

Taken overall, the feedback suggests differences in the importance attached to possible challenges at national level. Some challenges have been recognised more than others.

Not surprisingly, most responding regulators sited the issue of dealing with incentives to improve cost-effectiveness. The comments on this issue are presented in Table 1. The table illustrates that national regulators are usually responsible for dealing with this particular challenge. Moreover, the action taken is very often in the form of incentive regulation via a set of efficiency targets. Incentives typically play an important role which can be seen in the NRA responses to questions about incentives to choose innovative solutions and to encourage efficient use of electricity and/or renewable electricity production. Overall, comments by NRAs indicate a deep involvement in the topic and suggest that implementation of incentive initiatives has already occurred or is still in progress.

Another key issue noted by regulators is the need to enhance the definition of national objectives and policies and the significant role this plays as well. The definition of national objectives and policies is being or will be dealt with on a political level in Slovenia, Sweden and Great Britain. The acknowledgment of a need to enhance the definition of national policies is distributed evenly among responding NRAs, with an equal number of countries identifying and not identifying this as a challenge.

A similar balanced situation occurs when identifying incentives for network operators to choose innovative solutions.

The issue of roles and responsibilities ("need for improved definition and assignment of roles and responsibilities to stakeholders") has also been identified as important and here we especially need to take into account the recent findings of the European Commission's Task Force for Smart Grids (Chapter 5 of [6]).

Country	Action by	Description of action
Austria	NRA (E-Control)	Implicitly treated within incentive regulation model. TOTEX benchmarking and resulting individual and also general productivity offsets guarantee cost-efficient solutions.
Cyprus	NRA (CERA)	The regulator monitors and controls the work of the network operators and obliges them to operate in the most economical and efficient way and to proceed with the most cost-effective solutions.
Denmark	Several parties	A lot of activities related to smart grids are going on and have been going on recent years. Grid companies are generally well aware of advantages and economics of various incentives within the umbrella. Grid companies are well consolidated and will be able to invest. Whether investments/decisions will be taken depends primarily on each company's strategy.
Finland	NRA (EMV)	Incentive for (smart) grid investments. All network investments (standard network components) are accepted in network valuation (regulated asset base) by using standard unit prices so it also encourages smart gird investments (e.g. smart metering, automation, protection, systems). When we are using standard unit prices, the network operators have an incentive to make investments in the most cost-effective way.
Germany	Network operator	Incentive regulation
Great Britain	NRA (Ofgem)	The fundamental structure of the price control mechanisms is designed to achieve this objective. The new RIIO (Regulation, Innovation, Incentives leading to Outputs) mechanism is now being employed.
Ireland	NRA (CER)	While this has not been identified as a barrier, the existing revenue controls cover this for all investments. The revenue controls for the system operators include a 5-year retention of efficiency gains by the system operator. This would serve as an incentive to choose investment solutions that offer a cost effective solution.

Country	Action by	Description of action
Italy	NRA (AEEG), the Italian Government	For the transmission operator: An incentive was set by Regulatory Order 87/10, which refers to an indicator B/C, therefore promoting higher benefits and/or lower costs. For the distribution operators: The legislative decree of 3 March 2011 introduces an economic incentive (WACC extra-remuneration) for modernising distribution networks "by the smart grid concept". The prioritised solutions are control, regulation and management of load and generating units, including recharging systems for electric vehicles. The NRA is mandated to define the characteristics of the solutions above.
Lithuania	NRA (PUC)	The applied price cap principle requires the effective use of financial resources, which are defined by the X-factor. In addition, the cost of unreasonable investment plans is not included in the network price according to the Rules of Investment Approval Procedure.
Luxembourg	NRA (ILR)	Tariff incentives
Poland	NRA (URE)	The position paper on AMI Smart Grid Ready proposed some solutions in order to balance interests of companies and consumers.
Portugal	NRA (ERSE)	The structure of the price control mechanism applied to the DSO´s revenue calculation is designed to achieve this objective and published by the NRA in the Tariffs Code.
Sweden	NRA (EI)	The NRA has proposed that additional incentives for network companies to develop smart grid solutions are added to the regulatory framework. A decision on this is pending.

Table 1 – Comments regarding incentives for cost-effective solutions

4 National roadmaps and implementation plans

The challenge to improve national objectives and policies was recently highlighted by European stakeholders. A commitment by Member States towards national models for the deployment of smart grids was recommended by Expert Group 3 of the European Task Force: it is proposed that "EU Member States define national models and/or platforms, ensuring in particular dissemination and exchange of experiences" [6].

As part of this status review, we asked NRAs about their national experiences with national models/roadmaps and on-going or planned implementation steps.

Three NRAs (Austria, France and Great Britain) indicated that there is a national roadmap for smart grids in their Member State. Meanwhile, a further eleven countries (Cyprus, Denmark, Estonia, Hungary, Ireland, Lithuania, Poland, Slovenia, Sweden – to some extent – the Czech Republic and Italy) indicated that such a roadmap is being created at the moment or is planned for the future. A remaining twelve countries are not yet planning a roadmap.

In all three countries where a national roadmap has been created, the major stakeholders have been involved in the creation of the roadmap. In Great Britain, a smart grid forum has been created which is responsible for the follow-up of the roadmap. This forum has, among others, a supervisory and advisory role towards the NRA. The forum even tracks the developments elsewhere.

In Austria, the National Technology Platform on Smart Grids and the prepared road map has been financed by the relevant Ministry and the implementation and follow-up is the responsibility of the ministry and policy makers. In the meantime, for example, the public funding budget for the development of electricity infrastructure was increased and proposals in the roadmap are taken into account by implementing the 3rd Package into national law.

The French Environment and Energy Management Agency (ADEME) develops the national roadmap with large involvement of stakeholders.

Of the remaining countries, about half have a roadmap or action plan under development or in planning. In all countries, the major stakeholders are or will be involved. In Sweden, the NRA has proposed that the TSO should be in charge of the creation of a national action plan but that all stakeholders should be involved. No roadmap has been planned in Italy, but the law gives the NRA the duty to update, every two years, the regulation concerning the connection of renewable electricity production and the duty to define the characteristics of control, regulation and management of loads and generating units, including recharging systems for electric vehicles under the smart grid concept.

Further details for the three finalised roadmaps, for the nine on-going or planned roadmaps and for some implementation activities in the Czech Republic and Italy are provided in Annex 3.

5 Innovation and demonstration projects

5.1 Introduction

One of the main recommendations of ERGEG's Smart Grids Conclusions Paper [3] was that NRAs should ensure the dissemination and results of smart grid demonstration projects. The first priority in achieving this goal is to ensure that such projects are visible to interested parties so that knowledge and experience can be exchanged. This should reduce unnecessary duplication of particular trials and enhance the level of successful outcomes. With this in mind, this section seeks to:

- establish the level of activity of smart grid demonstration projects across Europe;
- increase their visibility; and
- describe the nature of the funding incentives and mechanisms and the level of protection for customers.

In order to help our analysis of active innovation/demonstration projects, the questionnaire defined them as follows:

A project must involve the trialling on a distribution or transmission system of at least one of the following:

- *A specific piece of new (i.e. unproven) equipment (including control and communications systems and software) that has a direct impact on the distribution or transmission system;*
- *A novel arrangement or application of existing distribution/transmission system equipment (including control and communications systems software);*
- *A novel operational practice directly related to the operation of the distribution/transmission system; or*
- *A novel commercial arrangement.*

Eleven of the twenty-nine NRAs surveyed reported that one or more innovation/demonstration projects having a value of approximately € 1 million or more per project have been started, with three additional countries having projects under evaluation or selection.

The results presented here do not offer a full reflection of the level of smart grid demonstration activity, as our data represents a cross-section of European countries and is therefore not to be considered as a comprehensive account of all efforts which may be underway at various levels. This is commented on further below.

5.2 The projects

Twelve countries reported a total of 43 projects. Of these, costs were provided for 35 projects having a combined value of € 415 million. A small number of these projects were primarily focused on the trialling of smart metering. Well over half the projects were focused on the development of electricity networks with the remainder involving both the electricity network and smart meters. Three countries stated that they have projects under evaluation or selection.

Project type	Number	Total budget [€ million]
Smart grid (no smart meter)	25	125
Smart grid and/or smart meter	18	290
Total	43	415[1)]
[1)] The budget details were not provided for all projects.		

Table 2 – Summary of demonstration projects as reported by the NRAs

It should be noted that Sweden expects to spend some € 900 million on high voltage direct current (HVDC) projects, which is not included in the data above. Also, Belgium estimates that some €135 million will be invested in smart grid projects (2009-2012) but no details were provided and so again this amount has not been taken into account in the table.

The experiences of two countries (Great Britain and Italy), whose NRAs have promoted demonstration projects, are briefly described in Annex 4.

The European Commission recently reported that over € 5.5 billion has been invested in about 300 smart grid projects. This figure has been estimated by the Joint Research Centre (JRC) of the European Commission in its recently published report "A view on Smart Grids from Pilot Projects: Lessons learned and current developments" [7]. The report includes EU budget funding (around € 300 million) for R&D, pilot projects to demonstrate the benefits of smart grids and fully deployed solutions. The majority of this investment is related to the roll-out of smart metering.

In contrast, CEER has focused its recommendations on demonstration projects for innovation in electricity networks. We have therefore attempted to focus our analysis on smart grid demonstration projects funded by tariffs and/or public money. The definition of innovation/demonstration projects (see 5.1) used in the questionnaire was intended to exclude smart metering projects and roll-out programmes.

The difference between the findings of our internal questionnaire and the JRC's report is not straightforward for several reasons:

- no immediate breakdown is possible between research and development, demonstration and deployment (i.e. many projects exist which include research-development and also demonstration elements, as witnessed by the implementation plan for the European Electricity Grid Initiative [8]);
- in the JRC report, it is not always possible to distinguish between "smart grid" and "smart meter" projects, taking into account the integration of systems; and
- CEER has examined a cross-section of EU countries and therefore more projects may be underway than are covered here.

For these reasons a detailed reconciliation of the two reports has not been carried out. However, we do not believe that there are any fundamental contradictions between them.

5.3 Funding incentives and mechanisms

This section explores the funding incentives and mechanisms and the level of protection provided for customers. We sought information from NRAs on the following questions. Where appropriate, we have included examples of some national practices/experience.

- *When demonstration projects are funded from the network tariffs, is there any incentive scheme in place to encourage the network operator to start demonstration projects?*
  The explanations provided suggest that the interpretation of the term "incentive" might have varied between respondents. It is interesting to consider what level of funding from public funds or network tariffs is required for such support to effectively incentivise the initiation of projects.

  In Finland, the regulatory model that will apply from 2012 to 2015 will include an innovation incentive allowing a proportion of research and development (R&D) costs to be passed through to customers. This is currently the position in Great Britain where up to 90% of the cost of certain projects can be funded from network tariffs. However, the network company still has to consider the balance between costs, benefits and risks before initiating a project. The situation is similar in Italy where there is a regulatory scheme for the promotion of demonstration projects, which are assessed by the NRA also on the basis of their starting date/time planning.

- *When demonstration projects are funded from the network tariffs, are there any mechanisms in place to prevent customers of small network operators experiencing a large increase in network tariffs?*
  Two NRAs responded positively to this question. While they did not specifically address the position of small network operators, they argued that the socialisation of project costs, competition and regulatory approval offered a degree of protection. It should be noted that the number and size of distribution companies varies greatly between countries.

- *Has the impact on network tariffs been assessed?*
  A minority of NRAs indicated such an assessment. In Great Britain, impact assessments have been carried out and published for all its innovation incentive schemes. The impact has been assessed in Portugal and shown to be negligible. A similar position exists in Italy.

- *When demonstration projects are funded from the network tariffs, are there any criteria in place that have to be fulfilled?*
  Three NRAs reported that criteria are in place, with a further two indicating that criteria are under development. Italy and Great Britain outlined the criteria while Portugal indicated that the NRA had to approve the project.

- *When demonstration projects are funded using public money, by whom and based on which criteria is it decided which projects receive funding?*
  NRAs noted that public funding is governed by a number of different agencies and this could be at national or regional level. The criteria that are applied also vary between countries and there are examples where competitive processes are used.

- *When different demonstration projects propose similar smart grid solutions, is there any preliminary assessment?*
  A preliminary assessment is undertaken in several countries. However, the approaches adopted are quite different. Sweden uses a 'case-by-case' approach (such projects are funded by public money); Italy relies on competitive ranking and publicly-available criteria; and Great Britain applies published criteria for all tariff-funded projects.

- *When demonstration projects are funded both by public money and network tariffs, how do you avoid duplication of costs and financial burden for the consumers?*
  A number of different approaches were described including direct cooperation between the NRA and government; regulatory mechanisms that exclude government funding; and case-by-case assessment.

- *Are there any guarantees in place to ensure that the results and lessons learned from the demonstration projects are disseminated to all interested parties?*
  We see differing approaches in this area, with some NRAs reporting that guarantees are in place, but with a greater number indicating that they are not. However, where there are rules on dissemination of the lessons learned, these are generally clear.

5.4 Recap of ERGEG recommendations on innovation and demonstration projects

The 2010 ERGEG Smart Grids Conclusions Paper included three recommendations relating to smart grid demonstration projects. We consider these within the context of our present analysis of the issue, as well as in relation to cost benefit analyses (see Section 6).

5.4.1 Pursuing innovation

Recommendation 5 - to encourage the deployment of smart grid solutions, where they are a cost-efficient alternative for existing solutions, and as a first step in this direction, to find ways of incentivising network companies to pursue innovative solutions where this can be considered beneficial from the viewpoint of society.

As mentioned under Section 5.3, a few NRAs have put in place incentive mechanisms to encourage network companies to pursue innovation/demonstration projects as defined for this questionnaire. In addition, we sought information from NRAs on whether innovation incentives had been identified as relevant to the development of smart grids. Nine countries (50% of respondents to this question) said this had been identified although the intended actions varied between them. As an example, Austria takes the view that the implemented regulatory incentive regime which already incorporates certain factors for incentivising investments (investment factor, operating cost factor) provides inherent incentives to reduce costs and to find innovative solutions as well. The majority of the other responses indicated that some sort of focused innovation incentive was required.

5.4.2 Dissemination of results

Recommendation 7 - to ensure dissemination of the results and lessons learned from the demonstration projects in case they are (co-)financed by additional grid tariffs or from public funds to all interested parties, including other network operators, market participants, etc.;

Also addressed in the previous section, it is worth noting that the majority of responses indicated that no requirements are in place to ensure the dissemination of results and lessons learned.

6 Cost benefit analyses for the demonstration and deployment of smart grids

In the 2010 ERGEG paper, regulators presented the following recommendation:

Recommendation 6 - to evaluate the breakdown of costs and benefits of possible demonstration projects for each network stakeholder and to take decisions or give advice to decision-makers based on societal cost benefit assessment which takes into account costs and benefits for each stakeholder and for the society as a whole.

For this status review, we asked NRAs whether a cost benefit analysis (CBA) has been undertaken for smart grids, with four countries indicating that an analysis has already been carried out. The Danish TSO and the Danish Energy Association have estimated that establishing a smart grid will have a net cost lower than the cost of traditional development. Great Britain carried out a cost benefit analysis as part of its smart grid vision work. These CBAs are described in more detail in Annex 5. In Poland, the cost benefit analysis was performed by one DSO. The Italian regulator and the Italian electricity research centre carried out a more focused analysis looking at one smart grid solution: the deployment of full-scale voltage quality monitoring in MV networks. The CBA results are based on a demonstration project launched by the NRA in 2006 which covered 10% of the MV distribution network.

In addition, a further six countries reported that a cost benefit analysis is either on-going or planned. It may be that cost benefit analyses are more often performed when demonstration and pilot projects are to be started and evaluated, which is also shown in the answers regarding planned cost benefit analysis as mirrored in Table 3.

Country	Description of upcoming CBA studies in Europe
Cyprus	The Electricity Authority of Cyprus (EAC) is considering starting a cost benefit analysis in order to submit it to the Regulator (CERA) for final approval.
Italy	It is expected that other cost benefit analyses will be carried out by the NRA (AEEG) referring to the trials tested in the demonstration projects (scope: distribution networks, medium voltage). Indeed, the 3-year plan of AEEG activities includes under “infrastructure issues“ the future evaluation of results of demonstration projects and subsequent tuning of regulatory approaches. Further, according to the Law Decree of 3 March 2011 (Art. 19), the NRA has the duty to prepare, before 30 June 2013, a quantitative analysis of the costs for the electricity system due to unbalancing of non-programmable renewable sources. This analysis is to be repeated every two years.
Lithuania	Cost benefit analysis to be carried out by UAB Technologijų ir inovacijų centras (Center of Technology and Innovation). Lithuania plans to finalise its study in September 2012.
Portugal	A CBA is planned in the framework of the smart grid pilot project InovGrid, which is under implementation. This pilot project involves 50,000 customers and some results of the CBA are expected during 2011. The Portuguese NRA (ERSE) required the CBA analysis and, at least in first phase, it is programmed that the CBA is developed under the pilot project scope by the

Country	Description of upcoming CBA studies in Europe
	DSO.
Slovenia	This will be part of 'Smart Grid program' prepared by Competency center SURE.
The Netherlands	The Ministry of Economic Affairs has sent out a request for proposals. Two parties (KEMA and CE Delft) have been selected to do the actual analysis. The Dutch NRA will participate via a steering committee.

Table 3 – Description of planned cost benefit analyses

7 Potential performance indicators and incentive schemes for regulating network outputs

In its 2010 Smart Grids Conclusions Paper [3], ERGEG identified a number (34) of performance indicators for regulating network outputs. These indicators can contribute to regulators' work to quantify the effects/benefits of the "smartness" of a network.

Further, the recent European Commission Communication on Smart Grids [5] states that "regulatory incentives should encourage a network operator to earn revenue in ways that are not linked to additional sales, but are rather based on efficiency gains and lower peak investment needs, i.e. moving from a 'volume-based' business model to a quality- and efficiency-based model".

As part of this status review, we asked NRAs about their experience with the ERGEG indicators. The results of that exercise are presented in Annex 6 and partly in the forthcoming sections. The list of indicators in the Annex corresponds to that presented by ERGEG in 2010. In addition, we also gathered more detailed information on those indicators which are in use or under consideration nationally. The information obtained from seven countries is presented in the forthcoming sections for nine selected indicators.

7.1 The indicators selected for the detailed analysis

From the 34 indicators proposed in the smart grid conclusions paper, nine were selected for further analysis in this report. The selection was based on the number of countries actually using the criteria and the extent to which the indicators fulfilled the following criteria.

i. The variation (improvement) of the indicator would determine a quantifiable benefit to grid users and, in general, society as a whole[4].
ii. It is possible to determine (measure or calculate) the value of the index in a sufficiently accurate and objective way[5].
iii. The value of the index can be influenced (even if to a limited extent) by the network operator or the system operator; this includes metering[6].
iv. The index should be as far as possible, technology neutral[7].

The European Energy Regulators already stated in their consultation paper on smart grids that " A good regulatory model, which could be used as the basis for a regulatory approach to smart grids, are the incentive regulation mechanisms adopted to promote other aspects of

[4] A regulatory scheme for promoting improvements in the performance of electricity networks requires the quantification, through appropriate indicators, of the effects and benefits of "smartness" [Smart Grid Conclusions Paper, page 11].

[5] Clear and transparent measurement rules are very important to make it possible to observe, quantify and verify such targets [Smart Grid Conclusions Paper, page 26].

[6] Performance targets should be cleansed of external effects outside the control of network operators [Smart Grid Conclusions Paper, page 26].

[7] It is also of paramount importance that no regulatory scheme or requirement represents an (unintended) barrier for necessary development in technology and applied solutions in the grid [Smart Grid Consultation Paper, page 31].

network business, e.g. quality of supply“. There is significant experience in performance-based regulation in the field of quality of supply, covering:

- Commercial quality (which includes indicator 3.4 “time to connect a new user”).
- Continuity of supply (group of indicators classified under 4.5 “Duration and frequency of interruptions per customer”).
- Voltage quality (group of indicators classified under 4.6 “Voltage quality performance of the electricity grid“).

For example, in half of the responding NRAs, continuity of supply indicators are used as a revenue driver for network operators. In the other half, continuity of supply is monitored or is under evaluation for either monitoring or to serve as a revenue driver. CEER has ten years of experience in benchmarking the indicators and regulations for quality of supply across Europe [4]. Therefore, these are not treated in this status review.

We chose to look more closely at the following nine indicators. The numbers refer to the full list of indicators in the Smart Grids Conclusions Paper [3] and as presented in Annex 6:

a) 2.1. Hosting capacity for distributed energy resources in distribution grids;
b) 2.2. Allowable maximum injection of power without congestion risks in transmission networks;
c) 2.3. Energy not withdrawn from renewable sources due to congestion and/or security risks;
d) 4.3. Measured satisfaction of grid users for the “grid” services they receive;
e) 5.1. Level of losses in transmission and distribution networks;
f) 5.5. Actual availability of network capacity (e.g. DER hosting capacity) with respect to its standard value;
g) 6.1. Ratio between interconnection capacity of one country/region and its electricity demand;
h) 6.2. Exploitation of interconnection capacity (ratio between mono-directional energy transfers and net transfer capacity); and
i) 7.4 Time for licensing/authorisation of a new electricity transmission infrastructure.

In the forthcoming sections, we discuss these nine selected indicators in more detail, grouped according to four headings.

7.2 Indicators of adequate grid capacity

7.2.1 Hosting capacity for distributed energy resources in distribution grids

This indicator is used in one country (Italy) as a revenue driver and is under consideration in four countries (Austria, Czech Republic, Latvia and Lithuania) for monitoring and in three countries (Austria, Ireland and Poland) as a revenue driver. Two countries (Great Britain and Norway) have minimum requirements in place for this indicator. This indicator is specifically referred to as a distribution indicator in the Smart Grids Conclusions Paper. Two countries indicate however that this indicator can also be used at transmission level.

The hosting capacity is the amount of electricity production that can be connected to the distribution network without endangering the voltage quality and reliability for other grid users. To calculate the hosting capacity, it is important that performance requirements for voltage quality and reliability are agreed upon.

The hosting capacity could also depend on the type of electricity production. This again means that it is important to define clearly how the hosting capacity is calculated. Incorrect definition or calculation of the index could result in new technology increasing the actual hosting capacity but not the index.

The definition of the criteria in Italy – including the hosting capacity indicator – was rather complex and involved a commission of three experts from Italian academia. Its use followed studies by the NRA (and consultants) which are published in Italian language as annexes to regulatory orders[8]. Such studies investigated the possibility of injecting power in each bus of the MV network, without violating the thermal capacity of MV lines or the voltage variation constraints and without determining rapid voltage changes above predefined thresholds. In Italy, this indicator is now used as a revenue driver (still with limited economic effects) for the smart grid demonstration projects. The rules and criteria for assigning the extra-remuneration include the increase in hosting capacity in MV busses which can be obtained by implementing the smart grid solutions trialled by the demonstration project without network reinforcements: the higher the increase of hosting capacity, the higher the possibility for the project to be selected by the NRA and to receive the extra-remuneration.

In France, RTE publishes maps with the connection potential ("potentiel de raccordement") for all MV, HV and EHV substations. When calculating the indicator, a certain amount of curtailment is considered, which is in turn included in the connection agreements. This is however non-binding information intended for potential producers, not monitored and calculated using a simplified model.

A similar approach is adopted in Italy, for both transmission and distribution networks, following the AEEG regulatory order 125/10. For HV and EHV networks, the transmission operator identifies and publishes the list of network areas and the list of HV lines to which the connection of new generating capacity is critical. For MV networks, the distribution operators must compare the minimum demand, the installed capacity and the future generation capacity for the areas served by a HV/MV substation. Coloured maps are used, i.e. a substation is 'red' (critical) when the injection capacity minus the minimum demand exceeds 90% of the capacity of the HV/MV transformer. Other thresholds (under the same criterion) identify the 'orange', 'yellow' and 'white' substations. The regulatory mechanism was launched to address the significant amount of applications for connection of new power plants, and its effect also applies to installed capacity.

When the hosting capacity indicator is used as a revenue driver, it should not incentivise the network operator to excessive unnecessary investments in the grid. The indicator should also give the right incentive towards the use of cost-effective technology.

[8] Some information in English is available in: M. Delfanti, M. S. Pasquadibisceglie, M. Pozzi, M. Gallanti, R. Vailati, Limits to Dispersed Generation on Italian MV Networks, Proceedings CIRED 20th Conference on Electricity Distribution, Prague, 8-11 June 2009. http://www.cired.be/CIRED09/pdfs/CIRED2009_0400_Paper.pdf

7.2.2 Allowable maximum injection of power without congestion risks in transmission networks

This indicator is used in one country (Italy) as a revenue driver and is under consideration in three countries (Austria, Czech Republic and Lithuania) for monitoring and in two countries (Austria and Poland) as a revenue driver. Two countries (Great Britain and Norway) have minimum requirements in place for this indicator.

This index can be considered as the transmission system equivalent of the hosting capacity. It can also be seen as the net transfer capacity from a (hypothetical) production unit to the rest of the grid. The condition “without congestion risks” should be interpreted as obeying the prescribed rules on operational security.

This indicator can be calculated on an hourly basis, considering the actual availability of network components and the actual power flows through the network. This would result in an indicator whose value changes with time. The indicator can also be calculated as a fixed value under pre-defined worst-case power flows and a pre-defined outage level (e.g. n-1). The resulting value would give the largest size of production unit that can be connected without risking curtailment.

When using this indicator as a revenue driver, the same care should be taken as with the hosting capacity as well as with the net transfer capacity. The incentive mechanism should not result in excessive unnecessary investments and the method for calculating the index should not favour one technology above another.

In Italy, the NTC (Net Transfer Capacity) is calculated, referring to the power which can be exported without congestion from some generating areas. An NTC constraint is used for the aforementioned generating areas, when solving the day-ahead market. The indicator therefore impacts the day-ahead market results (price and quantities). It also affects the following real-time balancing market. The results of this latter market also depend on network and generation constraints. A reward-penalty mechanism is imposed on the TSO (in its role of system dispatcher), depending on the total amount of the balancing energy. The TSO reward/penalty mechanism (for balancing energy) is decided by the NRA, which also decides the slope, the cap of rewards, the floor of penalties, etc.

The possibility to use this indicator as a revenue driver in the way implemented in Italy depends on the mechanisms for day-ahead and balancing markets.

7.2.3 Energy not withdrawn from renewable sources due to congestion and/or security risks

This indicator is used in two countries (Germany and Ireland) for monitoring and is under consideration in three countries (Czech Republic, Lithuania and Spain) for monitoring and in two countries (Great Britain and Poland) as a revenue driver. One country (Latvia) has minimum requirements in place for this indicator.

This indicator quantifies the ability of the network to host renewable electricity production. In that sense, it is similar to indicators like hosting capacity and allowable maximum injection of power. But whereas the latter two indicators only quantify the actual limits posed by the network, the energy not withdrawn quantifies to which extend the limits are exceeded. The value of this index is determined afterwards, so that there are fewer approximations and assumptions needed than for the other two indicators. In fact, the calculation is rather similar to the calculation of energy not delivered, an indicator that is commonly used for continuity of supply. The main assumption to be made will be the energy that would have been produced during curtailment or disconnection of the production unit.

Another advantage of using actual energy not withdrawn as an indicator, especially when used as a revenue driver, is that there is no risk of the network operator investing heavily in a network to be prepared for production capacity that never arrives. The associated disadvantage is that this indicator will give less incentive to invest before renewable electricity production is in place. This could result in the network being insufficiently prepared for a sudden increase in the amount of renewable electricity production.

7.3 Indicators of enhanced efficiency and better service

7.3.1 Measured satisfaction of grid users for the grid services they receive

This indicator is used in two countries (Czech Republic and Great Britain) as a revenue driver and in three countries (France, Italy and Portugal) for monitoring. It is under consideration in three countries (Austria, Lithuania and Poland) for monitoring.

This indicator would in principle be the ultimate indicator; after all, the grid is there for its users. However, it is not straightforward to quantify satisfaction of grid users in an objective way. Some of the customer-quality indicators presented in the CEER Benchmarking Reports on quality of electricity supply [4] are strongly related to this.

In Austria, a national survey will be undertaken in the near future to estimate grid-user satisfaction at distribution level.

In Italy, the NRA evaluates the customer satisfaction of grid users (consumers) by means of yearly surveys, which also cover other issues (e.g. billing). This is published regularly and used for deciding which regulatory actions (especially regarding the field of quality regulation) have to be prioritised. Portugal has a similar approach.

In Italy, it was found that there seem to be external effects of the perceived satisfaction related to grid services, due to the overall price of electricity. The NRA performs correlation analysis with other sub-indicators of perceived satisfaction in order to try to cleanse this external effect.

In France, polls are conducted on FNCCR's initiative (the organisation of owners of distribution networks) at approximately two-year intervals. They are primarily focused on distribution users and their results are included in NRA reports.

7.3.2 Level of losses in transmission and distribution networks

The transport of electrical energy through the distribution or transmission network is associated with a certain amount of losses. Therefore the amount of energy being produced has to be a few percentage points higher than consumption. When the marginal electricity production is based on fossil fuel, as is the case most of the time in most European countries, the losses result in additional carbon-dioxide emissions.

This indicator is used in twelve countries (Austria, Czech Republic, France, Great Britain, Ireland, Italy, Norway, Poland, Portugal, Slovenia, Spain and The Netherlands) as a revenue driver, in six countries (Czech Republic, Germany, Finland, Ireland, Norway and Sweden) for monitoring and is under consideration in one country (Luxembourg) for monitoring and in two countries (Luxembourg and Lithuania) as a revenue driver. This indicator can be determined for both distribution and transmission networks.

The losses in the distribution and transmission networks are reported in the majority of countries. As a result, there is a significant amount of experience in the use of this indicator. However, the indicator is likely to be calculated in different ways in different countries. It is not clear to which extent this will have an impact on the results and the ability to compare. An overview of methods for calculating losses as used in different countries is included in an ERGEG consultation paper on losses (E08-ENM-04-03, July 2008) and its associated conclusions paper (E08-ENM-04-03c, February 2009)[9]. The reader is referred to those papers for more details on methods in use for calculating losses.

The losses depend on the current and resistance of the network component. Only the latter can be impacted by the network operator. There are also differences in network structure, like typical length of lines and cables, which may make comparison between countries and even between network operators in the same country difficult.

The costs associated with the losses occurring during the transport of power through a network are in principle recovered by the network operator through the tariffs. When the losses are fully recovered through the tariffs, this removes any economic incentive for the network operator to reduce the losses. Putting a maximum amount on the costs associated with losses that can be recovered from the tariffs will create an incentive to prevent high losses. A fixed compensation for losses per network operator per year gives a direct incentive to reduce losses.

7.3.3 Actual availability of network capacity with respect to its standard value

There are two possible understandings of this type of indicator:

- The availability of network capacity compared to a reference value at national or local level; or
- The actual availability of network capacity in selected lines or network cross-sections compared to their normal capacity (e.g. winter peak net transfer capacity), due to unavailability of some network components or actual operational conditions.

[9] http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_CONSULT/CLOSED%20PUBLIC%20CONSULTATIONS/ELECTRICITY/Treatment%20of%20Losses/CD

This type of indicator is used for monitoring in five countries (Austria, Czech Republic, Great Britain, Italy and Norway) and is under consideration in two countries (Lithuania and Poland) for monitoring and in one country (Great Britain) as a revenue driver. One country (Norway) has minimum requirements in place for this indicator. This indicator is classed by two countries as transmission only, by one country as distribution only, and by five countries as both transmission and distribution.

Calculating the network capacity (the term “net transfer capacity” (NTC) is often used), is not obvious and several variables need to be considered, including the thermal capacity of network elements (at both transmission and distribution level), the need for operating reserve and stability reasons (especially at transmission level) and permissible voltage variations (especially at distribution level).

It is also important to realise that network capacity varies with time, again especially at transmission level. This is not of concern when the indicator is used for monitoring only. But when used as a revenue driver, an appropriate annual index should be calculated.

In Austria, NTC values for international connections at transmission level are frequently monitored by the NRA (on a yearly basis) and are also part of the monitoring of the electricity Regional Initiatives (ERI) multi-country region (region-wide monitoring of commercial flows).

In Italy, a comparison is made between actual (hourly) NTC in the day-ahead market and a standard NTC, which is defined on a yearly basis and differentiated by summer-winter months and by peak-medium-light load conditions. Standard and hourly actual NTC values are calculated by the TSO.

Another important aspect to consider is that network capacity is only of concern when it becomes less than the required network capacity or when such a situation is expected to occur in the future. The choice of the standard value to which the network capacity is compared is important in that context. This is again especially important when network capacity is used as a revenue driver. Such a revenue scheme should not incentivise network operators towards investing in network capacity that is not needed for many years to come. None of the responding countries uses network capacity as a direct revenue driver, but some relations between network capacity and revenue can still be identified.

In Italy, some impact on the revenues of the TSO is associated with the reward/penalty mechanism for balancing costs, which can be affected by the actual availability of net transfer capacity (both among price areas used in the day-ahead market and among network elements which can constrain the results of the balancing market). However, the indicator is also used mainly for market monitoring.

In order to handle grid congestion, the Nordic exchange area is geographically divided into bidding areas or trade zones. Bidding areas are generally consistent with the geographical area of each of the TSOs and Sweden (SE), Finland (FI) as well as Estonia (EE) have single bidding areas. Denmark, however, constitutes two areas (DK1 west of the Great Belt and DK2 east of the Great Belt) whereas the Norwegian grid is divided into five bidding areas (NO1 through NO5). For the hours in which there is adequate transmission capacity, the electricity price in all the areas will be the same, but in case of grid congestion (insufficient network capacity), adequate market splitting is used. Internal grid congestion within a bidding area is handled by the TSOs using other methods such as counter-trading or export capacity reductions. The costs are carried at first by the TSO, who transfers these to its network users through the grid tariffs. Congestion will thus not directly impact the TSO's financial result, but the TSO is in a position to minimise societal costs by balancing counter-trading costs and investments aimed at increasing the network capacity. In the near future, Sweden will be split into four bidding areas, minimising the need for export capacity reductions.

The use of the indicator as a revenue driver could be subject to drawbacks, including the impact on the calculation of standard NTCs and reduction of planned maintenance of transmission elements.

7.4 Indicators of effective support to trans-national markets

7.4.1 Ratio between interconnection capacity of one country/region and its electricity demand

This indicator is used in seven countries (Austria, Czech Republic, France, Germany, Ireland, Norway and Sweden) for monitoring and is under consideration in two countries (Lithuania and Poland) for monitoring. One country (Czech Republic) has minimum requirements in place for this indicator.

The limited capacity of international connections is often a serious barrier to having an open trans-national (Pan-European) market. Although international connections can be treated in the same way as other connections using the network capacity indicators, there are good reasons for introducing a dedicated indicator for international connections. Calculating the interconnection capacity suffers from the same limitations as the network capacity; in particular, the operational security rules have to be considered.

In Sweden, information on interconnection capacity between different regions is published by the market operator (NordPool). Information on electricity demand per region is published by the Swedish transmission system operator (Svenska Kraftnät). The transfer capacity between the regions within Sweden is published by the Swedish TSO for every hour of the year.

7.4.2 Exploitation of interconnection capacity (ratio between mono-directional energy transfers and net transfer capacity)

This indicator is used in five countries (Austria, Czech Republic, France, Germany and Norway) for monitoring and is under consideration in two countries (Lithuania and Poland) for monitoring. One country (Czech Republic) has minimum requirements in place for this indicator.

In Austria, the evaluation of this indicator is part of the regional monitoring work in the entire Central-East/Central-South (CEE/CSE) region (efficient use of limited available interconnection capacity). The decision on values is made by the NRAs of the respective region.

The basic elements of the indicators in this and the previous section (i.e. net transfer capacity, national electricity demand, mono-directional energy transfers) are currently monitored by the transmission system operators of each country and reported by ENTSO-E at European level in statistical yearbooks.

7.5 Indicators of grid development

7.5.1 Time for licensing/authorisation of a new electricity transmission infrastructure

There are two possible understandings of this type of indicator. It can be interpreted and used referring to:

- the licensing/approval of the new transmission project by the NRA and/or the competent authority;
- the permitting/authorisation process for the construction of the new transmission infrastructure.

The latter issue was discussed by the European Energy Regulators in 2007-2008 by means of the ERGEG papers “Cross-Border Framework for Electricity Transmission Network Infrastructure” (Ref. E07-ETN-01-03) and “Status Review on Building and Construction Authorisation and Permit Process - Case Examples” (Ref. E08-EFG-27-04)[10]. More recently, the Commission’s Energy Infrastructure Communication[11] identified the importance of faster and more transparent permit granting procedures. Also based on the common recommendations by all European stakeholders in [6], the Commission’s Smart Grids Communication [5] reiterated that permitting procedures for the construction and renewal of energy grids have to be streamlined and optimised, and regional regulatory barriers and resistances must be tackled.

This indicator is used in one country (Italy) for monitoring and in one country (Czech Republic) as a revenue driver. It is under consideration for monitoring in two countries (Lithuania and Poland).

In Italy, the calculation of this indicator is based on the definition of a number of milestones (i.e. future dates) for authorisation procedures carried out by the TSO. Similar milestones for construction of network infrastructure carried out by the TSO are also adopted. A reward-penalty mechanism is in place for TSO revenues depending on the achievement of milestones. Completion (or intermediate steps) in the authorisation or construction process before a milestone results in rewards. Completion (or intermediate steps) in the authorisation or construction process after the milestone results in a penalty.

The reward-penalty mechanism is set by the NRA (regulatory orders 188/08 and 87/10) and the NRA periodically reviews the milestones. As a possible drawback, one stakeholder publicly commented that the use of such a mechanism can result in the postponement of milestones (in network development plans) by the TSO. Further, the treatment of delays due to “external effects“ is a very important issue.

---

[10] http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_PAPERS/Electricity/2007/E07-ETN-01-03_CB-Frameword-ETNI_V24-04.pdf and http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_PAPERS/Electricity/2008/E08-EFG-27-04_BCAP_Case_Examples_06-Feb-08_0.pdf

[11] http://ec.europa.eu/energy/infrastructure/strategy/2020_en.htm

8 Conclusions

8.1 Adopting and understanding the definition of smart grids

In recent years, European Energy Regulators (and later the Commission in its accompanying document (SEC(2011) 463 final) to its Smart Grids Communication [5]) have adopted a definition of smart grids, which is technology-neutral and focused on what smart grids can deliver. CEER confirms to retain this definition, originally stated in 2009.

8.2 Regulatory challenges

In its 2010 Smart Grids Conclusions Paper ERGEG identified as one of the main priorities the need to address the main barriers to smart grids by encouraging cooperation amongst stakeholders. ERGEG agreed that while high-level principles can be applied across Member States, detailed implementation will vary from country to country.

As smart grids become increasingly relevant in Member States, regulators are considering possible challenges to their implementation. This analysis, which is important for regulators in order to take appropriate national actions, has already occurred in many countries. It is important as well to understand those issues that do not represent major barriers and therefore may not need to be proactively addressed.

Using an internal questionnaire, CEER analysed a range of possible challenges. Assessed by category, most NRAs identified very few challenges related to the know-how of smart grid issues, the role of stakeholders, general conditions and regulatory framework.

Assessed by specific issues, the feedback suggests differences in the importance attached to possible challenges at national level. Some challenges have been recognised more than others. Dealing with incentives to improve cost-effectiveness was sited (and commented on) by most of the responding NRAs.

The following three challenges generated the most reaction (identified and/or commented on) from the NRAs:

- how to encourage network operators to choose innovative solutions;
- the inadequacy of existing standards or lack of standards on smart-grid technology; and
- the need to enhance the definition of national objectives and policies at political level.

These national answers largely confirm the position of European Energy Regulators after the 2010 public consultation process, which identified three priorities (cost-effective regulation of outputs as a mechanism to ensure value for money paid by network users; encouraging an adequate level of innovation; and cooperation among stakeholders with an emphasis on standardisation). On this last priority, we welcome the support from stakeholders to the M/490 work for standardisation in the area of smart grids [6].

8.3 National roadmaps and implementation plans

Although currently only three countries (Austria, France and Great Britain) have a national roadmap in place, half of the remaining twenty-one countries (Cyprus, Denmark, Estonia, Hungary, Ireland, Lithuania, Poland, Slovenia, Sweden and – to some extent – the Czech Republic and Italy) have plans or concrete proposals for the development of such a national roadmap or for implementation. In all cases, all major stakeholders are or will be involved in the development.

8.4 Conclusions and further work needed on innovation and demonstration projects

CEER focussed its analysis on smart grid demonstration projects funded by tariffs and/or public money and excluded projects dealing only with smart metering. This status review presents a cross-section of smart grid demonstrations across Europe. CEER considers that there are very significant benefits to the efficient communication of the results of demonstration projects to all interested stakeholders. CEER has initiated a dialogue with the European Commission in order to contribute to its assessment of smart grid demonstrations (JRC catalogue of projects). Consideration will be given to ways of improving the dissemination of learning and the sharing of experiences from demonstration projects.

CEER recommends encouraging the deployment of smart grid solutions where they are a cost-efficient alternative to existing solutions, and as a first step in this direction, finding ways of incentivising network companies to pursue innovative solutions where this can be considered beneficial from the viewpoint of society.

Based on responses to our internal questionnaire, there are different approaches to encourage innovation:

- Ofgem (in Great Britain) and AEEG (in Italy) have put in place tailored incentive mechanisms to encourage network companies to pursue innovation/demonstration projects.
- Meanwhile, the framework is changing for some countries:
    - in Finland, the regulatory model that will apply from 2012 to 2015 will include an innovation incentive allowing a proportion of R&D costs to be passed through to customers;
    - in Lithuania, a special company (UAB Technologiju ir inovaciju centras) has been created for the purpose of encouraging innovative solutions;
    - in Portugal, a new option incentivising investments in innovative solutions has been proposed in the present public consultation on the Tariffs Code amendment to be applied in the next regulatory period 2012-2014;
    - in the Netherlands, developments are expected as well.
- Furthermore, some countries rely on current approaches which do not necessarily contradict innovative solutions.
    - As an example, Austria takes the view that models of incentive regulation with focused parameters provide inherent incentives to reduce costs and also to deploy innovative solutions, especially when complemented by other sources of funding for the demonstration phase;
    - Similarly, in Sweden, a separate funding scheme using public money is in place

for demonstration projects, whose funding decisions are not made by the NRA.

CEER also recommends ensuring dissemination of the results and lessons learned from the demonstration projects. Seven countries said there are guarantees in place, but nine said there are not. In the former ones, there are generally clear rules that ensure dissemination. Still, it is noteworthy that the majority of responses indicated that no requirements are in place to ensure the dissemination of results and lessons learned.

8.5 Conclusions and further work needed on cost benefit analyses

Our survey found that three countries (the Danish TSO and energy association, the GB Electricity Networks Strategy Group and a Polish DSO) have undertaken a cost benefit analysis of a full smart grid or specific value streams. A further, six countries indicated that a cost benefit analysis is either on-going or planned. Among these countries, Italy and Portugal closely relate the future cost benefit analyses to the demonstration projects, which are now starting.

8.6 Conclusions and further work needed on potential performance indicators

Regulators are highly aware of the importance of performance indicators within Member States. The same awareness appears in the European Commission's Communication on Smart Grids [5], which states that "regulatory incentives should encourage a network operator to earn revenue in ways that are not linked to additional sales, but are rather based on efficiency gains and lower peak investment needs, i.e. moving from a 'volume-based' business model to a quality- and efficiency-based model".

This move to quality and efficiency is already being applied by many NRAs. A significant number of countries indicated that they use some of the indicators proposed in the ERGEG Smart Grids Conclusions Paper. This can be either for monitoring, as a minimum requirement or as a revenue driver. In particular, the indicators for continuity of supply (one quality element) and the indicators related to losses (one efficiency element) are used as revenue drivers in more than half of the countries.

However, the experience of CEER members shows differences concerning the calculation of performance indicators and the way they are (or can be) used as a revenue driver.

It is important that the indicators, and any associated revenue scheme, are defined in such a way that they do not favour one technology above another. Other key features, such as the determination of a quantifiable benefit to grid users and, in general, society as a whole, the accountability of the indicators in a sufficiently accurate and objective way and the clear possibility to influence the value of the indicators by the network operator(s) or the system operator have been already identified by European Energy Regulators.

This puts high demands on the methods used to calculate or measure the respective indicators. Further work is therefore needed, at national as well as at international level, to develop suitable methods to calculate and measure indicators and to design suitable revenue mechanisms.

Annex 1 – CEER

The Council of European Energy Regulators (CEER) is the voice of Europe's national regulators of electricity and gas at EU and international level. Through CEER, a not-for-profit association, the national regulators cooperate and exchange best practice. A key objective of CEER is to facilitate the creation of a single, competitive, efficient and sustainable EU internal energy market that works in the public interest.

CEER works closely with (and supports) the Agency for the Cooperation of Energy Regulators (ACER). The forerunner to ACER was the European Regulators' Group for Electricity and Gas (ERGEG). ERGEG was established by the European Commission in November 2003 (Decision 2003/796/EC), as its formal advisory group of energy regulators on Internal Energy Market issues. With ACER fully operational since March 2011, ERGEG was dissolved by the Commission, with effect from 1 July 2011 (Decision of 16 May 2011, repealing Decision 2003/796/EC). Some of ERGEG's works passes to ACER (e.g. the Regional Initiatives) and some (such as the work formally carried out by the ERGEG Electricity Quality of Supply and Smart Grids Task Force) to CEER.

ACER, which has its seat in Ljubljana, is an EU Agency with its own staff and resources. CEER, based in Brussels, deals with many complementary (and not overlapping) issues to ACER's work such as international issues, smart grids, sustainability and customer issues.

The work of CEER is structured according to a number of working groups and task forces, composed of staff members of the national energy regulatory authorities, and supported by the CEER Secretariat.

This report was prepared by the Quality of Supply and Smart Grids Task Force of CEER’s Electricity Working Group.

Annex 2 – List of abbreviations

Term	Definition
ACER	Agency for the Cooperation of Energy Regulators
ADEME	(French) Environment and Energy Management Agency
AEEG	Autorità per l'energia elettrica e il gas (Italian NRA)
AMI	Advanced Metering Infrastructure
B/C	Benefit / Cost
CBA	Cost Benefit Analysis
CEE/CSE	Central-East and Central-South Electricity Regional Initiatives
CEER	Council of European Energy Regulators
DNO(s)	Distribution Network Operator(s)
DSO(s)	Distribution System Operator(s)
EC	European Commission
EEGI	European Electricity Grid Initiative
EHV	Extra High Voltage
ENTSO-E	European Network of Transmission System Operators for Electricity
EQS TF	(CEER) Electricity Quality of Supply and Smart Grids Task Force
ERGEG	European Regulators Group for Electricity and Gas
ERI	Electricity Regional Initiative
ERSE	Entidade Reguladora dos Serviços Energéticos (Portuguese NRA)
EU	European Union
HV	High Voltage
HVDC	High Voltage Direct Current
JRC	Joint Research Centre
LV	Low Voltage
MV	Medium Voltage
NRA(s)	National Regulatory Authority (Authorities)
NTC	Net Transfer Capacity
Ofgem	Office of the Gas and Electricity Markets (British NRA)
R&D	Research and Development
RIIO	Regulation, Innovation, Incentives leading to Outputs
TOTEX	TOTal EXpenditures
TSO(s)	Transmission System Operator(s)
WACC	Weighted Average Cost of Capital

Annex 3 – National roadmaps and implementation plans

Country	Responsible	Publication	Stakeholders involved	Responsible for follow up
Austria	National Technology Platform Smart Grids Austria	(only in German) www.smartgrids.at	The National Technology Platform Smart Grids Austria is a consortium of significant stakeholders in the area of electricity supply. Currently 34 members from Industry plus association (16+1), network operators and energy suppliers plus association (8+1) and R&D partners (8).	The National Technology Platform on Smart Grids and the prepared roadmap is/was financed by the Ministry and the implementation and/or follow up is the responsibility of the ministry and policy makers (in the meantime for example the budget for funding (especially for the development of electricity infrastructure) was increased and proposals of the roadmap are taken into account by implementing the 3rd Package into national law).
France	French Environment and Energy Management Agency (ADEME)	(only French): http://www2.ademe.fr/servlet/getBin?name=E5CD06235AC8FB098D2FC88B22F6E1F4_tomcatlocal1306936086761.pdf	The French TSO (RTE), the main DSO (ERDF, 95% of distribution networks), the association of distribution network owners (FNCCR), several French energy companies (manufacturers, producers, etc) and various experts (from universities and ministries).	
Great Britain	Electricity Networks Strategy Group (ENSG)	On the ENSG's website (http://webarchive.nationalarchives.gov.uk/20100919181607/http://www.ensg.gov.uk/assets/) in the report titled: "Electricity Networks	The members of the ENSG working group are: AEA; Association of Electricity Producers; CE Electric UK; Centrica Energy, DECC; EDF Energy Networks; Electricity North West Limited; Energy Networks Association; Energy Research Partnership; Energy Retail Association; E.ON Central Networks; Energy Technologies Institute; Intellect; National Grid; Ofgem; Renewable Energy Association; RLTech; RWE Npower; Scottish & Southern Energy; Scottish Executive; Scottish Power; The Centre	The Smart Grids Forum (SGF) http://www.ofgem.gov.uk/Networks/SGF/Pages/SGF.aspx) will take ownership of the Vision and Routemap. The Forum will: • Identify future challenges for electricity networks and system balancing, including current and potential barriers to efficient deployment of smart grids; • Guide the actions that DECC/Ofgem are taking to address future challenges, remove barriers and aid efficient deployment; • Identify actions that DECC/Ofgem, the industry or other parties could be taking to facilitate the deployment of smart grids; • Facilitate the exchange of information and knowledge between key parties, including those outside the energy sector;

Country	Responsible	Publication	Stakeholders involved	Responsible for follow up
		Strategy Group - A Smart Grid Routemap" Feb 2009.	for Sustainable Electricity and Distributed Generation; Smarter Grid Solutions; The Carbon Trust; Western Power Distribution.	• Help all stakeholders better understand future developments in the industry that they need to be preparing for; • Track smart grid developments and their drivers; and • Track smart grid initiatives in Europe and elsewhere.
Cyprus	The Electricity Authority of Cyprus (EAC) is in the process of preparing a draft roadmap in order to submit it to the Regulator (CERA) for discussion/comments and final approval.			
Denmark	Minister for Climate & Energy has created a Smart Grid Network to give recommendations for promotion of Smart Grids.			
Estonia	Planned, but not yet known.			
Hungary	NRA is responsible for the document.	It will be published on the NRA's homepage.	All interested parties.	NRA
Ireland	Being created, Sustainable Energy Authority of Ireland.	This will be confirmed as the roadmap is being developed.	The Sustainable Energy Authority of Ireland; electricity regulator; electricity transmission system operator; electricity distribution system operator; Department of Energy, Communications and Natural Resources; Science Foundation of Ireland; Smart Grid Ireland (a group representing consumers).	This will be confirmed as the roadmap is being developed.

Country	Responsible	Publication	Stakeholders involved	Responsible for follow up
Lithuania	Being created, Ministry of Energy.	There are working group meetings especially for this issue.	TSO and DSO, associations and consultants.	Head of the Smart Grid Project according to the approved Smart Grid Implementation Plan, also the Smart Electricity Grid Development Directions approved on May 2010.
Poland	The first step of implementing smart grids in Poland was the appointment of the "Advisory Group for introducing smart grids in Poland" by the Ministry of Economy.	The NRA published project of the NRA's position on minimum requirements for AMI Smart Grid Ready.	Ministry of Economy, NRA, TSO, association of DSO, association of suppliers.	
Slovenia	The "Smart Grid concept" is planned. It will be prepared by Competency centre SURE.	Not known yet.	Academic and research institutions, industry, TSO, DSO.	Ministry for higher education, science and technology.
Sweden	The Energy Markets Inspectorate (NRA) has proposed that the Government commission the Swedish transmission system operator (Svenska Kraftnät) to develop a national action plan that outlines the actions required to obtain an electricity network that is adapted to achieving the political aims for renewable electricity generation and the transition to a sustainable energy system. [From EIR 2010:18].	A decision on this by the Government is pending.	A decision on this by the Government is pending.	A decision on this by the Government is pending.

Country	Responsible	Publication	Stakeholders involved	Responsible for follow up
Czech Republic			Ministry of Industry and Trade, Energy regulatory office, TSO, DSOs and technical experts.	The Ministry of Industry and Trade of the Czech Republic will probably be responsible for this issue.
Italy	There is no national roadmap. However, some implementation elements are planned by various national laws, decrees and documents. The NRA is responsible for the elements mentioned here.	After 2013, the regulation of technical and economic aspects of connecting renewable generating units to MV / HV / EHV networks has to be updated by the NRA every two years.	According to Law Decree of 3 March 2011 (Art. 19), the NRA has the duty to update, before 30 June 2013, the regulation of technical and economic aspects of connecting renewable generating units to MV / HV / EHV networks. The National Action Plan on Renewable Energies of July 2010 indicates that incentives or rewards/penalties will be defined to speed up network development, similar to the Regulatory Order 87/10 by AEEG for transmission networks.	The NRA is responsible for the elements mentioned here.

Annex 4 – Innovation and demonstration projects

Promotion of demonstration of smart grid concepts in Great Britain
Ofgem introduced its first innovation incentives in 2005. These were the Innovation Funding Incentive designed to promote general technical innovation and Registered Power Zones, focused on encouraging innovative ways of connecting distributed generation.

In 2010, the Low Carbon Networks Fund (LCN Fund) was introduced. The LCN Fund allows up to £500m support (2010-2015) to projects sponsored by the distribution network operators (DNOs) of Great Britain to try out new technology, 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 Great Britain (GB) moves to a low carbon economy.

There are two tiers of funding which are available under the LCN Fund. The First Tier is designed to enable DNOs to recover a proportion of expenditure incurred on small scale projects. Under the Second Tier of the LCN Fund, Ofgem facilitates an annual competition for an allocation of up to £64million to help fund a small number of flagship projects. In the first year, four projects were awarded Second Tier funding totalling £63.6million. These projects are described briefly below. The governance arrangements for the LCN Fund are set out in the LCN Fund Governance document. One very important requirement of the LCN Fund is that the DNOs are required to disseminate the learning that the projects generate.

<u>Customer led network revolution (CE Electric UK)</u>

This Project seeks to trial how a combination of smart network technologies and flexible customer demand response can reduce the network costs associated with the mass take up of low carbon technologies. These technologies include photovoltaic (PV) solar panels, heat pumps and electric vehicle (EV) charging points in the North East of England where British Gas is rolling out smart meters, solar PV installations, heat pumps and controllable white goods. CE also proposes to deploy enhanced voltage control, dynamic thermal rating and storage.

The results from the trials have the potential to expand the 'tool kit' of solutions available to network planners. The project will help DSOs understand the impact that customers have on the network and how the deployment of smart meters and low carbon technologies will change that impact. It aims to provide evidence of the level of demand response which can be provided by domestic and commercial customers and at what cost. This could enable network planners to establish where this response can play a role in overcoming network constraints without the need for reinforcement. Equally, CE hopes the trialling of new technologies will demonstrate what role they can play as a cost-effective alternative to network reinforcement.

More details can be found at http://www.networkrevolution.co.uk/

<u>Low Carbon Hub (Central Networks)</u>

This is a small, discrete project which seeks to trial new technologies and operating techniques in order to connect more wind generation to a 33kV network in Lincolnshire. It is a technology-led project which seeks to utilise dynamic voltage control and a flexible AC transmission system (FACTS) device to increase the utilisation of current network assets and provide lower cost connections for DG customers.

The project builds upon a successful initiative undertaken on the 132kV network which was trialled under the Registered Power Zone initiative established by Ofgem in Distribution Price Control Review 4 (DPCR4) as well as an Innovation Funding Incentive project. Central Networks (CN) considers that there are significant new challenges associated with adapting these solutions to the 33kV network and substantial benefits in proving it successful. CN identified the trial area in Lincolnshire as one in which they had received a number of inquiries from distributed generators who would like to connect. The trial seeks to demonstrate whether the deployment of these new technologies could allow more generation capacity to be connected, cost effectively, without the need to build significant new network assets.

More details can be found at http://www.eon-uk.com/distribution/lowcarbonhub.aspx

Low Carbon London (UK Power Networks)

This is a substantial project proposal which seeks to extract network learning from a variety of separate trials across the inner and outer London area. These trials are proposed to take place in areas designated by the Greater London Authority as low carbon zones. The trials look to monitor the impact on the LV network of PV solar panels, the extensive deployment of electric vehicle charging points, heat pumps and 5000 smart meters. Enhanced management of DG is also planned. The project includes the deployment of IT solutions to utilise smart meter data in eight “Use Cases”. EDF also proposes to trial new commercial arrangements including time of use distribution use of system (DUoS) tariffs, offering flexible demand to National Grid and wind twinning. Wind twinning is the matching of demand with centralised wind generation so as to help balance the electricity system.

LV network templates (Western Power Distribution)

This project focuses entirely on the performance of LV networks in a variety of areas across South Wales. Western Power Distribution (WPD) proposes to install monitoring equipment at over 1000 HV/LV substations and on over 7000 LV feeders. Some 7300 customers will be directly involved as monitoring equipment will be installed in their premises. The substations have been selected in areas where low-carbon technologies are being installed either under the Welsh Assembly Government’s ARBED project (3000 homes, 1000 PV installations) or by npower under its community energy saving programme (CESP) and carbon emissions reduction target (CERT) schemes. The trial also involves monitoring circuits not affected by the low carbon trials. This will enable a direct comparison of data between trial areas to view the impact of low carbon technologies on the LV network. Bath University will process the data to produce new network ‘templates’ which should show how existing LV networks perform as domestic low carbon technologies are connected. These templates will be a development of the Energy Network Association’s (ENA) existing templates and are expected to be applicable to networks across GB. In addition, the output of the micro-generation connected will be visible and available to National Grid.

More details can be found at http://www.westernpower.co.uk/About-our-Network/Low-Carbon-Networks-Project.aspx

Promotion of field demonstration of smart grid concepts in Italy
In order to promote field demonstration of smart grid concepts, the Italian NRA (AEEG) started in 2010 a competitive selection process of demonstration projects of smart grids in distribution medium-voltage (MV: 1-35 kV) networks proposed by distribution companies.

Under the Regulatory Order 39/10, the selected demonstration projects are allowed to receive a tariff incentive. This incentive mechanism allows an extra-remuneration of capital expenditures for demonstration projects (CAPEX): extra-WACC (weighted average cost of capital) + 2% is allowed for 12 years on the part of the distribution RAB (regulatory asset base) associated to investments needed for the demonstration project. The ordinary WACC for the distribution investments is 7% pre-tax, so the total WACC for smart grid demonstration project is 9% (for 12 years, then back to 7% for the rest of the life span of the investments).

A minimum requirement for demonstration projects to participate in the evaluation and selection process is that the project applies to a real, automated, active and 'open' grid. Indeed, it must be a real case in existing “active MV distribution networks”, defined by AEEG as MV networks in which energy flows from MV to HV at least for 1% of time (in the year). Moreover, demonstration projects must implement real-time voltage control and only open protocols can be used for electronic communication among DSO control centre and single DG power plants (or storage plants or EV recharging points).

<u>Use of cost benefit analyses</u>

The project proponents are requested to indicate costs (external public funding and budget requests to be covered by network tariffs) and expected benefits (contribution to integration of DG, promotion of innovation, contribution to demand response, improvements in quality of supply, replicability). The selection ranking relies on a benefit/cost approach, which favours both the reduction of costs and the increase of expected benefits of demonstration projects.

The benefits for calculating the ratio benefits/costs include:

- increase of network hosting capacity (measured as the average hourly energy that can be injected in the smart distribution network beyond the level of minimum load power);
- innovation in voltage control for DG (for instance, reactive power remote control for DG plants, and/or automatic shedding in order to trial larger protection thresholds for frequency and voltage);
- innovation in other aspects of full smart grid concept (demand response, electric vehicles, etc.);
- time framework for pilot projects and results soon available;
- effects on quality of electricity supply (enhancement or at least no decrease);
- involvement of MV-connected generators (and/or storage and/or demand response resources) for participation in the balancing market.

The costs for calculating the ratio benefits/costs are normalised by the additional hosting capacity.

The detailed evaluation of proposed demonstration projects is based on four macro-categories: sizing of project and involvement of parties (30%), innovation (40%), feasibility (10%), replicability (20%).

Sub-criteria for the macro-categories are the following:

- on the project size: number of generation plants/storage involved, increase of energy injection into the grid, increase of energy production compared to the consumption, number of HV/MV substations involved;
- regarding the project innovation: participation of generation plants, especially to voltage control, presence of SCADA control system bi-directional communication and demand response, presence of storage systems and active power modulation, participation of DSO to ancillary service market;
- regarding project feasibility: timing of the project, quality of supply improvements;
- regarding project replicability: percentage of costs borne by non-regulated actors, use of standard protocols (only non-proprietary protocols are allowed), consistency between investment costs and objectives/expected benefits of the project.

<u>On-going activities</u>

AEEG received in November 2010 nine proposals of distribution network operators for demonstration projects. These proposals were evaluated beginning 2011 by the NRA (through qualified evaluators appointed by AEEG). A merit list was published at the end of the evaluation process according to the ratio benefits/costs and eight demonstration projects were selected.

AEEG recently selected and approved eight demonstration projects for the extra-WACC tariff incentive: four projects are by the three largest Italian DSOs, one from a regional DSO, one from a medium-sized DSO and two by small DSOs owning only one HV/MV substation. Costs of the demonstration projects are socialised (through distribution tariffs) to all Italian MV and LV users, which prevent customers of small network operators experiencing a large increase in network tariffs.

The total cost of the eight demonstration projects (approved for extra-remuneration 2%-12 years) is published by the NRA: the sum is €16.4 million.

A final project report by each DSO must be submitted to the NRA (and it will be published). Further, intermediate reporting to the NRA every six months is requested.

Annex 5 – Cost benefit analyses for the demonstration and deployment of smart grids

Cost benefit analysis on the deployment of smart grids in Denmark
The report "Smart Grid in Denmark" by the Danish TSO and the Danish Energy Association performed economic calculations of investments and benefits, based on socioeconomic (present value) calculations.

The investments relate to the reinforcement of the distribution networks, the installation of synchronous compensators and static var compensators, the electronics for automated control of facilities at the users' premises, the metering equipment in the distribution network, the upgrading of electronic meters and software solutions to be installed by the TSO and the DSOs.

The benefits were assessed only in terms of additional savings determined by the smart grid deployment:

- savings on reserves and regulating power (assessed through current costs and future requirements for them);
- savings on electricity generation by demand response actions;
- savings on energy-saving initiatives (based on analysis of results in other countries).

The economic calculations led to conclude that establishing a smart grid will have a net cost. Still, this net cost is much lower than the net cost of continuing the "traditional" approach. The report is also available in English and is available at:
http://www.energinet.dk/SiteCollectionDocuments/Engelske%20dokumenter/Forskning/Smart%20Grid%20in%20Denmark.pdf

Smart Grid CBA in Great Britain
In 2009, Great Britain's Electricity Network Strategy Group (ENSG)[12] initiated work on a vision and route map for a smart grid. A working group was established with broad stakeholder engagement to carry out this work and a consultant was also engaged to provide support. The final vision document was published in November 2009 and is available on the ENSG's website. This was followed by the Route Map in February 2010.

The ENSG's vision explores the definition of a smart grid, the drivers for its development, the key steps that will be involved and the likely timescale. In developing the vision, it was recognised that it would be necessary to build a business case for the deployment of more novel technologies, particularly where their initial costs were higher than "business as usual" solutions. Therefore, as part of the vision project, a cost benefit analysis (CBA) was carried out.

It was recognised that the CBA could only examine one of many smart grid investment paths

[12] The Electricity Networks Strategy Group is jointly chaired by government (i.e. the Department of Energy and Climate Change) and the gas and electricity regulator for Great Britain, Ofgem. More details are available at http://webarchive.nationalarchives.gov.uk/20100919181607/http:/www.ensg.gov.uk/index.php?article=126

and that the focus would have to be on the deployment of particular solutions to deliver specific value streams. These value streams included loss reduction, voltage optimisation and demand response. The approach to the CBA is explained in detail in the Vision document. The possible variations of each value stream where assessed on a net present value (NPV) basis allowing a range of overall cost benefits to be estimated. This demonstrated that positive and negative NPVs were plausible.

The results of this analysis were not considered sufficiently robust to support specific investment options. However, it did provide useful learning and a framework to consider the relationship between future energy scenarios and the value of smart grid solutions. This work is now being taken forward by the Smart Grid Forum in Great Britain.

Annex 6 – Potential performance indicators

Potential performance indicator (numbers according to the benefits identified by the ERGEG position paper)	Used as a revenue driver	Minimum requir.	Used for monitoring	Possible revenue driver	Possible for monitoring
1.1. Quantified reduction of carbon-dioxide emission	GB				CZ;IE;LT ;PL; ES
1.2. Environmental impact of electricity grid infrastructure	GB	NO	GB		CZ;LT;PL
2.1. Hosting capacity for distributed energy resources in distribution grids	IT	GB;NO		AT ;IE;PL	AT ;CZ;LT ;LV
2.2. Allowable maximum injection without congestion risks in transmission grids	IT	GB;NO		AT;PL	AT;CZ;LT
2.3. Energy not withdrawn from renewable sources		LV	DE; IE	GB ;PL	CZ;LT ;ES
3.1. First connection charges for generators, consumers and those that do both	AT;CZ;FI;LV;NL	FI	FI,FR;IE,LU,NO	PL	LT
3.2. Grid tariffs for generators, consumers and those that do both	AT;CZ;FI;NL	NO	DE;FR;IE;LU;NO	LV;PL	LT
3.3. Methods adopted to calculate charges and tariffs	AT;CZ;FI;NL	FI;GB;NO	FI;IE;LU	LV;PL	LT
3.4. Time to connect a new user [QoS indicator]	IT	NO;NL	AT; FR;GB ;LU ;PT	CZ;GB ;IE	FI;IE;LT;PL;ES
4.1. Ratio of reliably available generation capacity and peak demand			AT;DE;GB ;IE;LU; NO;SE		CZ;LT ;LV;PL
4.2. Share of electrical energy produced by renewable sources			AT;CZ;DE;FR;GB;IE; LU;NO;SI;SE		LT;LV;PL
4.3. Measured satisfaction of grid users for the "grid" services they receive	CZ ;GB		FR;IT;PT		AT;LT;PL

Potential performance indicator (numbers according to the benefits identified by the ERGEG position paper)	Used as a revenue driver	Minimum requir.	Used for monitoring	Possible revenue driver	Possible for monitoring
4.4. Power system stability performance	CZ;IE	GB	AT;CZ		DE; LT;PL
4.5. Duration and frequency of interruptions per customer [QoS indicator]	DK;EE;FI;FR;GB;IE;IT; LV;NO;PT;ES;SE; NL	NO	AT;DE;EE;FI;NO;PL	AT;CZ;PL	LU;LT;SI
4.6. Voltage quality performance of electricity grids [QoS indicator]	IE;LV	GB;IT;NO	AT;CZ;EE;FR;IT;NO;SI	AT;DK;FR;PL	DE; IT;LT;LU
5.1. Level of losses in transmission and in distribution networks	AT;CZ;FR;GB;IE;IT;NO;PL;PT:SI; ES;NL		CZ;DE; FI;IE;NO;SE	LU	LT;LU
5.2. Ratio between minimum and maximum electricity demand		CZ	DE; IE;SE		IT;LT;PL
5.3. Percentage utilisation of electricity grid elements		CZ	GB;NO;IE;SE		LT;PL
5.4. Availability of network components and its impact on network performances	IE; PT	CZ;NO	AT;GB:IT	NO	IT;LT;PL
5.5. Actual availability of network capacity with respect to its standard value		NO	AT;CZ;GB;IT;NO	GB	LT;PL
6.1. Ratio between interconnection capacity and electricity demand		CZ	AT;CZ;DE;FR;IE;NO;SE		LT;PL
6.2. Exploitation of interconnection capacity (ratio energy transfers / NTC)		CZ	AT;CZ;DE;FR;NO		LT;PL
6.3. Congestion rents across interconnections	NO	CZ	AT;CZ;FR;NO;PT;SI		LT;PL

Potential performance indicator (numbers according to the benefits identified by the ERGEG position paper)	Used as a revenue driver	Minimum requir.	Used for monitoring	Possible revenue driver	Possible for monitoring
7.1. Impact of congestion on outcomes and prices of national/regional markets	IT	CZ	AT;FI;GB;IE;NO;SI		LT;PL
7.2. Societal benefit/cost ratio of a proposed infrastructure investment		CZ;NO	FI;GB;IE;IT;NO		LT;LU;PL;NL
7.3. Overall welfare increase		NO	IE	AT	LT;PL
7.4. Time for licensing/authorisation of a new electricity transmission infrastructure	IT		CZ		LT;PL
7.5. Time for construction (after authorisation) of a new transmission infrastructure	IT	NO	CZ;IE;NO	IE	LT;PL
8.1. Demand side participation in electricity markets and in energy efficiency			CZ;IE;NO		LT;LV;LU;PL
8.2. Percentage of consumers on time-of-use/critical peak/real-time pricing		CZ	DE;IE;SI		IT;LT;LV;PL
8.3. Measured modifications of electricity consumption after new pricing schemes		CZ			IT;LT;LV;PL;SI
8.4. Percentage of users available to behave as interruptible load		CZ	AT;IE;NO;SE		LT;LV;PL
8.5. Percentage of load participating in market-like schemes for demand flexibility		CZ	IE		AT;LT;PL
8.6. Percentage participation of users at lower voltage levels to ancillary services		CZ			LT;LV;PL