ANNEX 3

Brief report on EU policies and experiences
EuropeAid/129506/L/ACT/TH
Thailand-EC Cooperation Facility – Phase II (TEC II)

GRANT CONTRACT
- EXTERNAL ACTIONS OF THE EUROPEAN UNION -

DCI-ASIE/2010/242-677

Smart/Intelligent Grid Development and Deployment in Thailand (Smart Thai)

BRIEF REPORT ON EU POLICIES AND EXPERIENCES

Beneficiary/Applicant: World Alliance for Thai Decentralised Energy (WADE THAI), Thailand
Partner: World Alliance for Decentralised Energy (WADE), UK
Associate: Full Advantage Co., Ltd. (FA), Thailand

“Smart/Intelligent Grid Development and Deployment in Thailand (Smart Thai)” July 2011
SMART GRID IN EUROPE

Although current networks presently fulfill their function, but they will not be sufficient to meet current challenges and policy imperatives. It is essential that, right across Europe, actors are able to agree upon a vision of the future that will ensure needs. It is essential that clear objectives are defined and a strategy for making vision reality is adopted. In response to new challenges and opportunities, electricity networks have begun to evolve. The aim is that they accommodate more decentralized generation services, with many actors involved in the generation, transmission, distribution and operation of the system. Thus the origin of smart grid in Europe took place.

Definition of smart grid:

By ERGEG (European regulator group for electricity and gases):- Smart Grid is an electricity network that can cost efficiently integrate the behavior and actions of all users connected to it – generators, consumers and those that do both – in order to ensure economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety.

General definition: Smart Grids could be described as an upgraded electricity network to which two-way digital communication between supplier and consumer, intelligent metering and monitoring systems have been added.

Communication between supplier and consumer: Smart Grids can manage direct interaction and communication among consumers, households or companies, other grid users and energy suppliers. It opens up unprecedented possibilities for consumers to directly control and manage their individual consumption patterns, providing, in turn, strong incentives for efficient energy use if combined with time-dependent electricity prices.

Intelligent metering: Intelligent metering is usually an inherent part of Smart Grids. Electronic meters, automated meter management systems and telecommunications – together with other communications systems that use electricity supply networks as their delivery infrastructure – will serve as enabling technologies. Information and Communication Technology (ICT) and business process integration will be valuable tools in the real time management of the value chain across suppliers, active networks, meters, customers and corporate systems.
Monitoring systems: Wide area monitoring and protection (WAM & WAP) systems will be applied to manage the congestions in the transmission systems in a way that improves the security and reliability of grid operation.

**Investment in “Smart Grid” electricity infrastructure will be needed…**

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**Advantages of Smart Grid**

1. Increased sustainability
2. Adequate capacity of transmission and distribution grids for “collecting” and bringing electricity to consumers
3. Adequate grid connection and access for all kinds of grid users
4. Satisfactory levels of security and quality of supply
5. Enhanced efficiency and better service in electricity supply and grid operation
6. Effective support of trans-national electricity markets
7. Coordinated grid development through common European, regional and local grid planning to optimise transmission grid infrastructure
8. Enhanced consumer awareness and participation in the market by new players
9. Smart Grids provide a platform for traditional energy companies or new market entrants such as ICT companies, including SMEs, to develop new, innovative energy services while taking due account of data protection and cyber-security challenges. That dynamic should enhance competition in the retail market, incentivise reductions in greenhouse gas emissions and provide an opportunity for economic growth.

**Starting of activities (step by step):**

**Initiation:** During the first International Conference on the Integration of Renewable Energy Sources and Distributed Energy Resources held in December 2004, industrial stakeholders and the research community suggested the creation of the European Technology Platform for the Electricity Networks of the Future. The European Commission Directorate General for Research developed the initial concept and guiding principles of the Technology Platform with the support of an existing FP5+6 research clusters which represents over 100 stakeholders in the electricity networks sector.
The Smart Grids European Technology Platform for Electricity Networks of the Future began its work in 2005. Its aim was to formulate and promote a vision for the development of European electricity networks looking towards 2020 and beyond.

In April 2006 the Advisory Council of the European Technology Platform (ETP) (http://www.smartgrids.eu/?q=node/27) for Europe’s Electricity Networks of the Future presented its Vision document for Smart Grids together with the, Strategic Research Agenda, published in 2007 that described the main areas to be investigated, technical and non-technical, in the short-medium term in Europe. Since then these documents have inspired several Research and Development programs within the EU and National institutions.

At the end of 2008, based on the contributions and discussions of many people in the EU Member States, the first draft of this Strategic Deployment Document (SDD) was released, under the Chairmanship of Pier Nabuurs CEO of N.V. KEMA. Today this document is formally finalized, and describes the priorities for the deployment of innovation in the electricity networks and the benefits that such innovation will deliver for all stakeholders. It also gives a timeline for deployment.

ERGEG launched its “Position Paper on Smart Grids” for public consultation on 17 December 2009. The purpose of the consultation was to assist regulators in understanding how smart grids can benefit network users and, potentially, other stakeholders in the European electricity supply system. The consultation has generated significant interest amongst stakeholders. 104 people attended the consultation workshop held in Brussels on 17 March 2010 and 50 written responses have been received. All of the responses have been considered by ERGEG and a summary of them has been produced. (http://www.energy-Regulators.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_ERGEG_PAPERS/Electricity/2010/E10-EQS-38-05_SmartGrids_Conclusions_10-Jun-2010_Corrige.pdf)

The Strategic Deployment Document has also benefited from input from a Mirror Group of Member State representatives, and as other activities and documents of the ETP SmartGrids, it has been main source of inspiration for many institutions, and key stakeholders in Europe in the last years.

Links to different document:

- Vision and Strategy for European Electricity Networks of the future
- Strategic Research Agenda (SRA) for European Electricity Networks of the future
- Download Strategic Deployment Document (SDD)

The EEGI is one of the European Industrial Initiatives under the Strategic Energy Technologies Plan (SET-PLAN) and proposes a 9-year European research, development and demonstration (RD&D) program to accelerate innovation and the development of the electricity networks of the future in Europe. (http://www.smartgrids.eu/documents/EEGI/EEGI_Implementation_plan_May_2010.pdf).

The European Electricity Grid Initiative (EEGI) Roadmap 2010-18 and Implementation Plan 2010-12, has been prepared by ENTSO-E (European network of transmission system operators) and EDSO-SG (European DSO Association for Smart Grids) in close collaboration with the European Commission, ERGEG and other relevant stakeholders. In May 2010, the EEGI adopted a detailed implementation plan, setting priorities for the period 2010-2018 and indicating financing needs of about € 2 billion. In order to be formally endorsed at the SET-PLAN conference in Madrid on 3rd of June 2010, this Implementation Plan is being submitted.
SET plan (European Strategic Energy Technology Plan) The SET PLAN supports European energy and climate policies through technology innovation. It aims to coordinate efforts at national and EU level through joint strategic planning and effective implementation mechanisms.


To respond to changes in demand, objective the Commission of ANEC, the European consumer voice in standardization adopted a third Energy Package that will come into force in 2011. This package provides the legal basis for adapting the energy system through the implementation of smart metering and promotion of smart grids. The ANEC Commission also set up a Smart Grid Task Force, composed of the relevant stakeholders, including ANEC and BEUC (European Consumers' Organization), to identify strategic decisions and regulatory recommendations for implementation of smart grids. The European Standards Organizations (ESOs) set up a Smart Meters Co-ordination Group (SM-CG) to execute this task, of which ANEC is a member.

(http://www.anec.org/attachments/ANEC-PT-2010-AHSMG-005final.pdf)

On 4 February 2011 a meeting of European Council was held that confirmed the need of standard for smart grid.

Thus Europe is entering into working state from an initiation level.

Role of stake holder

Users: Users’ needs include quality of service and value for money. In the coming years, users’ expectations will broaden and will include value added services, energy services on demand and total connectivity. They will be asking for connection of in-house generation, the ability to sell surplus generation back to the grid, real time tariffs and the freedom to choose their suppliers.

Electricity network companies: Network owners and operators are called upon to fulfill customers’ expectations in an efficient and cost effective way. They are required to undertake necessary investments to guarantee high levels of power quality and system security, while assuring adequate remuneration for their shareholders. Investment remuneration and stable regulatory frameworks will be necessary for a “level playing field” competition in a liberalized market.

Energy service companies: Companies will have to satisfy the growing needs of users. Some users will seek simple “turnkey” products. Cost efficiencies and savings will need to be made visible, in monetary terms. This must be accompanied by an increase in services delivered and a reduction of intrusion upon the customer, such as for maintenance of the system. In general, a trend will be observed from the present “infrastructure-driven” to progressive “service-driven” paradigms in the European electricity supply industry.

Technology providers: Significant technology and business changes lie ahead and equipment manufacturers will be key players in developing innovative solutions and in achieving their effective deployment by working with the grid companies. As with grid companies, technology providers will have important investment decisions to make. A shared vision will be critical to ensuring sound strategic developments that provide open access, long-term value and integration with existing infrastructure.

Innovation will be needed in relation to networks, demand, and for generation, both distributed and centralized, as grid system operational characteristics change.

Researchers: The research community has a critical role to play: without research there is no innovation and without innovation there is no development. Cooperation among universities and research centers, utilities, manufacturers, regulators and legislators must be fostered, not only for the successful development of new technologies but also to overcome non-technical barriers.
Traders: Free trade throughout Europe will be facilitated by open markets, harmonized rules and transparent trading procedures. Congestion management and reserve power must be resolved for a fully integrated European market. Customers will benefit from the opportunity to choose the energy supplier that best suits their requirements.

Generators: Electricity grids are complex, integrated systems and there is a sensitive interaction between generators, the grid systems, and the demands. It will be important for the future to ensure the continuing close involvement of generation companies, understanding the electrical characteristics of their Equipment and their operational dynamics.

Regulators: The European market for energy and related services should be supported by a stable and clear regulatory framework, with well-established and harmonized rules across Europe. Regulatory frameworks should have aligned incentives which secure a grid with increasingly open access, a clear investment remuneration system and keep transmission and distribution costs as low as possible. Effective and efficient innovation should be rewarded.

Governmental agencies: Governments and lawmakers will have to prepare new legislation to take into account apparently contradictory goals. Increasing competition is expected to keep a downward pressure on energy prices, but a more environmentally friendly energy mix may bring cost challenges. Legislation will be affected by innovative technologies, the evolution of grid organizations, the requirement for greater flexibility and increased cross-border trading and by the need to ensure economic development, greater competitiveness, job creation and high quality security of supply (both short and long term) in the EU.

Advanced electricity service and solution providers: New businesses will be provided with the choice between own (on-site) generation, including sales of surplus to the grid, and the purchase of electricity from supplier companies. They will have the opportunity to offer demand side response products and services to the grid. In the case of electricity-intensive industries, their decisions will be influenced by market price changes. Thus businesses will be seeking a wider range of solutions than is currently available.

Preparing adequate workforce and continuous education: Power engineering is perceived to be old-fashioned. Particular attention will need to be addressed to solve the shortage of skilled staff with manufacturers, grid operators, regulators, etc. A multidisciplinary approach (engineering, economic, regulatory legislation) has to be envisaged. Co-ordination between actors is essential in maintaining a secure supply, an efficient network operation and a transparent market. Common technical rules and tools need to be adopted by the different players regarding data exchange, modeling grids, ancillary services and their users. They must also share a vision of electrical system performance. A pan European approach is essential since, even if the technology is available and the vision and motivation exist, a smart power grid will not be implemented unless there can be a collective evolution into the future.

A future Vision (Comparison b/w today and tomorrow ):-

Important changes must be incorporated into the nature of electricity supply, as demand rises and traditional resources are depleted.

Today’s grids are predominantly based on large central power stations connected to high voltage transmission systems, which in turn supply power to medium and low-voltage local distribution systems. The transmission and distribution systems are commonly run by natural monopolies (national or regional bodies) under energy authorities’ control. In contrast, the generation sector is increasingly competitive.
**Future grids** Distribution grids will become active and will have to accommodate bi-directional power flows. Distribution networks, on the other hand, have seen little change and tend to be radial with mostly unidirectional power flows and "passive" operation. Their primary role is energy delivery to end-users.
ADDRESSING CHALLENGES — POLICY INITIATIVES ENABLING SMART GRID DEPLOYMENT IN EUROPE

Some of the barriers mentioned are: Uncertainty, lack of clear roles and responsibilities, data management, security and privacy issues, political will, regulatory structures and alignment of incentives, market requirements, ineffective implementation of unbundling, insufficient supporting schemes for RES, lack of definition of smart grids functionalities, safety and more.

Some Major issues related to smart grid

1. Developing common European Smart Grids standards

The conclusions of the European Council of 4 February 2011 confirm the urgent need to adopt European standards for Smart Grids. Consumers must have the freedom to chose how the new technology is used (e.g. whether to have a smart display or to receive the information in other ways, whether to accept the standard display or upgrade to more sophisticated equipment, where the meter/display is located etc.).

Action on smart grid standard

With the help of the Task Force, the Commission will monitor the implementation of the work program established in the mandate with a view to ensuring timely adoption of the standards. If progress in the course of 2011 is not sufficient, the Commission will intervene to ensure that the deadline is met and the necessary standards are set, for example by defining a network code.

The Commission will also follow the development of ICT standards at the European and international level to facilitate the implementation of Smart Grids.

2. Addressing data privacy and security issues

http://www.beuc.org/Content/default.asp?pageId=1120&searchString=smart%20grids

Consumer privacy, together with ensuring a fair division of the cost, is without doubt one of the most important aspects of the change towards smart energy systems. Data access and ownership, permission to gather data and the optimum frequency of data are all issues to carefully consider and address. Furthermore, consumers should have confidence that their metering system will not be tampered with or hacked into – ensuring that their bills are accurate, supply is maintained and personal information is secure. Smart meters and grids must be safe from infection by viruses and malware.

Privacy should be designed into smart meter systems right from the start as part of the compliance life-cycle and include easy to use privacy-enhancing technologies. We urge to make the principle of privacy by design mandatory, including principles of data minimization and data deleting.

Such a proposal is in line with the Data Protection Directive. It emphasizes the importance of taking appropriate technical and organizational measures both at the time of the design of the processing system and at the time of the processing itself. Any data exchange must also protect the sensitive business data of grid operators and other players, and enable companies to share Smart Grids data in a
secure way.

**Actions on data privacy and security of data in Smart Grids**

- The Commission will monitor the provisions of national sectoral legislation that might apply to take into account the data protection specificities of Smart Grids.
- The ESOs will develop technical standards for Smart Grids taking the ‘privacy by design’ approach.
- The Commission will continue bringing together the energy and ICT communities within an expert group to assess the network and information security and resilience of Smart Grids as well as to support related international cooperation.

**3. Regulatory incentives for Smart Grids deployment**

Regulatory challenges: enabling new services with a technology-neutral role; removing barriers e.g. by decoupling grid operators' profits from volumes, priorities efficient smart solutions; ensuring stable long term return investments; pushing grid companies to be user-centric; and the overarching challenge of incentivizing innovation.

Smart Grids deployment should first and foremost be market-driven. There is wide agreement among investors that the regulatory framework needs to be conducive to investment in Smart Grids.

**Actions to adjust the existing regulatory framework for Smart Grids**

- The Commission will develop regulatory incentives for the deployment of Smart Grids, for example in the application and revision of the Energy Services Directive and/or through the development of a network code or implementing act on tariffs.
- The Commission will establish guidelines to define a methodology for the smart meter implementation plans of Member States, as well as for their (possible) cost-benefit analyses.
- Beyond the targets for smart meters in the Third Package, the Commission will request Member States to produce action plans with targets for the implementation of Smart Grids.
- Through its role in the Regional Initiatives and its involvement in ENTSO-E, the Commission will encourage and promote coordinated action towards the deployment of Smart Grids at European and regional level.

**4. Smart Grids in a competitive retail market in the interest of consumers**

The Electricity Directive requires Member States to create well-functioning and transparent retail markets and to facilitate access for new entrants, including energy service companies and ICT providers that can provide services to consumers allowing them to change their behavior to their benefit. Promoting direct feedback to consumers using, for example, in-home displays or other means can also be important. Developing Smart Grids in a competitive retail market should encourage consumers to change behavior, become more active and adapt to new ‘smart’ energy consumption patterns.

**Actions to guarantee competitive Smart Grids services to customers**

- The EU Commission will introduce, through revision of the Energy Services Directive, minimum requirements for the format and content of information provision for customers, and for access to information services and demand management (e.g. in-house control of consumption).
- The Commission will monitor the implementation of the Third Package requirements needed to create a transparent and competitive retail market for the development of services (e.g.
time-of-use pricing and demand response) based on Smart Grids and metering. If the requirements are not implemented or not effective, the Commission may take further action, possibly in its review of the Energy Services Directive.

5. Continuous support for innovation and its rapid application

The EU Commission has launched several initiatives for the modernization of energy networks. These have shaped the Smart Grids vision, established the needs for technology R&D and prompted small-scale pilot projects to verify and demonstrate the functioning and benefits of Smart Grids. A continued R&D effort towards advanced electricity network technology is necessary, and the Platform is expected to provide inputs for its agenda.

Actions to support innovation and rapid application

During 2011, The EU Commission proposed additional new large-scale demonstration initiatives for rapid Smart Grids deployment, taking into account the needs identified in the EEGI. They included new ways and means to leverage financing, in line with the Energy Infrastructure Package and as requested by the European Council of 4 February 2011.

Roles of different organizations

On 17 December 2009, ERGEG (European regulator group for electricity and gases) launched a public consultation on its Position Paper on Smart Grids. The consultation period ended on 1 March 2010. 50 responses were received to this consultation document. A list of the respondents (Section 1.3) and an evaluation of responses (Annex 3) is appended to this document. Further, a workshop was organized by ERGEG on 17 March 2010 in order to discuss with all interested stakeholders (see Section 1.4) the preliminary views outlined in the Consultation Paper.

ANEC is the European consumer voice in standardization. They represent the European consumer interest in the creation of technical standards, especially those developed to support the implementation of European laws and public policies.

BEUC, the European Consumers’ Organization has a membership of 44 well respected, independent national consumer organizations from 31 European countries (EU, EEA and applicant countries). BEUC acts as the umbrella group in Brussels for these organizations and our main task is to represent our members and defend the interests of all Europe’s consumers.

About ENTSO-E and EDSO-SG

EDSO-SG (European DSO Association for Smart Grids) has recently been created by a number of Distribution System Operators and is open to wide membership.

The two associations, jointly with the European Technology Platform Smart Grids will play an important role in the planning, monitoring and dissemination of this initiative. In the dissemination of the results regarding the distribution network, Eureletric will also play a key role.

SETIS: It’s a commission that initiated plan SET aims to increase, coordinate and focus EU support on key low-carbon energy technologies. [http://setis.ec.europa.eu/](http://setis.ec.europa.eu/) (Strategic Energy Technology Information System "SETIS")

The European Energy Research Alliance (EERA) – founded by leading European research institutes – aims to accelerate the development of new energy technologies with the help of Joint Research Programs supporting the SET-Plan by concentrating activities and resources, combining national and EU sources of funding and maximizing complementarities and synergies.(set plan brochure).

JRC: JRC is the joint research centre by European Commission’s. The JRC research found that in 2007 public and private European investors together dedicated €3.3 billion to R&D on EU priority low-carbon energy technologies. €2.38 billion were invested in R&D on non-nuclear energy, of which €1.66 billion came from the private sector.

EII Team (European Industrial Initiative):- Under the overall guidance of the Steering Group of the SET Plan, the EII team is composed by Industry, European Commission and Member States and when necessary other relevant stakeholders (research, financial communities, etc.). It provides a flexible platform for planning and programming of actions to implement the initiative. It is to provide to the Steering Group, the Implementation Plan for endorsement and an indication of the availability of programming instruments and budget for its implementation. [http://www.smartgrids.eu/?q=node/171](http://www.smartgrids.eu/?q=node/171)
References

EnergyRetailers_WhitePaper_Final_ExecutiveSummary.PDF
(http://www.smartgrids.eu/documents/newforum/8thmeeting/ETPSmartGrids_EnergyRetailers_White
Paper_Final_ExecutiveSummary.pdf)

towards_smartpower_en.pdf
(http://ec.europa.eu/research/energy/pdf/towards_smartpower_en.pdf)


EEGI_Implementation_plan_May 2010.pdf
(http://www.smartgrids.eu/documents/EEGI/EEGI_Implementation_plan_May%202010.pdf)


2009_comm_investing_development_low_carbon_technologies_en.pdf
n_technologies_en.pdf)

2009_comm_investing_development_low_carbon_technologies_roadmap.pdf
n_technologies_roadmap.pdf)

2009_comm_investing_development_low_carbon_technologies_impact_assessement.pdf
n_technologies_impact_assessement.pdf)

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da
n_technologies_summary_impact_assessement_en.pdf)

2009_comm_investing_development_low_carbon_technologies_r_and_d.pdf
n_technologies_r_and_d.pdf)

jrc_091007_newsrelease_rd_investment_set.pdf

CCS_EII_Implementation_Plan_final.pdf (http://setis.ec.europa.eu/activities/implementation-
plans/CCS_EII_Implementation_Plan_final.pdf/at_download/file)

Solar_EII_CSP_Implementation_Plan_final.pdf (http://setis.ec.europa.eu/activities/implementation-
plans/Solar_EII_CSP_Implementation_Plan_final.pdf/at_download/file)

Solar_EII_PV_Implementation_Plan_final.pdf (http://setis.ec.europa.eu/activities/implementation-
plans/Solar_EII_PV_Implementation_Plan_final.pdf/at_download/file)

Wind_EII_Implementation_Plan_final.pdf (http://setis.ec.europa.eu/activities/implementation-
plans/Wind_EII_Implementation_Plan_final.pdf/at_download/file)

plans/European%20Industrial%20Bioenergy%20Initiative -EIBI.pdf/at_download/file)
Implementation Plan 2010-2012 - European Sustainable Nuclear Industrial Initiative.pdf


20110412_act_en.pdf


SMART_GRIDS_-_EURELECTRIC_VIEWS_V21_FINAL-2009-030-0440-01-E.pdf


ANECP-2010-AHSMG-005final.pdf (http://www.anec.org/attachments/ANECP-2010-AHSMG-005final.pdf)

smart2020report.pdf (http://www.gesi.org/LinkClick.aspx?fileticket=tbp5WRTHuOY%3D&tabid)


Case Studies (The Netherlands, France, Germany and England) – Please see attached documents
4.7. France

National official documents, laws and rules

Official national documents and the legal framework that influences Smart Grids development in France is given by the documents listed in Table 29.

Table 29 National Official Documents, Laws and Rules in France

<table>
<thead>
<tr>
<th>National Official Documents, Laws &amp; Rules</th>
<th>France</th>
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</thead>
<tbody>
<tr>
<td>National strategies, energy targets &amp; strategies and transition paths</td>
<td>Available</td>
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<tr>
<td>- Report of expert group N°1 of the &quot;Grenelle de l’Environnement&quot;: Climate change and energy management (French)</td>
<td></td>
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<tr>
<td>- PROJET DE LOI ADOPTÉ PAR L’ASSEMBLÉE NATIONALE EN PREMIÈRE LECTURE: de programme relatif à la mise en œuvre du Grenelle de l’environnement</td>
<td></td>
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<tr>
<td>Laws and Rules in the energy sector that have implication on Smart Grids</td>
<td>Available</td>
</tr>
<tr>
<td>- LOI n° 2005-781 du 13 juillet 2005 de programme fixant les orientations de la politique énergétique (French)</td>
<td></td>
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<tr>
<td>- PROJET DE LOI ADOPTÉ PAR L’ASSEMBLÉE NATIONALE EN PREMIÈRE LECTURE: de programme relatif à la mise en œuvre du Grenelle de l’environnement</td>
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R&D Framework, Programmes and Policy

The current R&D framework in France is on one hand determined by ADEME’s rules for the attribution of subsidies for R&D and innovation projects and on the other hand by ADEME’s strategic orientation for Research and Development (2007-2010), see Table 30 and Table 32.

Currently, one very Smart Grids specific call for R&D exists, namely the call for “Energy networks and demand side management”. The equivalent document containing R&D implementation guidelines of the innovation policy which is available on the link provided in Table 32 is “Smart Grids, demand-side management and decentralised electricity production: Mounting a national R&D programme”. The goals of this report were:

- **Analyse the role of actors in French research**, in terms of new knowledge to be acquired regarding electricity networks;
- **Propose a new conceptual framework for national R&D on electricity networks**, complementing work currently pursued by researchers in France, in order to explore in greater detail other possible futures for electricity networks;
- **Set up organisational and financial modes for this additional research**, based on a list of projects that clearly distinguishes between European and national public funding;
- **Link these proposed directions for research, organisation and funding to an industrial vision** ensuring that national manufacturers and parts makers will continue to rank among the top global competitors.

Table 30 R&D Framework, Programmes & Policy documents in France

<table>
<thead>
<tr>
<th>R&amp;D Framework, Programmes &amp; Policy</th>
<th>France</th>
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<tbody>
<tr>
<td>- ADEME’s rules for the attribution of subsidies for R&amp;D and innovation projects;</td>
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<tr>
<td>- ADEME’s strategic orientation for Research and Development 2007-2010</td>
<td></td>
</tr>
<tr>
<td>R&amp;D - programmes</td>
<td>Available</td>
</tr>
<tr>
<td>- Call for R&amp;D projects “Energy networks and demand side management”</td>
<td></td>
</tr>
<tr>
<td>R&amp;D and Innovation policy, Innovation Agenda, Technology Roadmaps</td>
<td>Available</td>
</tr>
<tr>
<td>- Smart grids, demand-side management and decentralised electricity production: Mounting a national R&amp;D programme;</td>
<td></td>
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<tr>
<td>- Roadmap for smartgrids and electricity systems that integrate renewable energies</td>
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Additionally, there is a French roadmap for Smart Grids: “Roadmap for smart grids and electricity systems integrating renewable energy sources”. For this document, a group of experts identified 5 broad challenges that provide a framework for visions, bottlenecks and needs for research demonstrators in the field of Smart Grids. Furthermore, these challenges have been set into an economic framework in which the cost/ benefit analysis for the various actors in the system is a determining factor for the arbitration of the technological, economic, institutional and regulatory choices to come. The roadmap is available on ADEME’s website (see according link in Table 32).

Scenarios, project information and platforms

There are no project data bases or specific websites with project information available. But there is one document available drawing scenarios which are not directly related to Smart Grids, but important in the Smart Grids System context: „Energy Efficiency in the European Union: Overview of policies and good practices” by ADEME (see also the link in Table 32). This report identifies eighteen energy efficiency measures according to criteria such as energy impact, implementation coherence, financing schemes or valid past evaluation.

Three platforms/ networks can be mentioned: DERBI the competitiveness cluster, TENERRDIS and CEPENERGIES. The first cluster DERBI (www.pole-derbi.com) is dealing with network management and storage. Energy-producing buildings in a mediterranean climate and energy production outside buildlings and brings together business, laboratories, universities, training centres, professional associations, financial and regional collectives involved in the network of renewable energy throughout the Languedoc-Roussillon region (south of France).

The second cluster TENERRDIS (www.tenerrdis.fr) is a competitive cluster covering all sectors of new energy technologies. Besides energy production it also covers the transport and construction sector. Tenerdis encourages project partnerships between companies, research institutions, training and institutional stakeholders.

Table 31 Scenarios, Project Information & Platforms in France

<table>
<thead>
<tr>
<th>Scenarios, Project Information &amp; Platforms</th>
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<tbody>
<tr>
<td>Project Data bases, Websites with Project Information, Synopses books</td>
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<tr>
<td>Scenarios</td>
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<tr>
<td>Documents or Websites about National &amp; regional networks and platforms</td>
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Finally, CEPENERGIES promotes energy generation without greenhouse gas emission and its international goal is to develop R&D and to form industrial partnerships with foreign companies and groups in the field of climate change.
# List of links to French documents

The following Table 32 lists all links to above mentioned Smart Grids related documents (if available online) and other websites.

**Table 32  Links to Smart Grids related documents in France**

<table>
<thead>
<tr>
<th>French Documents</th>
<th>Links</th>
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<tr>
<td>Smart grids, demand-side management and decentralised electricity production: Mounting a national R&amp;D programm</td>
<td>[<a href="http://www.google.at/url?sa=t&amp;source=web&amp;cd=1&amp;ved=0CBsQFjAA&amp;url=Http%3A%2F%2Fwww2.ademe.fr%2Fservlet%2FgetBin%3Fname%3D9137/DDBF7A06A5CCF871CFAF3A6C0FF7A1242119409511.pdf&amp;ei=q8xST3cEM23R0QQu4XVoQ&amp;usg=AFCicNE_PEs8biAALzU7aYbzU7aYb">www.google.at/url?sa=t&amp;source=web&amp;cd=1&amp;ved=0CBsQFjAA&amp;url=Http%3A%2F%2Fwww2.ademe.fr%2Fservlet%2FgetBin%3Fname%3D9137/DDBF7A06A5CCF871CFAF3A6C0FF7A1242119409511.pdf&amp;ei=q8xST3cEM23R0QQu4XVoQ&amp;usg=AFCicNE_PEs8biAALzU7aYbzU7aYb</a></td>
</tr>
<tr>
<td>Roadmap for Smart Grids and electricity systems integrating renewable energy sources</td>
<td><a href="http://www.marches.ademe.fr/servlet/getDoc?sort=1&amp;cid=88&amp;m=3&amp;iid=58128&amp;ref=76018&amp;nocache=yes&amp;p1=111">www.marches.ademe.fr/servlet/getDoc?sort=1&amp;cid=88&amp;m=3&amp;iid=58128&amp;ref=76018&amp;nocache=yes&amp;p1=111</a></td>
</tr>
<tr>
<td>DERBI competitiveness cluster</td>
<td><a href="http://www.tenerrdis.fr/en">www.tenerrdis.fr/en</a></td>
</tr>
<tr>
<td>TENERRDIS cluster: New energy technologies sector</td>
<td><a href="http://www.capenergies.fr">www.capenergies.fr</a></td>
</tr>
</tbody>
</table>
4.8. Germany

National official documents, laws and rules

The *Energy Concept of the Federal Government* defines the national strategy in the framework of Smart Grids, as stated in Table 33. The according link is provided in Table 36 below. Particular Laws and Rules that have implications on Smart Grids development in Germany were not mentioned in the questionnaire.

<table>
<thead>
<tr>
<th>National Official Documents, Laws &amp; Rules</th>
<th>Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>National strategies, energy targets &amp; strategies and transition paths</td>
<td>Available - Energy concept of the Federal Government</td>
</tr>
<tr>
<td>Laws and Rules in the energy sector that have implication on Smart Grids</td>
<td>- not mentioned</td>
</tr>
</tbody>
</table>

R&D Framework, Programmes and Policy

As regards the R&D framework, Germany is one of the few countries examined having a particular framework for R&D in Smart Grids, named *eEnergy: Potential of ICT for the optimisation of energy supply and the energy consumption*. The related R&D programme is the E-Energy Programme with the focus on the ICT-based energy system of the future. Six model consortia have been awarded funds in the framework of a technology competition held by the Federal Ministry of Economics and Technology in close cooperation with the Ministry for the Environment, Nature Conservation and Nuclear Safety. Furthermore, focus areas of this programme are *innovation policies, information society and telecommunications*. The overall goal of the E-Energy Programme is „Paving the way towards an Internet of Energy“ with technical solutions for grid operation, new business models and electronic market places.

<table>
<thead>
<tr>
<th>R&amp;D Framework, Programmes &amp; Policy</th>
<th>Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D framework for research in smart grids? if not: R&amp;D-framework for energy research? if not: R&amp;D-framework in general?</td>
<td>Available - Potential of the Information and Communication Technology (ICT) for the optimisation of energy supply and the energy consumption (eEnergy)</td>
</tr>
<tr>
<td>R&amp;D and Innovation policy, Innovation Agenda, Technology Roadmaps</td>
<td>Available - The German Roadmap E-Energy / Smart Grid, - Analysis and evaluation of standards and norms in the framework of the funding programme E-Energy (Federal Ministry for Economics and Technology)</td>
</tr>
</tbody>
</table>

Finally, a German Roadmap E-Energy / Smart Grids has been published (compare link in Table 36). Additionally, recently the within the E-Energy framework a report with analysis and evaluation of standard and norms in the Smart Grids context was elaborated.

**Scenarios, project information and platforms**

In Table 35 the German project data base and scenarios are highlighted. So a data base with knowledge from and for the E-Energy Projects exist, but it is not publicly accessible.
There are several scenarios available in the context of the Smart Grids development in Germany. First, there is the scenario “Internet of the Energy”, upon which the E-Energy Programme is built. Second, the dena-Netzstudie (Grid Study published by the German Energy Agency) focuses on scenarios of implications of the integration of renewables, especially wind power, on the German electricity grids. The goal of this study was to analyse system solutions for the German electricity grid until 2020 with outlook to 2025 to integrate a share of 39% renewable energy into the electricity supply system in the German transmission grid and in parallel, guarantee security of supply.

And finally, there is an estimation of the enhancement needs for the German distribution grids due to photovoltaic and wind integration until 2020.

**Table 35  Scenarios, Project Information & Platforms in Germany**

<table>
<thead>
<tr>
<th>Scenarios, Project Information &amp; Platforms</th>
<th>Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Data bases, Websites with Project Information, Synopses books</td>
<td>Available</td>
</tr>
<tr>
<td>Scenarios</td>
<td>Available</td>
</tr>
<tr>
<td>Documents or Websites about National &amp; regional networks and platforms</td>
<td>Available</td>
</tr>
</tbody>
</table>

The website for the E-Energy Programme/Platform is: [www.e-energy.de](http://www.e-energy.de).

**List of links to German documents**

The following Table 36 lists all links to above mentioned Smart Grids related documents (if available online) and other websites.

**Table 36  Links to Smart Grids related documents in Germany**

<table>
<thead>
<tr>
<th>German Documents</th>
<th>Links</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential of the Information and Communication Technology (ICT) for the optimisation of energy supply and the energy consumption (eEnergy)</td>
<td><a href="http://www.e-energy.de/documents/Studie_Potenziade_Langfassung.pdf">www.e-energy.de/documents/Studie_Potenziade_Langfassung.pdf</a></td>
</tr>
<tr>
<td>The German Roadmap E-Energy / Smart Grid</td>
<td><a href="http://www.e-energy.de/documents/DKE_Roadmap_SmartGrid_230410_English.pdf">www.e-energy.de/documents/DKE_Roadmap_SmartGrid_230410_English.pdf</a></td>
</tr>
<tr>
<td>&quot;Internet der Energie&quot; (Internet of Energy) - ICT for energy markets of the future.</td>
<td><a href="http://www.e-energy.de/documents/BDI_InternetDerEnergie.pdf">www.e-energy.de/documents/BDI_InternetDerEnergie.pdf</a></td>
</tr>
<tr>
<td>Estimation of the enhancement needs of German distribution grids due to photovoltaic and wind integration until 2020</td>
<td><a href="http://www.e-energy.de/documents/BDEW_Gutachten_Verteilnetze_Ausbaudarf.pdf">www.e-energy.de/documents/BDEW_Gutachten_Verteilnetze_Ausbaudarf.pdf</a></td>
</tr>
<tr>
<td>E-Energy Platform</td>
<td><a href="http://www.e-energy.de">www.e-energy.de</a></td>
</tr>
</tbody>
</table>
4.17. The Netherlands

National official documents, laws and rules

The *Energierapport 2008 "Schoon en zuinig"* identifies ambitions in the area of energy conservation, sustainable energy supply and CCS (Carbon Capture and Storage). The Ministry of Economic Affairs issues an energy report at least every four years. The latest version recommended the formation of a national *Taskforce in the area of Smart Grids*, which has already been stated above. This formation resulted in the document "on the road to smart grids" (*Energie Transitie*) where public private partnerships and seven energy platforms were founded since 2002 and coordinated by co-operation between six ministries.

<table>
<thead>
<tr>
<th>National Official Documents, Laws and Rules</th>
<th>The Netherlands</th>
</tr>
</thead>
<tbody>
<tr>
<td>National strategies, energy targets &amp; strategies and transition paths</td>
<td>Available</td>
</tr>
<tr>
<td>- Energierapport 2008 (Dutch)</td>
<td></td>
</tr>
<tr>
<td>- &quot;EnergieTransitie&quot;, PPP and seven energy platforms since 2002 coordinated under co-operation between six ministries (Dutch)</td>
<td></td>
</tr>
<tr>
<td>- Strategy from National Task Force</td>
<td></td>
</tr>
<tr>
<td>Laws and Rules in the energy sector that have implication on Smart Grids</td>
<td>Available</td>
</tr>
<tr>
<td>- Elektriciteitswet 1998</td>
<td></td>
</tr>
</tbody>
</table>

The primary legislation guiding the energy supply system in the Netherlands is given by the *Elektriciteitswet* (1998).

R&D Framework, Programmes and Policy

From 2004-2010 the *EOS programme* was the main framework for Dutch energy R&D, including Smart Grids. Currently (2011), EOS is in a process of re-evaluation. The *Long-Term Energy Research Strategy The Netherlands* (2006) gives the R&D framework for energy research. Chapter 5 of the strategy describes the electrical infrastructure and Smart Grids. The link to the strategy is listed in Table 70.

In July 2010, the *National Smart Grids Task Force* has issued its vision and strategy "Op weg naar intelligente netten" (on the road to Smart Grids), recommending Smart Grid experimental gardens on a larger scale. Decisions will follow in 2011.

<table>
<thead>
<tr>
<th>R&amp;D Framework, Programmes &amp; Policy documents in the Netherlands</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Besluit van 23 september 2004, houdende regels inzake de verstrekking van subsidies in het kader van energieonderzoek op lange termijn (Besluit EOS: lange termijn), laws and rules (Dutch)</td>
</tr>
<tr>
<td>- Vision and strategy &quot;Op weg naar intelligente netten&quot; on the road to smart grids (by National Smart Grids Task Force)</td>
</tr>
<tr>
<td>R&amp;D programmes</td>
</tr>
<tr>
<td>- Within the R&amp;D framework as mentioned above.</td>
</tr>
<tr>
<td>R&amp;D and Innovation policy, Innovation Agenda, Technology Roadmaps</td>
</tr>
<tr>
<td>- Innovatieagenda Energie, dated July 2008. (Energy Innovation Agenda);</td>
</tr>
<tr>
<td>- The built environment of the Netherlands - Energy Innovation Agenda</td>
</tr>
</tbody>
</table>

In 2008 the *Innovatieagenda Energie* (Energy Innovation Agenda) was published. It indicates the various themes that the Dutch cabinet will focus on over the next few years. Smart Grids is mentioned as an intervention for sustainable electricity supply in the "Infrastructure: Learning and experimental"-category. Additionally, “A smart-
grid electricity network for plug-in hybrids and fully electric cars” is a major objective for 2020.

Furthermore, the document *The built environment of the Netherlands – Energy Innovation Agenda* gives “An outlook on energy-neutral new construction and sustainable existing buildings”. An issue stated in many places in the document is sustainable electricity supply therefore the document can be seen as at least indirectly influencing Smart Grids deployment in the Netherlands.

**Scenarios, project information and platforms**

Access to the collected information of projects funded by the Ministry of Economic Affairs Agriculture and Innovation is possible on the Energie Onderzoek Subsidie’s (EOS) website. But project descriptions mainly are in Dutch.

Scenarios are available in chapter 1.2 “Beelden van de elektriciteitsvoorziening in 2050” of the *Energiërapport* noted above.

As regards Smart Grids related platforms or networks in the Netherlands, there is one named “Vision2030” (since 2008), issued by Dutch TSO TenneT.

Another platform is *Dutch Power* (since 2005). It clusters utilities, equipment suppliers, manufacturers and authorities working together and exchanging information in the area of energy infrastructure.

**Table 69  Scenarios, Project Information & Platforms in the Netherlands**

<table>
<thead>
<tr>
<th>Scenarios, Project Information &amp; Platforms</th>
<th>The Netherlands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Data bases, Websites with Project information, Synopses books</td>
<td>Available</td>
</tr>
<tr>
<td>Scenarios</td>
<td>Available</td>
</tr>
<tr>
<td></td>
<td>- &quot;Beelden van de elektriciteitsvoorziening in 2050&quot;, scenarios in chapter 1.2 of the Energiërapport 2008;</td>
</tr>
<tr>
<td>Documents or Websites about National &amp; regional networks and platforms</td>
<td>Available</td>
</tr>
</tbody>
</table>

On a large symposium in January 2011 the *National Smart Grids Taskforce* tested its vision and strategy by asking a wide range of stakeholders (enterprises, energy companies, municipalities, building and construction, end-users) for feedback. The symposium is part of the process to decide later in 2011 about the experimental gardens, as mentioned above. Results of this test are available on the Agency NL’s website (see links below).
### List of links to Dutch documents

The following Table 70 lists all links to above mentioned Smart Grids related documents (if available online) and other websites.

<table>
<thead>
<tr>
<th>Dutch Documents</th>
<th>Links</th>
</tr>
</thead>
<tbody>
<tr>
<td>EnergieTransitie, public private partnerships and seven energy platforms since 2002 (Dutch)</td>
<td>[<a href="http://www.energie(transitie.nl">www.energie(transitie.nl</a>](<a href="http://www.energie(transitie.nl)">http://www.energie(transitie.nl)</a></td>
</tr>
<tr>
<td>Elektriciteitswet 1998</td>
<td><a href="http://wetten.overheid.nl/BWBR0009755">wetten.overheid.nl/BWBR0009755</a></td>
</tr>
<tr>
<td>Website of Agentschap NL on the area of smart grids (intelligente netten)</td>
<td><a href="http://regelingen.agentschap.nl/content/intelligente-netten">http://regelingen.agentschap.nl/content/intelligente-netten</a></td>
</tr>
<tr>
<td>Dutch Power since 2005, utilities, equipment suppliers, manufacturers and authorities working together and exchanging information on the area of energy infrastructure</td>
<td><a href="http://www.dutchpower.net/">www.dutchpower.net/</a></td>
</tr>
</tbody>
</table>
Scenarios for the development of smart grids in the UK

Context

Smart grids can be defined as electricity networks that can intelligently integrate the behaviour and 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. History suggests that networks can lock-in production and consumption patterns and that, once established, these patterns can endure for decades. With the UK now poised for far-reaching electricity sector reform, and on the verge of large capital spending commitments, choices made in the near future will carry long-term consequences, encouraging some system pathways, while restricting others. Electricity networks will play a central part in the remaking of energy systems. Smart grids, by intelligently linking together different parts of the system, promise to be a key enabler of change. Smart grids are expected to permit much greater levels of intermittent renewables generation, improve network asset use, encourage the active engagement of energy consumers – or the remote management of demand – and allow electricity to play a greater role in transport (via electric vehicles) and heat markets (via heat pumps).

A smart grid involves a cluster of enabling technologies (including but not limited to smart meters), standards, institutions and practices. While there is a broadly shared sense of what a smart grid is, there is less agreement about detailed functionality, architecture and levels of participation. Different countries are following different approaches; for example, the US is taking a top-down standards-based approach, while the UK’s incremental approach takes into account “localised needs, opportunities and legacy”. As a result, both the destination and pace of change are uncertain, and go beyond any narrowly defined technical or business imperatives. Smart grids will not be delivered by traditional electricity suppliers alone – an integration of ICT and energy organisations and technologies will be required. Business integration, and also wider participation, brings tensions; for example, the pace of innovation and asset replacement is much faster in the ICT sector than in energy, and international experience is already revealing citizen concerns about data privacy and data security.

Aims and Objectives

The central aim of the research is to develop and evaluate a small number of „socio-technical” scenarios for the development and deployment of smart grids in the UK. These are not intended to be energy scenarios per se, but the smart grid scenarios may be set in the context of and informed by wider energy scenarios. Each scenario should be developed and evaluated in terms of factors such as the pace and scalability of technology deployment, cost and finance, organisational and business models involved, regulatory style (including standards and inter-operability issues), the role of users, and international drivers and linkages. Attention to spatial aspects is welcome, and in-depth case studies may be used to flesh-out some of the issues involved. The scenarios should be set in the context of energy infrastructure renewal and the UK’s overarching energy goals of decarbonisation, security of supply and affordability. They should also be able to take account of the dynamics of energy system transition, and the link between short and long term change.

A great deal of research is currently under way on smart grids and smart meters. Most of this focuses on primarily technical aspects, and we do not want to duplicate this. Rather, UKERC invites proposals which address the financial, regulatory, legal, organisational, behavioural and societal issues involved, while also being firmly grounded in an understanding and appreciation of energy technologies and ICT. An interdisciplinary project team, spanning the physical and social sciences, applying a combination of quantitative and qualitative research methods will be needed to address the range of issues involved. Proposals that make use of international experiences and comparisons are encouraged, as is business and stakeholder involvement.

A Road Map to Deliver Smart Grid in the UK

Summary

The concept of a ‘smart grid’ involves the combination of instrumentation, communications
and analytics that allows power network infrastructure to be operated in a dynamic and efficient manner as opposed to the ‘passive’ operational approach which is currently the norm in the UK. There exists general consensus that the challenges of climate change and system security, in particular the ability to accommodate significant volumes of decentralised and renewable generation, requires that the network infrastructure must be upgraded to enable smart operation. Failure to do so will act as a major obstacle in the transition to a low carbon economy.

A second important aspect of network development involves the construction of a number of strategic interconnections across the North Sea to create a new off-shore grid. This opens up the opportunity to more fully exploit the vast untapped potential of off-shore wind energy. However, there are a series of obstacles which have hitherto hindered progress in upgrading the network. In particular, the current regulatory regime is not well designed to encourage network operators to embrace new technological opportunities and this is exacerbated by the extent of the risk and uncertainty involved. The government has a key role to play in injecting the necessary momentum by providing strong direction to the regulator on the outcomes that must be delivered. In addition, the government needs to ensure the appropriate financing routes are in place that will enable Ofgem to set a regulatory framework that leads to a low cost of capital for investors whilst retaining the necessary management incentives on network operators to deliver the required outcomes. The creation of a Green Investment Bank provides a useful vehicle to help meet this objective since the government would be able to underwrite losses arising from changes to the policy framework and any resulting stranding of assets. The government road map should be phased in three stages, designed to ensure that network developments do not obstruct or slow down the decarbonisation of the power system:

**Prepare (2010 – 2015):** Early in this period the government must identify a series of key indicators and associated targets for the implementation of smart grid and ensure that the regulator is obliged to deliver these targets. The network operators need to develop their plans to meet the targets and this will need to be based on sufficient testing and trialling of the solutions to be adopted. Finally, the regulator will need to ensure that the appropriate regulatory and commercial arrangements are in place to drive the subsequent deployment process.

**Enable (2015 – 2025):** During this decade the power network needs to become fully automated and interconnected and this process must be driven by obliging the regulator to ensure that staged targets are met against a series of key indicators. These indicators might include parameters which specify the system coverage of instrumentation, grid efficiency achieved, carbon reduced from a more efficient grid, proportion of despatchable demand, capacity of non-generation balancing services and progress with key strategic interconnectors.

**Deliver (2025 onwards):** The power system will have changed enormously by this time and the regulatory and commercial arrangements for the networks must support the ongoing progress towards a fully decarbonisation future.

It is a major undertaking to initiate the transition to a smart grid future and the government will need to develop an approach which tackles the complicated technical, regulatory and financial issues involved. Nevertheless, the urgency to undertake this transition means that it is vital that we do not hide behind this complexity and avoid taking the necessary steps. This note sets out an
ambitious but practical set of actions that we believe are necessary to drive the transition that the UK power system requires.

Context

Traditionally, local power distribution networks have been built and operated on the basis of providing sufficient transport capacity (wires, transformers, etc.) to cope with the range of potential demands from local power users. The core activity of network businesses has involved investment in the infrastructure to create new capacity or maintain existing capacity, and operational interventions have largely resulted from the need to repair faults, typically arising from extreme weather events. This so-called ‘passive’ approach to system operation has proved adequate hitherto given that power flows on the network have been fairly predictable. However, this benign situation is unlikely to continue. The transition towards a low carbon economy will trigger a series of changes in the way power is produced and consumed which will create a number of challenges and opportunities for distribution network operators. In particular:

- Much of the expected growth in large scale renewable generation will result in new generation capacity embedded within distribution networks. Moreover, the power produced by these generators will be intermittent and difficult to predict, being driven by factors such as local weather conditions.
- The drive toward reducing the carbon footprint of the built environment is likely to lead to many homes and businesses producing their own heat and power through small scale micro-generation units.
- Electricity demand could rise significantly as it increasingly becomes the energy source for heating and transport and the old approach of simply increasing system capacity could prove very expensive.

These changes cannot occur to the extent required unless changes are made to the way the distribution networks are managed. It is not feasible to accommodate significant embedded renewable and micro-generation on the network and maintain system security without moving towards a more dynamic approach to network operations. This, in turn, will enable the infrastructure assets to be used more efficiently, thereby reducing the amount that needs to be spent on reinforcing the network.

The concept of a ‘smart grid’ involves the combination of instrumentation, communications and analytics that allows a more dynamic and efficient operation of network infrastructure. There are a whole range of technologies and approaches that can fall within this definition, however, the ultimate goal would involve four key dimensions:

- Full monitoring in real time of power flows and network condition across the system,
- The real time communication of this data to network control centres,
- Expert computer systems capable of identifying optimal operational responses to changes in network condition, and
- The ability to remotely control levels of generation and demand along with other elements of network configuration.

It is now broadly accepted that a transition towards smart grid infrastructure is an essential element in the transition to a low carbon economy and most developed economies are therefore beginning to grapple with the best way to effect such a transition. Technology already exists that
would enable smart grid operation – the challenge is one of deployment and investment. This note sets out the obstacles to such a transition and proposes a way forward for government as it seeks to identify policies for the roll-out of smart grid.

The delivery challenge

Despite the fact that technologies already exist that would enable smart grid operation, it has not proved easy to initiate a process to upgrade the UK electricity networks. There are several significant obstacles:

1. **Regulatory regime**: Distribution network companies are a product of the regulatory regime that has driven their behaviour for nearly 20 years. They have been incentivised to deliver capital investment programmes rather than increasing spending on improving system operation and this, in turn, has reinforced the focus on refining tried and trusted methods and approaches. One of the key benefits of smart grid is that it has the potential to reduce the need to reinforce grid infrastructure. Moreover, the transition to smart grid will involve the adoption of a variety of new technologies and operating practises which will inevitably increase the risk associated with delivering outcomes. It is, therefore, not surprising that the network companies have failed to embrace the transition to smart grid as a core business imperative and changes in the regulatory regime are necessary to rebalance incentives between capital and operational expenditure and encourage network operators to take risks with new operational practises.

2. **Technology risk**: Information and communication technology is central to a smart grid and this is a field which has seen radical change over recent decades. It is likely that this level of change will continue and, therefore, a high probability that currently available technologies will become obsolete over relatively short timescales. This situation demands careful specification of technical standards such that the system can be adapted as new technological opportunities arise in addition to ensuring that robust ‘cyber-security’ systems are in place.

3. **Customer behaviour**: It is, as yet, unclear how changes in customer behaviour might emerge. Customers might remain largely passive purchasers of the product electricity in which case any behavioural change will need to be driven through regulation and the imposition of new centrally determined products and services. Alternatively, customers might be attracted to explore a range of new energy service retail products which in turn reveal new benefits to improve quality of life alongside reducing energy consumption and cost. In light of this uncertainty, the level of prescription and centralisation of customer facing aspects of a smart grid system -in particular, smart metering systems- is the subject of much debate.

4. **Future network need**: There are a number of credible future scenarios for how the electricity system may look in 20 years involving very different levels of demand, generation mix and the extent of interconnection to other power systems. It is impossible to design a network investment strategy that is robust to all possible future outcomes and progress demands that some strategic decisions are taken about the shape of the future system. This would be a significant intervention and there is no precedent in the current regulatory framework for such a centralised strategic view to be taken. However, in the absence of a guiding hand it is extremely difficult to envisage how ‘bottom-up’
investment strategies will deliver the level of change required.

5. Cost: Any project to upgrade the entire UK electricity system to ‘smart status’ will not be cheap and will require huge levels of capital investment, perhaps around £20bn over and above the already vast sums needed to maintain and extend the network and install smart meters. The cost of capital will determine how efficiently these investments can be financed and this in turn will depend on the regulatory and commercial arrangements involved. Careful thought is therefore required to ensure that appropriate incentives on management to deliver the required outcomes. It is a major undertaking to initiate the transition to a smart grid future, and the government will need to develop an approach which tackles the complicated technical, regulatory and financial issues outlined above. Nevertheless, the urgent need to commence the transition, which is reflected in the consensus for action, makes it important that we do not hide behind this complexity and avoid taking the necessary steps. This note sets out a suggested action plan which we believe is practical and will create the necessary momentum for change.

Lessons from current policy initiatives

The development of smart grids is on the agenda of governments around the world. The USA has been in the vanguard of this initiative with equipment manufacturers investing substantial effort in the research and development of technology that can assist with system efficiency, reliability and demand management and with electricity providers planning a range of smart grid deployments. More recently, the federal government has stepped in with a significant funding infusion of around $4bn through the American Recovery and Reinvestment Act.

However, even in light of this progress, it is generally accepted that wide scale smart grid deployment will be a lengthy and fraught process progressed on a state-by-state, project-by-project basis with each initiative governed by state laws involving energy efficiency, conservation, demand management, metering, and other issues requiring regulatory approval for new rate structures and cost recovery. Although the regulatory process in the UK is very different from that in the USA, this experience does highlight the importance of ensuring that regulation and the associated commercial arrangements are aligned to facilitate, rather than obstruct, smart grid deployment.

Progress at the EU level is somewhat behind that in the USA with most of the work on smart grids focused at the technology and research level. This has lead to a variety of efforts to raise the profile of smart grids and highlight the opportunities for power networks. Recently, the commission has published a communication on financing low carbon technologies in which it advocates spending €2bn on integrating research and 20 large scale demonstration projects with the objective of facilitating the roll-out of smart grid to 50% of the European Networks by 2020. It is important to note that much of the EU policy work on electricity networks to date has focused on developing an integrated European super-grid to promote the security of supply and efficiency of the single European electricity market. A key element for any plan to implement smart grid within Europe therefore must involve aligning smart grid developments with the requirements of constructing major trans-national power interconnectors, creating the so-called ‘super-smart grid’.
In the UK, network policy development has been largely lead by the regulator, Ofgem, through three major initiatives:

The Energy Strategy Network Group (co-chaired with DECC) brings together key stakeholders in energy networks and work to-date has largely focussed on identifying transmission system needs to accommodate ~35% renewable generation by 2020. It is now turning its attention to smart grids with a view to producing recommendations for government on a deployment programme.

RPI-X@20 is a major project looking at the possible need for fundamental change to the regulatory framework in light of new investment challenges for networks, including the need to develop smart grids. A number of working papers have so far been published as a result of this work.

Ofgem has also developed a series of Long Term Energy Network Scenarios (LENS) to help inform the development of network policy.

In parallel with these longer term policy initiatives, Ofgem is conducting a periodic review of the price control arrangements for distribution networks with the outcome due to cover the period from 2010 to 2015. Previous attempts to incentivise innovation in network operation have proved ineffective, largely due to the relatively small financial sums involved. Therefore, in recognition of the urgency to move forward the implementation of smart grid technology over the period covered by the current price review, Ofgem has proposed a Low Carbon Fund of up to £500m that distribution companies can use to finance major smart grid pilot projects.

The next stage in the development of smart grid policy in the UK was flagged by DECC in the recent Low Carbon Transition White Paper. This stated that the government intended to publish a high level vision for a future smart grid later this year, followed by a delivery plan. Given that progress is being made at EU level and by Ofgem in the UK, it is important to understand the role government has to play in driving forward smart grid implementation.

The role of government

The future is highly uncertain and inherently unpredictable and any course of action—or inaction- represents a bet on future outcomes. It is interesting to note that the Ofgem LENS scenarios identified policy issues such as the role of government and the level of focus on the environment as key uncertainties in addition to other more fundamental issues such as technological change and customer behaviour. It is inevitable that a regulator that has historically been focused on cost efficiency will be cautious about sanctioning huge investment that may prove to be wasted under credible future scenarios.

Government therefore has two important roles in driving forward the transition to a smart grid future:

Firstly, to inject momentum by clearly setting out the parameters within which it expects Ofgem to act to ensure that time and effort is not wasted in preparing for alternative futures, and

Secondly, to recognise the extent of the ‘policy change risk’ and the impact this can have on the costs of investment and, therefore, to reduce investment costs by creating
financing routes that insulate investors from the risk (cost) of future policy change and any associated stranding of assets.

A key challenge for government is to decide how it shapes the actions of Ofgem to ensure that momentum is appropriately injected. A smart grid will involve the application of a variety of technologies and analytics, and it is unlikely that the government will be able to define a specific technology and mandate a nationwide roll-out. On the other hand, an overarching framework that can incentivise the network operators to identify the number of ‘bottom-up’ projects that would be necessary to create a smart grid will be extremely difficult to define. We believe that the government needs to identify a series of key indicators for the implementation of smart grid, and give Ofgem the obligation to ensure that the regulatory and commercial arrangements are in place to deliver these outcomes. This would be analogous to the role of Ofgem in relation to the renewables targets where it is not for Ofgem to assess whether the targets are sensible, but rather to facilitate their delivery through appropriate reforms to the market arrangements. However, we believe that the critical role played by Ofgem in the activities of network businesses suggests a stronger and active mandate to ensure delivery. Key indicators for a smart grid might include, for example, the proportion of premises with smart meters and load that can be despatched, the proportion of the system which has been fitted with instrumentation which can send real-time information to automatic system control analytics, and the efficiency and carbon reduction achieved by such automation. Network operators will need a clear business case to invest the time and money necessary to deliver a transition to smart grid and the returns will need to reflect the risks involved. Unless the government puts in place a financing route that insulates investors from significant policy in addition to performance risk, there is a real danger that investors might demand excessive costs of capital or simply be unwilling to provide the necessary funding. It seems that a government backed Green Investment Bank can fulfil a valuable role in meeting this objective.

Latest Ofgem thinking as part of the RPI-X@20 review advocates an ‘adapted regulatory framework’ where a combination of industry and Ofgem define the investment path going forward taking into account government targets and policy. It is argued that this will ‘encourage innovation (including trials) and learning, and take account of the value of keeping options open’. However, there is a real risk that ‘keeping options open’ can translate into inaction unless the outcomes are tightly defined by government and aligned with a rapid transition to a smart grid future.

Finally, the government needs to arrive at a definitive view on the value of interconnectors in delivering both decarbonisation and improved security of supply. There is little dispute that a well interconnected Europe has the potential to deliver improved security of supply and at lower cost than a narrow nationalistic solution. However, this depends on an effective European market in which resources are shared equitably between member states. Perhaps of greater significance is the fact that strategic interconnectors can open up the option of moving towards an energy system that is virtually entirely supplied through renewable energy sources by enabling the full potential of, for example, offshore wind energy in the North Sea or concentrated solar power from the Mediterranean to be shared across Europe. It is therefore important that government progresses investments in strategic interconnectors in parallel with the programme to deploy smart grid technologies. This initiative would almost certainly require that strategic interconnectors are provided with a regulatory return instead of taking merchant risk as is the case under the existing regulatory framework.
The smart grid road map

The government needs to establish a road map that includes clear and measurable indicators against which progress can be assessed. Moreover, Ofgem must be obliged to deliver these outcomes in the most efficient manner possible and it is important to establish whether this requires any amendment to existing statutory objectives. Hitherto, government energy policy has focused primarily in two key areas:

Increasing volumes of low carbon generation (renewables, nuclear, coal CCS)
Changing customer behaviour (energy efficiency, distributed generation, smart metering)

However, the benefits from many of these developments will ultimately be limited unless corresponding changes occur in network infrastructure and operation. The timescales for the road map for smart grids must therefore be co-ordinated with other developments to ensure that networks do not constrain and, potentially, promote developments in low carbon generation and efficient consumption. There is likely to be a limited period of time during which the existing network and operational procedures will be able to cope with increasing levels of decentralised and renewable generation. However, at some point, network operators would need to restrict the use of such assets -or operate the system at higher risk levels- and this will significantly slow down the transition to a low carbon economy. We therefore recommend a road map that is split into three discrete phases: prepare, enable and deliver.

Prepare: 2010 – 2015

It is unlikely that the penetration of renewable energy will grow to the extent before 2015 that it cannot be accommodated within the existing network along with current upgrade proposals or that system balancing cannot be achieved using currently available sources of balancing services. This provides a valuable window of opportunity that must be fully utilised to prepare for the future beyond this point.

By 2015, the network operators must have developed complete investment plans for how they will deliver the transition to smart grid and they must have undertaken -or been sufficiently closely involved with- the necessary testing and trialling to ensure that these plans can be delivered. This requires that Ofgem approves the necessary investment costs that will enable this objective to be achieved. It is unlikely that Ofgem will be able to determine this through setting aside a ‘financial pot’ -such as the £500m Low Carbon Fund- but instead will need to take a view from a technological perspective against the future outcomes specified by government. The price control arrangements will have to be specified in a sufficiently flexible manner such that the necessary testing and trialling can be undertaken in a scope and scale that facilitates substantial learning. It is likely that a range of trials will be required, from small scale testing of individual technical solutions, through to studies covering the ‘smart’ operation of whole towns or cities. In addition, the trials should include technologies that integrate the smart meter rollout with the smart grid to assure that the maximum benefit is achieved from the smart meter rollout as it occurs. As part of the testing and trialling process, Ofgem will need to confirm the technical standards that will underpin the smart grid system. This is an important exercise which is
necessary to ensure that future technological developments can be adopted without requiring a significant retrofit of existing instrumentation and equipment. In addition to undertaking the necessary technological preparations, Ofgem will need to confirm and then implement the regulatory and commercial arrangements that will underpin the subsequent deployment of smart technologies. As mentioned previously, it is likely that changes will be required in order to shift the emphasis away from increasing network capacity towards investments that improve network utilisation, and network operators will need to be incentivised to take increased risk with new technologies and operating practises. It is also important that this period is used to stimulate new providers of balancing services such as demand control and storage. It is recommended that regulations are introduced to force system operators to ‘pump prime’ these markets which will become very important in subsequent years. For example, system operators -potentially both at the transmission and distribution level- could be given a long term and increasing obligation to purchase a proportion of balancing services from non-generation sources. System operators would therefore need to enter into long term contractual arrangements during this period to ensure that these services are available in sufficient volumes in subsequent years.

During this time period, network operators should have incentives to commence early implementation of any technical solutions which demonstrate significant smart grid benefit and facilitate a full smart grid. This is critical to ensure that the UK does not delay in achieving carbon reductions from a smart grid, which may be necessary to overcome shortfalls in other areas.

Finally, the government and Ofgem will need to agree during this period which strategic interconnectors need to be built to improve system security and open up the opportunities for transmission from areas of large renewable power resource. It is likely that this will involve joint initiatives with other north western European Member States in specifying and agreeing a North Sea transmission infrastructure. It is likely that a new regulatory framework will be required to underpin these investments and that a tender process could be involved to ensure the assets are constructed at least cost.

**Enable: 2015 – 2025**

The decade from 2015 to 2025 is extremely important since it is during this period that the UK must change from an energy system similar to the one we have today to one that is very different. Network infrastructure must not hold up this transition. During this decade, the networks must become fully enabled to deliver the smart grid future and this will involve:

- A nationwide re-fit of the power network to create a fully network-connected system that identifies all aspects of the power grid and communicates its status and the impact of consumption decisions to automated decision-making systems on the network
- The construction of new strategic interconnectors and appropriate international coordination of system balancing
- The development of a range of commercial arrangements to support system balancing
from new sources such as storage and the demand side. The delivery of this outcome will be underpinned by the government road map to smart grid, which needs to involve a number of key indicators and a target delivery profile against these indicators (typically moving from low levels in 2015 to ~100% levels in 2025 or sooner, since some smart grid technologies are likely to be required to facilitate the delivery of 2020 renewables targets). These indicators and targets will need to be specified as early as possible in the ‘prepare’ phase since this will allow the network operators and Ofgem to make the necessary preparations ahead of 2015. It is likely that the key indicators will include parameters which specify the system coverage of instrumentation, proportion of despatchable demand, efficiency of the system, capacity of non-generation balancing services and progress with key strategic interconnectors.

By 2025 at the latest, it is essential that we have a fully network-connected system that identifies all aspects of the power grid and communicates its status and the impact of consumption decisions to automated decision-making systems on the network, along with a North Sea power network capable of connecting significant additional volumes of off-shore wind power. This will provide the basis for accommodating large volumes of decentralized renewable generation, meeting the increase in demand associated with the electrification of heat and transport sectors and providing the springboard to move towards a fully decarbonised power system.

**Deliver: 2025 onwards**

It is impossible to say how the market will evolve in 20–30 years time. Key developments might include:

- High penetration of electric vehicles
- New products to control household energy demand
- Significant increase in local renewable generation

In addition, experience might identify that the regulatory and commercial framework requires further development. However, it is important to be clear that these developments can only be realised in the context of a fully automated and interconnected grid system and it is vital that this state of readiness is achieved by 2025.

**Costs and financing**

The costs of developing a fully automated and interconnected grid system are significant. The recent analysis by Baringa for DECCiii estimated the costs of a nationwide roll-out of smart meters to be around £10bn. In the US, the Electric Power Research Institute (EPRI) estimates that national distribution of smart grid and smart metering would cost approximately $197bn-covering 142 million customers of electricity in the US who purchase about $343bn of electricity annuallyiv- and it projects that such an investment will produce benefits over 20 years equal to 4 to 5 times the required investment. Since a large portion of the cost is associated with adding sensing to the transformer network, the network design in the UK should result in a substantially lower cost due to a customer density per transformer of 125 in the UK compared to
approximately 5 homes per transformer in the US. Therefore, costs in the UK are likely to be less than the US figures of £867 per customer or approximately £25bn in total. The cost of new interconnectors will depend on the distance and terrain covered and the capacity involved, however, the Britned interconnector (260km and 1GW) cost around £0.5bn.

These costs (before taking into account any of the potentially substantial benefits) represent only a small part of the vast overall sums required for investment in the energy sector – Andris Piebalgs recently estimated €1tn across Europe- let alone that required for other infrastructure assets (transport, water, etc). With these enormous sums involved it is important that policy makers focus on reducing financing costs since small increases in the costs of capital can equate to very significant sums of money. Income for the networks is currently determined by Ofgem through a variety of regulatory arrangements and a key aspect of the regulatory design involves the allocation of risk between the licence holder (and its investors) and customers. Traditionally, network businesses have involved relatively low levels of risk enabling Ofgem to insulate customers from the risk of non-delivery whilst attracting sufficient investment through setting (relatively) low costs of capital.

However, the move to new technologies and operating practices associated with smart grids involves a potentially sharp increase in the risks of delivering required outcomes, and Ofgem will have to decide how much of this risk rests with the companies and how much with customers. If too much risk is placed with investors then high capital costs will be required and it may even be difficult to attract the necessary investment. Alternatively, complete removal of risk from investors may undermine the management incentives to ensure effective delivery of the required outcomes. In the current proposals for the Low Carbon Fund, Ofgem has suggested that only 10% of the investment capital is placed at risk, even though there is the real prospect that the entire pilot could be self-financing. This highlights the appreciation that risk can act as a significant deterrent to action by network operators.

As part of the smart grid road map, the government must ensure that adequate and cost-competitive financing routes are available for network investment. The concept of a Green Investment Bank, where investments are underpinned by government guarantee, presents the opportunity for government to underwrite certain key risks, such as the stranding of assets arising from changes in the policy framework. This presents Ofgem with the opportunity to insulate customers from significant risk whilst ensuring that investors are only exposed to those risks necessary to incentivise delivery of the necessary outcomes. Therefore, even though the total investment sums associated with the implementation of a smart grid are relatively small within the overall context of the infrastructure investment required, a Green Investment Bank still has an important role to play in facilitating this vital element of the transition to a low carbon future.

Conclusions

The government must develop a road map for the implementation of smart grid infrastructure which ensures the necessary investments have been made which promote, rather than delay, the
deployment of low carbon generation and efficient consumption solutions. This in turn requires that key indicators are identified and corresponding targets set such that a fully automated and interconnected grid system is in place by 2025 at the latest. There is a window of opportunity between now and 2015 in which the necessary preparations and trials can be made to ensure that appropriate deployment plans are developed along with the changes required to the regulatory and commercial framework. Ofgem has a key role to play in this transition and must be responsible for ensuring that these targets are met which may require changes to existing statutory objectives. In addition to setting a technical road map, the government also needs to ensure that appropriate and sufficient funding routes are available to meet the targets. A Green Investment Bank has an important role to play since it presents Ofgem with the opportunity to restrict the risks placed on investors to those necessary to incentivise delivery of the necessary outcomes without allocating all the remaining risk to customers.

\[\text{see, for example, ‘Towards Smart Power Networks: Lessons learnt from European FP5 research projects, EUR 21970’}\]


\[\text{Baringa Partners, April 2009, Smart Meter Roll-Out: Market Model and Evaluation Project}\]

\[\text{U. S. DOE Energy Information Administration, January 2009, “Electric Power Annual, Table 7-1 Number of Ultimate Customers Served by Sector, by Provide” and “Table 7.3. Revenue from Retail Sales of Electricity to Ultimate Customers by Sector, by Provider, 1996 through 2007”}\]

\[\text{EPRI, July 2004 , Power Delivery System of the Future: A Preliminary Estimate of Costs and Benefits, .}\]