



How to deliver smarter grids in GB

A REPORT PREPARED FOR THE SMART GRIDS FORUM

March 2011

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1 Introduction and objectives

We were commissioned by Ofgem and DECC to prepare a paper for consideration by the Smart Grids Forum (“the Forum”) at its first meeting on 6th April 2011. Its purpose is to help the Forum decide how it can play an effective leadership role in smart grid development in GB. It aims to catalyse discussion and help the Forum agree the outputs it will deliver in the first year.

1.1 The purpose of the Smart Grids Forum

The aim of the Forum is to provide both leadership and momentum to the development of smart grids in GB. It should help policy makers understand the issues that need to be addressed and the level of direction that will need to be provided to stakeholders to achieve desired outcomes. Therefore, the expectation is that its focus should be on the policy agenda for smart grids, rather than on their detailed implementation.

These objectives are captured in the terms of reference for this group. These are to bring together key opinion formers, experts and stakeholders to:

- track smart grid developments and their drivers;
- review related work in the industry, Government and Ofgem and in Europe;
- identify barriers to network companies adopting smart grid solutions;
- identify the key policy issues that need to be addressed and help guide decisions on the prioritisation/scheduling of these policy decisions; and
- report annually on progress towards delivering smart grids.

The operation of the Forum is intended to:

- assist Government and Ofgem to identify the priorities and focus their work in creating an enabling framework for smart grid development, and work that has an impact on smart grids;
- help industry or other stakeholders to identify activities that they need to prioritise and to help identify work that might be best delivered jointly; and
- help network companies better understand future developments in the industry that they need to be preparing for.

The Forum will primarily focus on the role that the electricity network will play, both technically and commercially, but is expected to touch on related issues

such as how to encourage Demand Side Management (DSM) and smart metering communications models as necessary.

1.2 The purpose of this paper

This report draws on evidence from GB and overseas to help the Forum determine its work programme for the next 12 months. It is split into two parts.

The first part of this report provides context for the Forum's work. Work has already taken place in this area, particularly by the Electricity Networks Strategy Group (ENSG). Where possible, the Forum members should start from a common understanding about what is already known about smart grids, their value drivers and the existing policies that affect their development.

Since membership of the Forum is aimed at those who have a good understanding of issues related to smart grids, this report does not provide a large amount of background information. However, we also recognise that it is aimed at a wide variety of parties who may have different expertise. We therefore provide a list of references containing more detailed background information in Annexe 1 of this report.

The second part of this report then provides a framework for the Forum to decide on its workplan for the coming year. It considers different areas of work that the Forum could look at and provides some criteria for prioritisation. It then looks at the composition and resources of the group to understand what role it could realistically play.

The report is structured as follows.

- **Part One: Context for smart grids in GB**
 - What is a smart grid?
 - Why is a smart grid required?
 - What are the value drivers of a smart grid and how well do we understand them?
 - What policy measures are in place in GB and what other work is taking place?
 - What is going on in Europe and internationally?
- **Part Two: Framework for the Forum**
 - What are the Forum's aims?
 - What are the most significant barriers to smart grids?

Introduction and objectives

- What areas might the Forum wish to look at and how could it prioritise its work?
- What outputs should the Forum aim for in its first 12 months, and how will these be delivered?

2 Context for smart grids in GB

In this section of the paper we provide context for the Forum's work. We have tried to base this, where possible, in the work that has been done by the ENSG. The aim is to allow the Forum members to start from a common understanding about what is already known about smart grids, their value drivers and the existing policies that affect their development. There will be an opportunity at the first meeting of the Forum to debate whether this is the right starting point, before agreeing their role and proposed outputs.

This section seeks to answer the following questions.

- What is a smart grid?
- Why is a smart grid required?
- What are the value drivers of a smart grid and how well do we understand them?
- What policy measures are in place in GB and what other work is taking place?
- What is going on in Europe and internationally?

2.1 What is a smart grid?

There is no single agreed definition of a smart grid. We use the *Smart Grid Routemap*¹ developed by the ENSG as our starting point.

A smart grid is part of an electricity power system which 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.

Expanding on this, DECC identified that a smart grid is likely to have the following characteristics²:

- **Observable:** the ability to view a wide range of operational indicators in real-time, including where losses are occurring, the condition of equipment, and other technical information.

¹ ENSG (2010) *A Smart Grid Routemap*

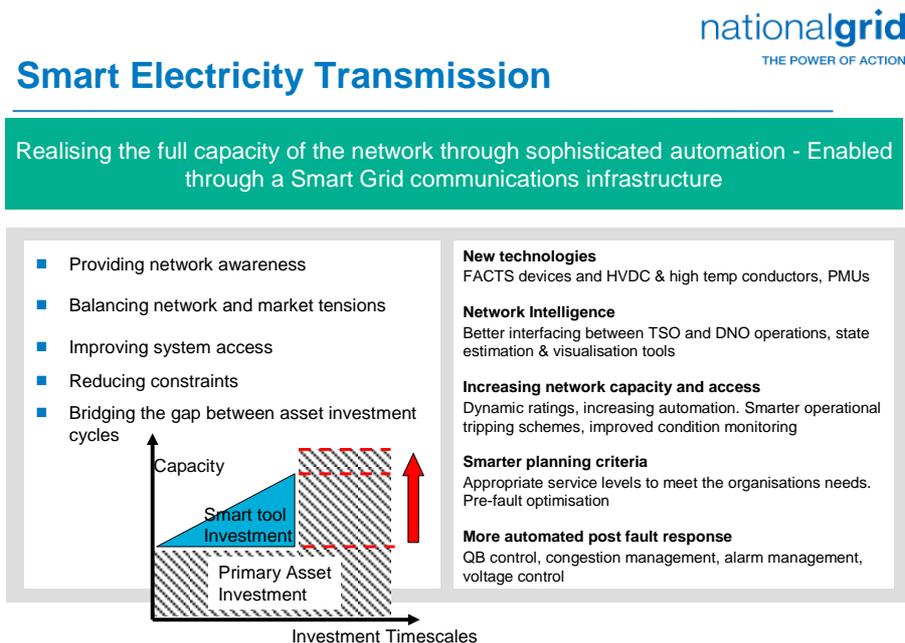
² DECC (2009) *Smarter Grids: the opportunity*

- **Controllable:** the ability to manage and optimise the power system to a far greater extent than today. This can include adjusting some demand for electricity according to the supply available.
- **Automated:** the ability of the network to make certain automatic demand response decisions. It will also respond to the consequences of power fluctuations or outages by, for example, being able to reconfigure itself.
- **Fully integrated:** integration and compatibility with existing systems and with other new devices such as smart consumer appliances.

At this point, a distinction must be made between what “smart grid” means for transmission and distribution.

At the transmission level, the network is already relatively “smart”, given its requirement to manage frequency, voltage and current. Smart grid issues are therefore focussed on the network becoming even smarter. An example of how this may impact a Transmission Operator is illustrated in Figure 1 below.

Figure 1. Smart Electricity Transmission



Source: National Grid

Networks are currently much simpler at the distribution level. Distribution Network Operators (DNOs) typically operate passive networks today, with relatively straightforward flows of electricity. They do not have a history of

Context for smart grids in GB

making trade-offs between investment and active management options. Much of the near term action to deliver smart grids is therefore likely to be focussed on the distribution networks.

However, although there are differences between what smart grids mean for transmission and distribution networks, there are important interface issues between them.

We also note that the definition of a smart grid may evolve over time. The Forum may want to keep this under review as new information about the latest in smart grid technology becomes available from GB and international experience.

2.2 Why is a smart grid required?

Electricity network design has been relatively stable for a number of decades. Today, electricity flows on the distribution networks are relatively predictable and stable, flowing from generation on the transmission system towards customers whose behaviour is predicted from well-established statistical models. As a result, network owners can invest so that the network is, outside exceptional circumstances, able to meet all customer demand. However, there are three broad policy drivers which mean that this may change.

- **Carbon targets:** The primary drivers for change are the 2020 and 2050 carbon reduction targets and the fact that the achievement of these targets is likely to require the almost complete decarbonisation of the electricity sector.
- **Security of supply:** There is also a need to ensure secure and sustainable energy supplies into the future given changing supply and demand patterns.
- **Affordability:** This will have to be achieved while ensuring that networks continue to deliver long term value to existing and future customers.

These policy drivers create demand and supply-side challenges for the energy sector.

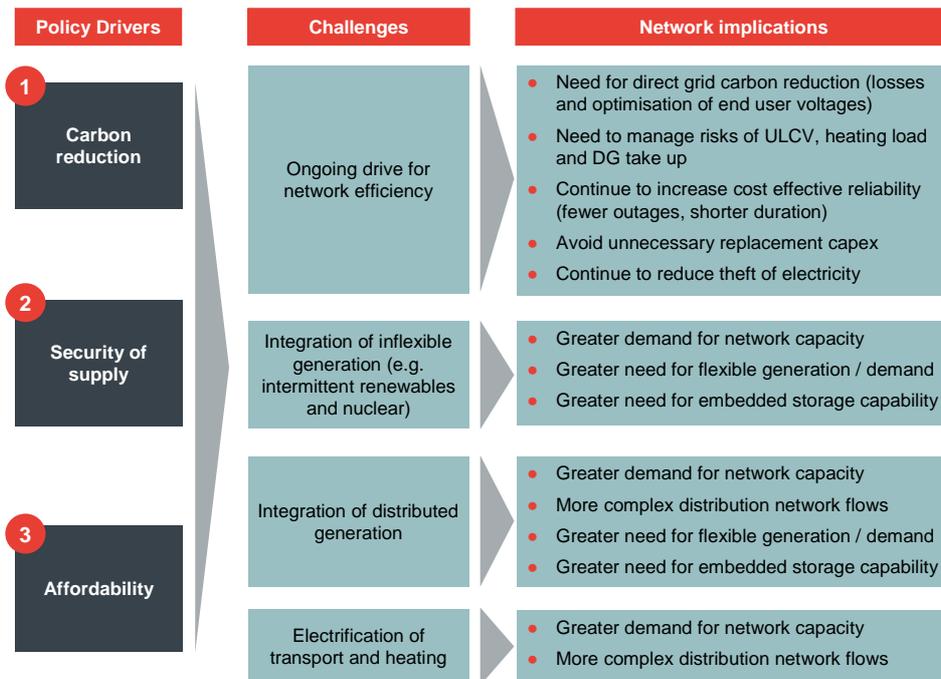
- **Integration of inflexible intermittent generation:** More electricity will be generated from renewable sources, like wind, which are intermittent or nuclear, which is inflexible.
- **Integration of distributed generation:** An increasing number of distributed generators (which may or may not be despatchable) will be connected to local distribution networks rather than national transmission networks. This will make the energy flows on distribution networks more complex and less predictable.

- **Electrification of transport and heating:** Low carbon electricity will increasingly be used for transport and heating, adding to total demand, but potentially providing a source of flexible and controllable demand (and embedded storage) that could be exploited via smart technology.

Added to this is the ongoing requirement for the companies to **drive for network efficiency**.

Although much of the required change will be at the generation and demand end of the energy supply chain, networks, as the link between them, will have to respond. The result is that distribution network flows are expected to be less predictable and more volatile. Therefore the networks themselves, and the devices connected to them, will have to be more controllable. We illustrate the network implications of these policy drivers in Figure 2 below.

Figure 2. Policy drivers, challenges and network implication for smart grids



Source: Frontier Economics using ENSG analysis

2.3 What are the value drivers of a smart grid?

From a policy perspective, what smart grids can deliver is more important than what they are. To understand the value drivers of a smart grid, they must be placed in the context of the counterfactual: what would the non-smart response be to the network implications they face. The potential value from a smart grid arises if there is an incremental net benefit associated with the smart solution

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compared with the counterfactual solution. The policy agenda should then be focussed on removing any barriers that would prevent networks making the best choices between the smart (or alternative) options, rather than be about prescribing a particular outcome.

We have mapped the network implications to a set of smart grid benefits and an associated counterfactual in Figure 3. We note that there is no agreed list of smart grid benefits. For completeness we map these smart grid benefits to those presented in the ENSG *Smart Grid Vision*³ in Annexe 2.

³ *A Smart Grid Vision*, ENSG (November 2009).

Figure 3. Value drivers of a smart grid

Challenge	Network implications	Smart grid benefit	Counterfactual
Ongoing drive for network efficiency	<ul style="list-style-type: none"> Need for direct grid carbon reduction (losses and optimisation of end user voltages) Need to manage risks of ULCV, heating load and DG take up Continue to increase cost effective reliability (fewer outages, shorter duration) Avoid unnecessary replacement capex Continue to reduce theft of electricity 	<ul style="list-style-type: none"> Enhanced grid information to reduce technical losses and user voltages Increased grid data to improve reliability, avoid / defer replacement capex, reduce theft and manage risks 	<ul style="list-style-type: none"> Lower direct grid carbon reduction Higher network opex and replacement capex for a given level of reliability / risk
Increase in inflexible intermittent generation	<ul style="list-style-type: none"> Greater demand for network capacity Greater need for flexible generation / demand Greater need for embedded storage capability 	<ul style="list-style-type: none"> Enhanced grid data to improve grid planning, utilisation and optimise load related capex Greater controllable load, DG (where despatchable) and embedded storage for balancing purposes 	<ul style="list-style-type: none"> Higher network investment More centralised flexible generation investment
Increase in distributed generation	<ul style="list-style-type: none"> Greater demand for network capacity More complex distribution network flows Greater need for flexible generation / demand Greater need for embedded storage capability 	<ul style="list-style-type: none"> Enhanced grid data to improve grid planning, utilisation and optimise load related capex Greater controllable load, DG (where despatchable) and embedded storage for balancing purposes Greater controllable load, DG (where despatchable) and embedded storage for local network management purposes 	<ul style="list-style-type: none"> Higher network investment Higher investment in local generation / storage flexibility (where possible) More centralised flexible generation investment
Electrification of transport & heating	<ul style="list-style-type: none"> Greater demand for network capacity More complex distribution network flows 	<ul style="list-style-type: none"> Enhanced grid data to improve grid planning, utilisation and optimise load related capex Greater controllable load, DG (where despatchable) and embedded storage for local network management purposes 	<ul style="list-style-type: none"> Higher network investment Higher investment in local generation / storage flexibility (where possible)

Source: Frontier Economics using ENSG analysis

There has been little work to date to fully quantify the expected costs and benefits of these options to understand where the value may lie, or which parties (networks, generators, suppliers, customers or society) may benefit⁴. The ENSG did a first cut estimate at the benefit that might be attributable to certain smart grid technologies over two phases, as presented in Figure 4 (note that the figure presents gross rather than net benefit figures).

Figure 4. ENSG benefit assessment

ENSG benefit assessment (discounted value (£m) to 2050)			
Phase 1 (2010-2020)		Phase 2 (2020-2050)	
Enhanced grid information to reduce technical losses and user voltages	Voltage	1,435-1,913	
	Losses	628-838	
Increased grid data to improve reliability, avoid / defer replacement capex, reduce theft and manage risks	Outages	212-223	
	Asset mgt.	1,145-1,205	
Enhanced grid data to improve grid planning, utilisation and optimise capex	Capacity planning	64-67	Capacity planning c. 2,700
	Demand response	1,030-1,981	Demand response c. 1,800
Greater controllable load, DG (where despatchable) and embedded storage for balancing purposes	DG	186-279	DG & embedded storage c. 2,300
	Demand response	1,030-1,981	Demand response c. 1,800
Greater controllable load, DG (where despatchable) and embedded storage for local network management purposes	DG	186-279	DG & embedded storage c. 2,300

Source: ENSG (November 2009)

However, we note that there were a number of important caveats associated with this benefit assessment and further work to estimate the net benefits, and the parties to which costs and benefits may fall, is still required. This was also recognised by DECC in its consultation “Smarter Grids: The Opportunity” (December 2009).

⁴ Although we note that a quantification was undertaken on the transmission side by the ENSG and reported in “ENSG: Our Electricity Transmission Network: Our vision for 2020”, ENSG (July 2009).

Additional work has been undertaken in the specific area of estimating the value of DSM. This includes the work by the ENA⁵ that focussed on network benefits from DSM, the work commissioned by the CCC to look at the flexibility DSM can deliver to generation systems in 2030⁶ and the work commissioned by DECC to look at trade-offs in the value of DSM for network and balancing purposes that is due to be published shortly.⁷

We also note that further work is planned in this area by Sustainability First within the context of the Smart Demand Forum. This project will run to March 2014 and aims to:

- evaluate and understand potential GB electricity demand-side response as a resource across all sectors (including how micro-gen fits in);
- develop a clearer understanding of the economic value and potential of this resource to different market actors and to different customers over the next 10-15 years; and
- systematically evaluate the key consumer, commercial, regulatory and policy issues and interactions.

Despite these developments, there is a general lack of well-based quantification of the costs and benefits of smart grids. This is an area where further work would be of value to better enable policy change evaluation.

2.4 Policies and initiatives in GB

This section describes the key policies currently in place, or under development, in GB that will impact on smart grid deployment and the organisations that are already working in this area.

2.4.1 Overview of existing policies in the UK

There are already a number of policies in place by Ofgem and DECC that will impact on smart grid development. We think it is helpful to group them as follows.

⁵ *Benefits of Advanced Smart Metering for Demand Response based Control of Distribution Networks*, ENA, SEDG, Imperial College (April 2010).

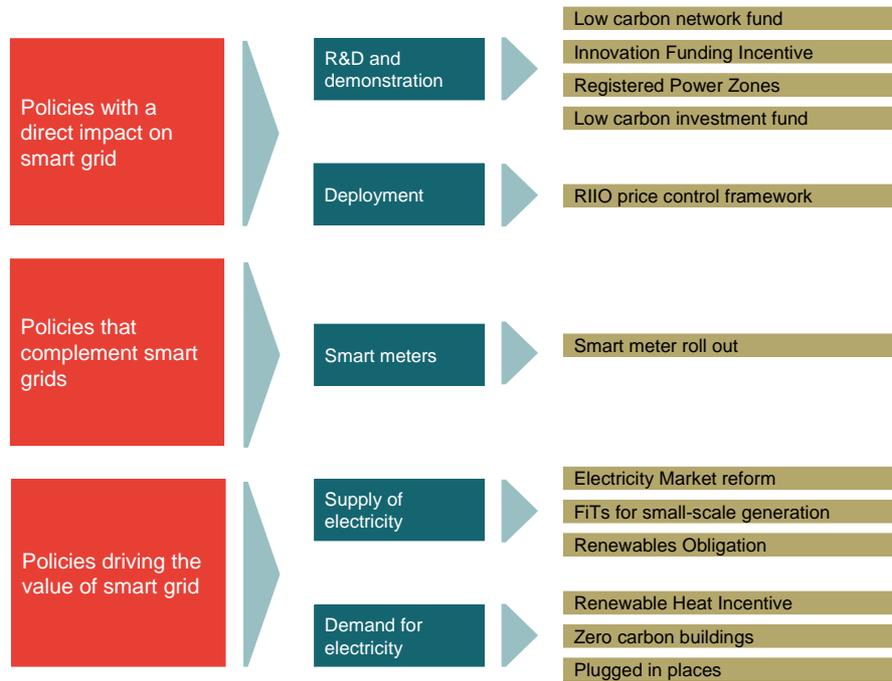
⁶ *Options for low-carbon power sector flexibility to 2050*, Poyry (2010) http://downloads.theccc.org.uk.s3.amazonaws.com/4th%20Budget/fourthbudget_supportingresearch_Poyry_%20power%20sector%20flexibility%20to%202050.pdf

⁷ Quantification has also been undertaken as part of the European Roadmap 2050 (http://www.europeanclimate.org/index.php?option=com_content&task=view&id=72&Itemid=79). However this has a European focus and does not produce UK specific results.

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- **Policies with a direct impact on smart grids:** Ofgem and DECC have set up several funds for the demonstration of smart grids, while the new price control review framework (RIIO) is intended to provide a framework to allow larger scale deployment.
- **Policies that are complementary to smart grids:** Smart meters, in particular, will be an important complement to smart grids. The implementation plan associated with the mandatory roll-out of smart meters is currently being developed.
- **Policies impacting on the value drivers of smart grids:** There are many policies in place that will directly impact on the value drivers of smart grids.
 - **Electricity supply:** Existing policies to decarbonise electricity supply such as the Renewables Obligation, and Feed-in Tariffs for small-scale generation, as well as new policies to incentivise renewables, nuclear and Carbon Capture and Storage, which are currently under consideration as part of the DECC's Electricity Market Reform process, will increase the inflexibility and intermittency of electricity generation/supply.
 - **Electricity demand:** Policies which will change the nature of electricity demand are also being put in place. DECC has introduced policies to incentivise the take up of electric heat pumps, and Office for Low Emission Vehicles (OLEV) has introduced policies to provide incentives for electric vehicle deployment.

Figure 5 sets out an overview of the most important UK policies.

Figure 5. Overview of existing UK policies

Source: Frontier

Policies with a direct impact on smart grids are described below. A more exhaustive list of policies driving the value of smart grids, along with a brief description of each, is set out in Annexe 3.

Policies with a direct impact on smart grids: demonstration

Ofgem and DECC have put a number of funds in place to allow demonstration of smart grids.

- **Low Carbon Network Fund (LCNF) (Ofgem):**

- **Aim and mechanism:** The LCNF aims to explore how networks can facilitate the take-up of low carbon and energy saving initiatives by providing a low risk space for companies to try out technical, operating or commercial arrangements.
- **Scale:** As part of the 2010-2015 price control arrangements, the LCNF allows up to £500m support to projects and large scale trials sponsored by the DNOs. Two tiers of funding are available. The First Tier allows DNOs to recover a proportion of expenditure incurred on small scale projects. Under the Second Tier, Ofgem runs an annual competition for an allocation of up to £64m to help fund flagship projects.

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- **Aim and mechanism:** The LCIF aims to develop new technologies in the smart grids' supply chain and to pilot the development of integrated networks at a regional scale through a capital grant scheme to smart grid demonstrations and pilot projects.
- **Scale:** DECC granted £2.8m to eight small smart grid demonstration projects in 2011.
- **Current status:** The eight smart grid demonstration projects are meeting the expected timelines and the capital spend of the projects is now in place. DECC expects to start getting findings from these projects within the next few months and will publish the results on the DECC and ENA websites.

As noted above, Ofgem plans to develop the LCNF and IFI schemes as part of the RIIO price control review process. The current proposals are as follows.

- **Network Innovation Competition (Ofgem):**

- **Aim and mechanism:** The NIC aims to build on the LCNF introduced in the last electricity distribution price control review. It will provide upfront partial funding to network companies, or possibly third parties, for innovation projects related to the role of networks in delivering low carbon or environmental benefits across the electricity and gas transmission and distribution networks.
- **Scale:** Decisions on the annual maximum amount of money to be raised from consumers to support the NIC will be made at each price control review.
- **Current status:** The NIC will be in place for the next gas distribution and electricity and gas transmission price reviews starting in 2013, and is intended to be implemented in the next electricity distribution price review starting in 2015. It is intended to be a transitional measure, and will be reviewed periodically to assess whether it is still required.

- **Innovation Allowance (IA) (Ofgem):**

- **Aim and mechanism:** The Innovation Allowance aims to build on the IFI schemes. It is a direct allocation of funding to companies to enable them to undertake smaller scale innovation projects. It will provide partial funding, and companies are required to submit an innovation strategy as part of their business plans setting out their innovation aims, objectives and deliverables.
- **Scale:** For the gas distribution price control and electricity and gas transmission price controls, the allowance is proposed to be set at a

minimum 0.5% of allowed revenues, with the companies being able to request up to 1% depending on the quality of their accompanying innovation strategies.

- **Current status:** The IA stimulus will be in place for the next gas distribution and electricity and gas transmission price reviews starting in 2013, and is intended to be implemented in the next electricity distribution price review starting in 2015. It is intended to be a transitional measure, and will be reviewed periodically to assess whether it is still required.

Policies with a direct impact on smart grids: deployment

The demonstration funds should help smart grid development in the short to medium term. However, large-scale deployment requires networks to consider smart grid investments, alongside other network investments, on an equal basis.

Progress has also been made in this area with Ofgem's recent review of the price control framework, and the introduction of RIIO. RIIO aims to encourage the development of smarter networks through a longer control period, stronger incentives and equalisation of incentives from opex and capex efficiencies.

RIIO will be implemented in 2013 for the next transmission price control review, and in 2015 for the distribution price control review.

2.4.2 Overview of organisations interested in smart grid development

There are a number of other organisations in GB that also have an interest in smart grid development.

To ensure consistency with these bodies, the Forum has members that sit on these bodies.

- **Electricity Networks Strategy Group (ENSG):** There has already been work to create a smart grid vision through the ENSG which sets out the potential role of smart grids in a sustainable energy sector and some of the things that might have to change. The joint chairs of this group are the same as the joint chairs of the Forum.
- **Energy Networks Association (ENA):** The ENA formed the Energy Networks Futures Group that has been active in smart grid development and participated in the progression of the ENSG smart grid route map. It has published a number of reports on DSM, some in conjunction with the **Energy Retail Association (ERA)**.
- **Smart Demand Forum (SDF):** The SDF is currently being set up by Sustainability First with the aim of identifying practical solutions, incentives and pathways to realise the potential resource which flexible and / or despatchable electricity load could offer into the GB electricity

market. It aims to bring together a group of GB demand-side interests including a range of market actors, consumer bodies, vendors, Government, the regulator and environmental bodies. It will participate in the international Smart Energy Demand Coalition.

- **Smart Grids and Smart Metering Group:** Intellect is currently setting up a stakeholder group to represent members with an interest in the smart grid area. This includes members with an interest in software, consumer electronics, utilities, telecoms, meter manufacturers, satellite communications, the legal profession, consultancies and broader technology companies. This stakeholder group will be part of the international umbrella organisation for stakeholders, the Global Smart Grid Federation.

2.5 Policies and initiatives in Europe and internationally

2.5.1 Overview of policy development in Europe

The European Commission is becoming increasingly active in developing policy and coordinating the demonstration of smart grids across Europe.

European action on smart grids

In late 2009, the Commission established a Smart Grids Task Force to produce policy and regulatory recommendations to ensure consistent and fast implementation of smart grids across the EU. The most important activities of the Task Force are as follows.

- **Common technology standards:** The Commission intends to produce a set of common technology standards by the end of 2012. In March 2011, the Task force published a mandate to European standardisation organisations, tasking them to produce a set of common standards to be applied across Europe⁹. The aim will be to produce standards which are detailed enough to ensure interoperability but maintain a certain degree of flexibility for Member States, given their different requirements.
- **Wider coordination activities:** In mid-April 2011, the Task Force will publish a Communication proposing to coordinate European action in a number of areas, including on regulatory incentives, data privacy, the maintenance of retail competition, and the support of innovation. The

⁹ http://ec.europa.eu/energy/gas_electricity/smartgrids/doc/2011_03_01_mandate_m490_en.pdf

Communication is also likely to propose that Member States develop their own national action plans for smart grids. This Communication will be out to consultation for two months after its publication and may be the first step towards producing a Directive on smart grids.

The Commission is also active in the coordination of the research and demonstration across Europe. The most important European research programme is the European Electricity Grid Initiative (EEGI)¹⁰. This was set up as part of the Commission's Strategic Energy Technology plan, on the initiative of a group of transmission and distribution network operators, represented by the European industry bodies European Network of Transmission System Operators - Electricity (ENTSO-E) and the European DSO Association for Smart Grids (EDSO-SG). The aim is to coordinate research and demonstration of smart grid technologies across Europe, avoiding duplication of effort and promoting the exchange of best practice.

EEGI is still at the planning stage. Consultation on a roadmap produced by ENTSOE and EDSO-SG closed at the end of January 2011. This roadmap proposes a nine year RD&D programme for electricity networks, with an estimated cost of €2bn over nine years. It is proposed that in the first years of the programme, funding is covered by Member States and the Commission (with EU funds concentrating on investments with EU benefits). From 2013, new tariff schemes in Member States should begin to provide additional funding.

Related policies

Along with its activities that impact directly on smart grids, the Commission is also very active in policies to encourage smart meters, and in setting the overall climate policy framework, which will be a key value driver for smart grids. The following are the most important policies.

- **The Third Energy Package** currently being transposed in the UK and elsewhere in Europe, contains relevant measures for smart grids:
 - The Electricity Directive¹¹ contains a provision for the roll out of smart meters to 80% of customers by 2020 in each Member State, subject to a national cost-benefit test being passed.
 - The Directive also encourages the long-term modernisation of the distribution grid, specifying that this should encourage decentralised generation and energy efficiency through measures such as the introduction of smart grids.

¹⁰ <http://www.smartgrids.eu/?q=node/175>

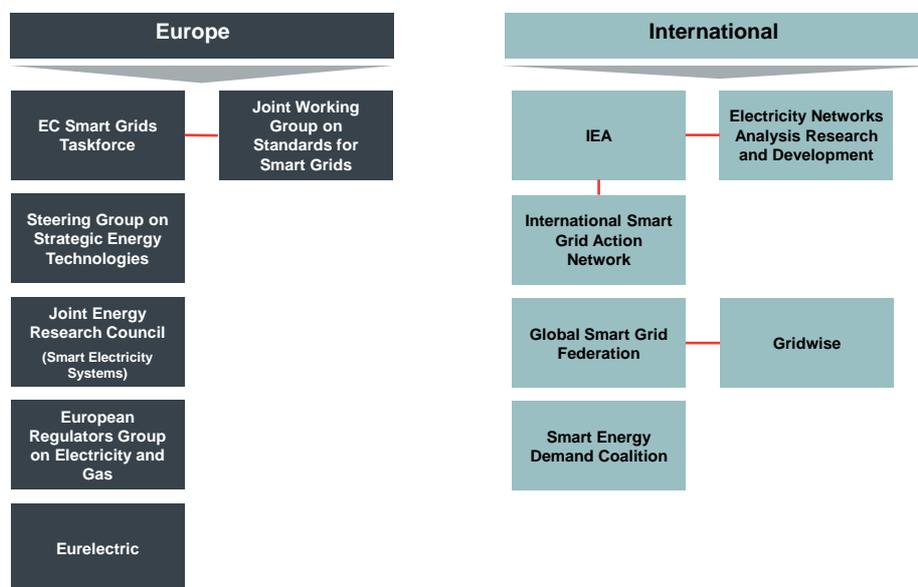
¹¹ Directive 2009/72/EC <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:211:0055:0093:EN:PDF>

- **The 2008 EU Climate and Energy Package** set 2020 targets for a reduction in EU greenhouse gas emissions of 20% below 1990 levels, for 20% of EU energy consumption to come from renewable resources and for energy efficiency to drive a 20% reduction in energy use compared with projected levels. Measures to achieve these targets will all help drive the value of smart grids. Tightening of the overall greenhouse gas reduction target is likely to be considered in the next few years.

2.5.2 Overview of groups and initiatives

There are a very large number of organisations working on smart grids. Some of the most important organisations are set out in Figure 6.

Figure 6. Selection of key international smart grid bodies



Source: Frontier

At this stage, most organisations are operating at the strategic level, rather than at the level of detailed demonstration or deployment. Most are still at the stage of setting out roadmaps and collating examples of international action. We provide an outline of the activities of these organisations in Annex 4.

2.5.3 International deployment of smart grids

Our observation is that GB is at the leading edge in terms of policy development in this area,¹² but that in terms of testing of technology, there may be more to learn from international experience. However, the issues facing the GB grid are not identical to those being faced internationally and best practice will need to be viewed in this light.

Detailed lists of international initiatives have been collated by ISGAN and the Commission, and will be published shortly.

We note that in the discussions we had with stakeholders, the two examples of international initiatives that were most frequently mentioned were South Korea and Portugal.

- **Jeju Island in South Korea:** The Korean Government has set up a road map to develop a national smart grid by 2030 and is undertaking a Smart Grid Testbed in Jeju Island. The project was initiated in 2009 and will run to 2013, with investment of 65b won (about £36m).¹³ Ten consortiums in five areas will participate in testing technologies and developing business models.
- **Portugal Innogrid:** EDP's Inovgrid project aims to roll out smart grids to all its 6 million customers in Portugal by 2015. A pilot was completed in 2009 and work began on a smart city in Evora in 2010.

¹² This seems to be backed up by the recent Eurelectric report "Regulation for Smart Grids", Eurelectric (February 2011).

¹³ <http://www.smartgrid.or.kr/10eng3-1.php>

3 Framework for the Forum

This section provides a framework for the Forum to decide on its workplan for the coming year. It considers different areas of work that the Forum could look at and provides some criteria for prioritisation. The objective is that it can produce some useful outputs in 12 months time and agree its ongoing role.

This section seeks to answer the following questions.

- What are the Forum's aims?
- What are the most significant barriers to smart grids?
- Given the barriers to smart grid development, what areas might the Forum wish to look at and how could it prioritise its work?
- What outputs should the Forum aim for in its first 12 months, and how will these be delivered?

3.1 The Forum's aims

The Forum aims to bring together key opinion formers, experts and stakeholders in the development of GB smart grids to provide strategic input to help shape Ofgem and DECC's thinking. It should help keep network companies focussed on addressing the future networks issue and provide drive and direction for the development of smart grids. This is in response to a concern that without clear "leadership", it may take longer than necessary for industry to adopt smart grids.

The Forum should focus on the role that the electricity network will play, both technically and commercially in response to the drivers for change identified in the previous section. However, where appropriate, it may need to touch on related issues (such as how to encourage DSM or what are the appropriate smart metering communications models) given the strong links they will have with smart grid development.

Before looking in detail at the options for activity that the Forum could undertake, it is helpful to group the outputs envisaged in the Terms of Reference of the Forum into two categories.

- **Drive policy change:** One of the main functions of the Forum will be to drive policy change. The focus of the Forum will therefore need to be on the following.
 - Policy makers need to be clear what potential smart grids have in delivering a sustainable energy sector and long term value for customers. Without this they will not be able to evaluate policy options.

They need to understand the technical (in the broad sense) potential and the value that smart grids can bring relative to alternative approaches.

- The focus should then be on identifying any barriers to the adoption of smart grid solutions. These barriers could take a number of forms, including legal, regulatory, institutional or economic. Identifying the cause of the barrier helps specify the work programmes that may need to be developed to remove it.
 - The Forum is also ideally placed to put smart grids in the context of wider policy developments. It could consider how smart grid policy should impact on the wider work programmes of DECC and Ofgem (for example when developing the detail of the smart meter roll-out).
- **Provide a common basis of understanding and disseminate learning:**

The Forum is also tasked with collecting and disseminating information to ensure that Government, regulators, industry and other stakeholders are up to speed on critical issues which will form an input to effective policy making.

 - It can review the output of trials and smart grid initiatives in GB, Europe and elsewhere (with a focus on aspects relevant to policy formulation rather than technology itself).
 - It can also review the international policy landscape to see how smart grid development is being promoted or hindered.
 - It may also facilitate the exchange of information and knowledge between key parties, including those outside the energy sector.
 - It will report at least once a year on what the Forum has done and what progress has been made in GB to delivering smart grids.

3.2 What are the most significant barriers to smart grid development?

The work of the Forum should be focussed on identifying, and addressing, the barriers to smart grid development in GB.

This section provides an overview of the main barriers commonly discussed, and links them with the cause of the barrier. For example, the barrier may be caused by a market failure (such as the presence of an externality), a legislative block (such as the prohibition of a party undertaking a particular activity) or a regulatory mechanism (such as an insufficient reward for undertaking a particular activity through the incentive framework). Clarity about the cause of the barrier

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helps to identify the actions required to alleviate it and thus the type of work that the Forum may want to undertake.

We consider the following barriers to smart grid development:

- uncertainty;
- network incentives;
- disaggregated value chain;
- customer engagement;
- interoperability; and
- R&D and trialling.

As part of the first meeting of the Forum, members may wish to review this list and determine if there are other material barriers that should be included. We discuss each of these barriers in turn.

3.2.1 Uncertainty

It is well recognised that there is considerable uncertainty about the future demand and supply conditions in the electricity sector. Many of these uncertainties are driven by policy (e.g. the credibility of future carbon targets and the additional policies that may be in place to drive particular solutions). But there are also uncertainties about technology development (e.g. EV battery capacity) and international policy (e.g. that may impact on security of supply concerns).

One outcome of this uncertainty may be a lack of action. This could be due to an increase in risk caused by the uncertainty and a failure to either:

- allocate the risk appropriately (i.e. with risks being allocated where they can be best managed, including mitigation of policy risks within the regulatory framework or through the provision of information and/or assumptions); or
- reward the risk.

The complexity of decision making in such an environment may also slow progress.

3.2.2 Network incentives

The framework for network regulation may itself constitute an important barrier if the network incentives are insufficient to promote the efficient introduction of smart grids. The RIIO approach has made a number of changes to increase the likelihood that it is fit for this purpose (for example by developing the trailing mechanisms and lengthening the control period). However, some remain

concerned that a lack of incentives will be one of the main barriers to smart grid investment.

The issues relating to network incentives can be divided into two groups:

- those relating to the ability of the regulator to understand what is needed to facilitate smart grid solutions at the time of a price control settlement; and
- those relating to the incentive structures put in place within the settlement itself.

Barriers related to specification of price control settlement

There are a number of potential areas in which the price control settlement may act as a barrier.

- **Timing:** The length of control has been extended to provide more potential benefit to the networks from investing in smart grid technology. However, little information will be available from the LCNF trials at the time the next electricity distribution controls come to be set, which will make it difficult for the regulator to justify additional allowances. New information about smart grid options is likely to become available during the control period. Whether this can be mitigated by specific uncertainty mechanisms and/or re-openers is a major challenge for RIIO.¹⁴
- **Fixed cost/scale of investment:** Some have argued that there are significant fixed costs associated with development of smart grids. This means that a large upfront investment would be needed before the full functionality of a smart grid is required. This makes it difficult to invest in a smart grid in an incremental way, increasing the upfront cost and also the risk that an asset will become stranded, either because it turns out it was not required or is of the wrong technical specification. A firm will only be expected to invest if the regulator “signs-off” this investment as part of the price control review. However, the regulator may be risk averse to having to make this investment decision on behalf of customers for similar reasons. The issue is further complicated if there are national (rather than local network) fixed costs associated with development of a smart grid.
- **Disaggregated benefits:** As noted below, some of the benefits of smart grids may sit with other parties. This may mean that there is a non-trivial

¹⁴ Ofgem set out proposals for mechanisms to address such concerns in *Ofgem (2010) Consultation on strategy for the next transmission and gas distribution price controls - RIIO-T1 and GD1 Uncertainty mechanisms*, <http://www.ofgem.gov.uk/Networks/Trans/PriceControls/RIIO-T1/ConRes/Documents1/T1%20and%20GD1%20BP%20prop.pdf>

effort required on the part of the network operator in co-ordinating and contracting between parties to implement a smart grid solution. If this is not taken into account adequately by the regulator, transaction costs may prevent networks accessing the value that other parties may have via a contractual arrangement.

Incentive structures within the settlement

The nature of the incentive structures within any particular settlement may also act as a barrier. For example:

- **The strength of incentive:** There are still questions about whether there is sufficient reward for the risk that will need to be taken to invest in smart grid, as opposed to traditional, technologies. Within an output based framework, network operators may not be willing to take the risk that smart grid investment does not deliver and further spend is therefore required to deliver committed outputs.
- **Equalisation of incentives:** The strength of incentives between different parties also needs to be equalised to ensure efficient outcomes. For example, if incentive strength within the regulatory frameworks provided to the TSOs and DNOs differ in respect of active management options, this may distort optimal trade-offs being made between the two parties.

3.2.3 Disaggregated value chain

The supplier hub model, together with network separation and involvement from many other parties such as aggregators, ESCOs and microgen providers as well as customers, means that the costs and values associated with a smart grid are spread across a number of parties. Further, the costs and benefits are not aligned between these different parties, and they may change over time.

This may act as a barrier to smart grids if the transaction costs associated with individual parties contracting to apportion costs and benefits between each other are high, or if the incentive regime does not appropriately reward companies for doing this. Similar issues drove the requirement to mandate the smart meter roll-out, rather than rely on the market delivering it.

An important aspect of this may relate to the customer awareness and opinion. For example, customers may be unaware of the private and social benefits of smart appliances. Equally, there may be a reluctance to take up “big brother technology” if there are concerns about “losing control” over appliances or privacy issues associated with companies understanding customers’ movements and appliance use. Undertaking marketing and customer awareness raising activities may be in the interests of the market as a whole, but disaggregation of the value chain may make this more difficult or expensive to achieve. Where

there are social benefits from raising customer awareness, this may have to be tackled centrally.

Another aspect may relate to the capture, assimilation and dissemination of information. There is a vast amount of work going on in this area in GB, Europe and internationally both in the policy and trialling fields, meaning the cost of keeping up with this and understanding the implications for smart grids in GB may be high. There may be benefits associated with pooling effort in this area, and then disseminating the important learning which become difficult to achieve across a disaggregated value chain.

Linked to this is a potential legislative barrier, where certain parties are prohibited from undertaking certain activities in the value chain. For example, a party operating under an electricity distribution licence cannot also own and operate generation or storage under a generation licence for network balancing purposes.

3.2.4 Customer engagement

Many of the benefits of smart grids will only be realised if customers engage actively. This is a particular issue for the provision of DSM. Customers may not engage because:

- they are unable to; or
- they are unwilling to (because they do not have appropriate incentives).

The extent to which Suppliers, Aggregators and other customer-focussed stakeholders can play a role to help customers overcome such barriers is an important area for debate.

Inability to engage

Customers may be unable to engage effectively for a number of reasons.

- Customers may be capital constrained where smart grid solutions require up front investment costs (for example, for smart appliances or home automation systems). Further, there is evidence that customers may not make an investment, even if it has a positive net benefit associated with it.¹⁵ This may lead to a lower than optimal take up of smart appliances.
- Customers may also be unable to engage as a result of the requirements for co-ordination. For example, to avoid local distribution network reinforcement or mitigate short run network constraints where reinforcement is not practically possible in time, a number of customers on any piece of network may have to agree to have their load controlled. If

¹⁵ This was a big driver in the thinking behind the “Green Deal”.

sufficient customers do not wish to do so then the network may need to be upgraded and all will have to pay. When operating at the local network level, transaction costs are almost certainly too high for customers to compensate each other based on their willingness to pay for unconstrained electricity consumption. Therefore without compelling customers to provide DSM, less DSM may be expected as a result.

Lack of incentive to engage

Where customers are able to make a clear decision in relation to smart grid solutions based on their personal interests, there may still be barriers resulting from a lack of sufficient incentive. This will be a problem if the pricing signals provided to customers are not cost-reflective.

There may be a number of reasons for an absence of cost-reflective signals:

- Signals about the impact of incremental or decremental load on the network may need to become increasingly disaggregated and localised. This may make cost-reflective signals difficult to calculate and difficult for customers to process. There are also issues about whether network charges will be reflected in final tariffs by suppliers (given that they may not wish to offer multiple tariffs based on location) or if it is believed that tariff complexity is unhelpful to customers.
- The continued use of some form of synthetic load profiling in settlement would mean that the benefits of DSM are smeared, and customers do not see the real benefits of their actions.
- There may be concerns about whether the (potentially sharp) pricing signals required to provide cost-reflective signals will be politically acceptable. For example, would it be acceptable for customers in individual streets to face higher charges than their near-neighbours.

3.2.5 Interoperability

There are a number of areas where standards and protocols need to be agreed if they are not to act as a barrier. These need to cover such issues as the communications systems that will be a core part of smart grid functionality (type and timescales of data transmission) through to the product standards for smart appliances.

3.2.6 R&D and trialling

There may be barriers to this activity being undertaken either because the regulatory framework does not recognise the long term nature of payoffs, or because such activities have spillovers which cannot be captured by the party

bearing the cost. This is a barrier that Ofgem has been tackling with the LCN Fund and Innovation Stimulus.

3.3 Suggested areas of work

The work programme that the Forum takes on should be driven by a desire to reduce the barriers that have been identified. It should also aim to focus on those issues that are closely associated with smart grid development. It is easy to spin off into related areas that, while important, may not be core to this particular debate.

In terms of areas to focus on, the Forum could prioritise its workplan based on the following criteria.

- **Urgency:** A decision is needed soon, either because the driver for change is expected near term (e.g. connection of wind farms) or there are long lead times associated with the change (e.g. it will require a change in primary legislation).
- **Materiality:** There is a high probability that the barrier will occur, or a high value associated with it materialising.
- **Requirement for information:** A lack of information is currently available to evaluate the two points above and therefore further work is required to be able to understand the level of priority.
- **Co-ordination:** Multiple parties need to be involved in the decision making process. One of the main benefits of the Forum is that it covers a diverse group of interests. This can be used to share perspectives and promote understanding.

It is hoped that a consensus can be reached on the areas of focus for the first year. We would also expect further information to be gathered during this period which will help to allow the work programme to be updated once this is available.

The Forum is intended to provide a “leadership” role in the development of smarter grids in GB. It may be that different members of the Forum have different views about what leadership is required. This may be on a spectrum between those that favour a decentralised model through to those that are looking for central guidance to determine smart grid outcomes.

- **Facilitating:** At one end of the spectrum, leadership may be about putting in place a regulatory and commercial framework which should result in the

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industry finding the best customer value solution (whether smart or not) as and when required.

- **Directing:** An alternative model has a central agent (most likely Government or Ofgem) intervening directly to ensure that a particular solution is delivered by the industry, potentially within a particular timescale.

There are clearly options between these two extremes where different levels, or types, of intervention are required. It may be helpful for the Forum to consider when a more Facilitating approach is appropriate, and when more Directing intervention is necessary. For example, a more Directing approach might be considered appropriate when:

- there are significant transaction or co-ordination costs associated with the industry either determining or implementing the best solution across a disaggregated value chain;
- there is significant uncertainty around whether a smart solution is appropriate, particularly driven from the potential outcomes from broader Government policy;
- there are strong asymmetries of information (particularly in relation to smaller customers) in relation to the private and/or external benefits of a smart solution; and
- it is difficult to ensure that the industry can be effectively incentivised in relation to the external benefits of a smart solution.

The rest of this section considers a set of work areas that the Forum may wish to consider. We classify these work areas according to the two groups of objectives for the Forum that we set out at the start of this chapter (albeit in reverse order):

- Provide common understanding; and
- Drive policy development.

Each suggested workstream is linked to one or more barrier. A summary of the workstreams, and associated barriers, is presented in Figure 7.

Figure 7. Suggested workstreams and the associated barriers

		Barriers					
		Uncertainty	Network incentives	Disaggregated value chain	Customer engagement	Interoperability	R&D and trialling
Smart Grid Forum Objectives	Provide common understanding	Economic framework for evaluation					
		Forecasting/ vision development					
		Scale					
		Transition planning					
		DSM					
		Gaps in trialling					
	Drive policy development	Regulatory framework					
		Role of networks					
		Smart meters					
		DSO role					
		European and international developments					
		Data sharing					
		Appliance standards					

Source: Frontier Economics

For each of the two groups of activities, we have ordered the workstreams given our initial view of their priority. Given the amount of work it is reasonable for the Forum to do during the first year, we would suggest focussing on the top three workstreams in each list (as highlighted in the red boxes in Figure 7). However, this prioritisation exercise, and the assessment of the amount of work that it can take on, is clearly something for debate by the Forum based on its collective expertise.

3.3.1 Providing and disseminating a common basis of understanding

There are a number of areas where there may be benefit in either:

- discussion of currently available analysis to ensure that all parties have a common understanding of its conclusions and implications; or
- commissioning of further research to ensure that any conclusions are drawn on the basis of robust evidence and analysis.

The Forum may wish to consider whether there are further areas in which work is required to achieve a common basis of understanding.

Developing an economic framework for evaluation

Barriers: Disaggregated value chain, Network incentives, Customer engagement

Understanding more about where the value of a smart grid may lie would be of value in answering a number of questions about smart grid development. If decisions need to be taken about particular policies (e.g. the specification of data requirements as part of the smart meter roll-out) then it would help if there was an agreed framework for the analysis of the costs and benefits associated with smart grids. Discussion could therefore take place in the Forum to decide how best to design an economic framework to evaluate smart grid policy.

This is complex given that:

- costs and benefits are spread across the value chain (and could include societal costs and benefits as well);
- the counter-factual against which any smart solution will need to be evaluated is also complex;
- there is much uncertainty in the assumptions that will underlie the analysis; and
- it is not clear how divisible some of the required investments are.

The challenge is to make the task manageable and yet sufficiently robust. One of the first tasks will be to understand how the value of a smart grid will vary depending on the timing and mix of the supply and demand side challenges facing the networks. The impact of these will vary depending on the particular smart grid value driver being considered. An illustrative example is provided in Figure 8.

Figure 8. Economic evaluation of smart grid value drivers

Smart grid value driver	Counterfactual	Scenarios to be evaluated			
		Status quo	Increase in inflexible generation	Increase in distributed generation	Electrification of transport & heating
Need to understand cost over time and probability of success (e.g. probability, size and certainty of customer response)	Need to understand cost and constraints (e.g. technological development)				
Enhanced grid information to reduce technical losses and user voltages	Lower direct grid carbon reduction	✓			(↑)
Increased grid data to improve reliability, avoid / defer replacement capex, reduce theft and manage risks	Higher network opex and replacement capex for a given level of reliability / risk	✓			
Enhanced grid data to improve grid planning, utilisation and optimise load related capex	Higher network investment	✓	↑	↑	↑
Greater controllable load, DG (where despatchable) and embedded storage for balancing purposes	More centralised flexible generation investment	(✓)	↑	↑	
Greater controllable load, DG (where despatchable) and embedded storage for local network management purposes	Higher network investment Higher investment in local generation / storage flexibility (where possible)			↑	↑

 likely to be of increasing importance	<ul style="list-style-type: none"> • Relative scale of value drivers under different scenarios • Information on the timing of potential value • Understanding of potential diversity of interests (e.g. use for networks vs. balancing)
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Source: Frontier Economics

Coming up with a framework to evaluate policy choices in the area of smart grids should be a priority for the Forum given it is required now and would benefit from input from the diverse expertise of Forum members.

Forecasting through to Vision development

Barriers: Uncertainty, Network incentives

The case for smart grids rests to a large extent on the “pull” in terms of changes in generation mix and how electricity is consumed. However, there is a large degree of uncertainty about what will happen when and where. Much of the change will be led by Government policy and it can be difficult for industry to get a full picture of these initiatives and their estimated impact.

Although Government policy is driving a number of the assumptions, there would be benefit from wider stakeholder groups inputting into the development of the forecasts. This could also provide an opportunity for key assumptions relating to smart grid value drivers to be clarified. For example, to understand the level of DSM that could be expected, it would be helpful to know whether there will be smart appliance product standards, compulsory time of use tariffs, changes to the Settlement system, or compulsory remote control of appliances.

If the leadership style was to be Facilitating, the Forum could help develop a set of base output assumptions to underpin the network business plans as part of the RIIO process. For example, it could define the annual number of EVs that the network should be designed to connect. Based on this, companies could then put together their business plans to meet such output assumptions, given their uncertainty. This should reduce the risk to networks from planning investment, while not constraining their ability to respond to the assumptions about future demand and supply in the way they best see fit.

A more Directing leadership style might go further and start to look at narrowing down the options for how those assumptions are translated into actions within the business planning process. For example, it could set out what smart grid technologies should be adopted in particular sets of circumstances. However there is clearly a high risk of unintended consequences (and associated cost) associated with policy intervention to determine outcomes such as technology choice.

The choice between these approaches depends on whether there is a view that there are particular market failures around scale of investment, technology choice or transaction costs that mean that a market-based approach will not work.

We would see this as another priority area for the Forum, given the role it could play in the RIIO process and the need for co-ordination across policy makers and industry.

Scale

Barriers: Disaggregated value chain, Network incentives

There does not appear to be a consensus about whether investment in a smart grid can be undertaken on a piecemeal basis (i.e. they can be developed incrementally, in terms of penetration and functionality) or whether, given the integrated nature of the national grid, it is more efficiently undertaken at scale (on a national basis and across a wide functionality). There are likely to be elements of each.

- **Scale of penetration:** Full penetration of smart grids does not have to occur for some of the benefits to be unlocked. For example, initial development could be focussed on particular geographical areas where certain technologies are clustered. Smart grids could be rolled out incrementally across the country as penetration levels increased.
- **Scale of functionality:** Functionality may also be added incrementally, for example through software upgrades. However, there may be a cost associated with “future proofing” the original smart grid investment to enable this approach.
- **Need for central coordination of functionality:** For some aspects of a smart grid, perhaps in relation to communications, there may need to be a co-ordinated national approach to the investment. This may also be driven, in part, by the smart meter roll-out.

Understanding this issue could be something the Forum wishes to consider since it has implications for a number of other activities including investment planning, incentive development, the transition analysis and the development of the economic framework for analysis of smart grid investments. Given the close links with the first two workstreams, we would also see this as something the Forum should consider within the first year.

Transition planning

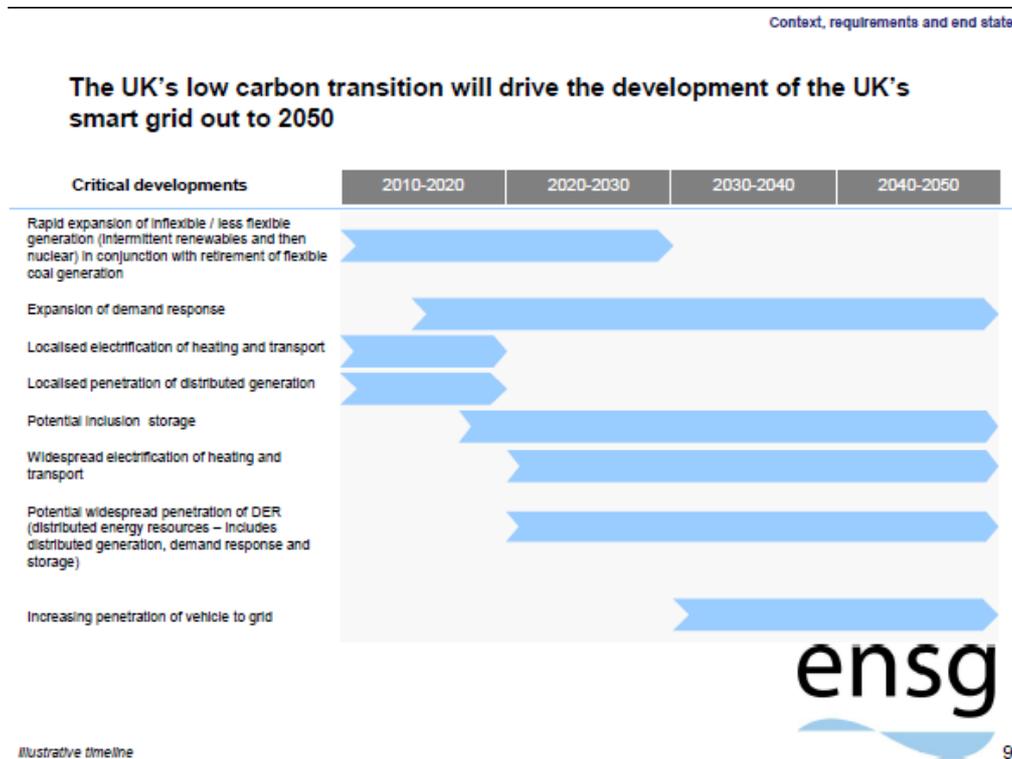
Barriers: Uncertainty, Network incentives

To date, the work on smart grids in GB has generally looked at snapshots in time (e.g. 2020, 2050). What may be needed now is more understanding of the transition, and identification of the relative importance of different drivers for the value of smart grid solutions. For example, when, and under what circumstances, will the crunch points happen for networks? How do you better understand the drivers and trigger points? How much excess capacity is on the system and when will you need to make the decisions (at scale) to invest or seek smart alternatives? What are the lead times for reinforcement and for policy change?

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The ENSG produced a very high level timeline of some of the drivers for a smart grid as reproduced in Figure 9.

Figure 9. High level timeline for drivers for GB smart grids



Source: ENSG

Taking this to the next level of detail may be something that the Forum wishes to progress. This could also feed into the business planning process within the RIIO timetables for DNOs.

If a Facilitating approach is being followed, it may be that it is only the lead times for the non-smart counterfactual which need to be understood. This is because industry would be best placed to then assess whether, and when, a smart approach should be taken against this background.

If there is a concern that other barriers exist that means smart grids will not happen without further Directing, the smart lead times may also need to be developed. This could then go on to identify barriers and critical path activities that may delay the efficient development of a smart grid.

Although this looks like an important piece of analysis, it may be something that follows on from the work on forecasting/vision development.

DSM

Barriers: Customer engagement, Disaggregated value chain, Network incentives

There is a question whether the current roles and relationships of networks, suppliers and SO will support active demand management. Of particular interest for networks is whether they can use DSM to avoid reinforcement in the short, medium or long term, or whether they should assume that the value of DSM will be higher to others in the value chain (e.g. suppliers for balancing purposes) for all but the management of very localised constraints.

Although DSM is one of the big drivers for smart grid functionality, it is also one of the areas where there is already activity in GB to address some of the issues being raised (for example work is being undertaken by ENA/ERA, Sustainability First within the Smart Demand Forum, as part of some of the LCNF projects and by DECC).

Based on this existing activity, it needs to decide what role it could additionally play, or whether it just needs to monitor developments elsewhere. Depending on the conclusions from this discussion, it may not be a priority area for the Forum in its first year.

Gaps in trialling

Barriers: R&D and trialling

Ofgem has already sought to address the barrier associated with a lack of incentive for R&D. It is important to get the Forum's view about whether the current activity in relation to R&D and particularly trialling is sufficient to provide information in a timely manner to support smart grid decision making.

The ENA is already undertaking work to identify whether there are gaps in the trialling being undertaken under the LCNF. The Forum may wish to consider these results and provide its own input into what trials it thinks should be brought forward in future.

3.3.2 Driving policy change

Beyond providing a common basis of understanding, the Forum may wish to consider areas in which it is believed that some form of policy review, and potential policy change, is required.

Regulatory framework

Barriers: Uncertainty, Network incentives, customer engagement

One of the main questions for the Forum is therefore whether existing policies will be sufficient to drive the change required or whether further intervention is necessary. In the short term the question is whether the new RIIO framework will deliver smart distribution networks. Of particular importance, given the level

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of uncertainty that will be present when companies have to develop their business plans, is how this will be managed throughout the eight year control period. Forum members might also be able to provide examples of where smart grid solutions have been identified as the preferred/lower cost option but commercial and regulatory barriers/concerns mean that they would not be implemented. Another important area for debate may be about whether environmental outputs can be defined to reward the smart grid outcomes that are agreed to be valuable.

There may also be questions that the Forum can address around how the results from the LCNF trials can be translated into business as usual behaviour, particularly given the trial timelines means that little information will be available to input into the business planning process. A number of questions will need answering including when (and under what conditions) will the networks need to move from trialling to deployment and, once you have made small scale trials work, is the roll-out relatively quick?

There may also be other questions beyond the network regulatory framework. For example, the Forum could consider the need for changes to settlement arrangements to address issues with the continued use of profiles, and the arrangements to facilitate more advanced tariff structures. The Forum may also wish to consider consistency across the regulatory framework, in particular in relation to Ofgem's recent statements regarding the benefits of tariff simplification.

Given the urgency and materiality of checking that the regulatory framework is fit for purpose, this looks like an area for consideration by the Forum in its first year.

Role of networks

Barriers: Network incentives, Customer engagement, Interoperability

The Forum may wish to debate the role of networks. In particular, should networks simply be responding to growth in end use/distributed generation technologies by ensuring there is network capacity to meet whatever demand is, wherever it is on the network? Or should they be able to take a more strategic/directive approach?

High costs may be incurred if networks are simply built to be consumer-led, particularly as this may be in response to the subsidy-driven take up of technologies which may result in expensive clustering. An alternative would be for networks to direct where these investments should be put given the overall cost to the system.

A Facilitating approach would aim to make network charging cost reflective so that customers face the costs they impose on networks. However, this may be hard given it will require localised pricing. It also fails to address the fixed

network effects barrier where not enough customers are prepared to lose control over their connection rights for lower network charges.

A more Directing approach could instead be used. For example in Queensland where they are dealing with high demand growth, anybody wanting to connect a pool pump, air conditioner or electric heater must allow the DNO to control that demand to manage network constraints. This would be a fairly extreme solution and there are intermediate approaches that provide some flexibility in choice, at least at the appliance purchase stage.

Getting a shared view about the role of networks would also appear to be a priority task for the Forum, given that other decisions (for example about investment requirements and expected customer response) will flow from it.

Smart meters

Barriers: Customer engagement, Disaggregated value chain, Interoperability

Smart grid requirements are already being discussed within the requirements for the smart meter functionality and roll-out. The Forum may wish to consider whether the current processes allow sufficient network engagement and are transparent to other smart grid stakeholders. It could also pick up any issues that are failing to be resolved in those discussions. In particular, it may wish to consider the role of the DCC and the optimal data speed to be provided by the communications solution. It could either seek to increase the influence of smart grid requirements if it felt it was not getting sufficient consideration in the existing decision making process, or it could test whether the business case for the proposed specification was robust to the Economic Framework that may be developed for consideration of smart grid investments.

The tight timescales associated with smart meter roll-out means that, if there is work for the Forum in this area, it will need to be prioritised.

DSO role

Barriers: Disaggregated value chain, Network incentives, Interoperability

There are scenarios where it may be necessary for DNOs to undertake SO activities such as taking responsibility for ensuring that demand and supply for energy on their networks is balanced, and that the resulting planned physical production and consumption is consistent with network capability. There could therefore be a workstream to assess the likelihood that DNOs will need to do this over what timescales. It could also assess whether the hierarchy of controls in the industry needs to change to balance demand and supply under expected conditions.

The extent of the SO role that DNOs may need will depend on how the industry develops in response to the drivers for change. Depending on the outturn scenario, the types of active management could be quite different, from

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something close to existing responsibilities around managing constrained connections (which can be achieved within the current framework) through to regional balancing markets operating in real time (which may require DSOs to buy and sell electricity, which is not currently part of the definition of the licensed “distribution business” in the same way it is for the transmission business).

Real time regional markets may only be required when there is a significant reliance on wind generation, with many “prosumers” and where there is wide scale use of EVs and electric space heating that could provide discretionary demand. This is not foreseen in the short to medium term and therefore may not be something that the Forum needs to prioritise. However, it will be important to understand whether the changes required to facilitate a DSO role relate to the licence (in which case the lead time may be relatively short) or to primary legislation (which will clearly have a longer lead time). Whether this should be a priority area for consideration by the Forum largely rests on this question given the importance of understanding the lead time associated with change, should it be required.

A Facilitating approach would look at whether existing roles and responsibilities were sufficient to allow DNOs to undertake these activities if that were the most efficient way of balancing the whole network.

A more Directing approach would seek to define what the role should be. This may be appropriate if there was a concern that DNOs would each go for different solutions that made sense for their individual networks, but which raised the costs of balancing the national network.

Europe and international developments

Barrier: Disaggregated value chain

The Forum could be used to co-ordinate input into discussions the Government and other stakeholder groups have in the European and international forums on smart grids. It could also be used to disseminate the policy implications, and trialling information, that is emerging.

There may be two main strands to this. First, it could be used to input into policy development with the European Commission. The Forum could provide input into an assessment of what UK policy should be in this area. It could also advise DECC on how it could help other stakeholders influence European policy.

Second it could disseminate learning from smart grid development in Europe and internationally. On the second point, it may be possible to tap into the other groups that are also looking to gather international experience. However, the Forum could seek to add value to this work by evaluating the implications for GB, given that the issues facing the GB grid are not identical to those being faced internationally.

Data sharing

Barriers: Interoperability

Effective sharing of data across the value chain is an important enabler for a smart grid. The Forum could look specifically at how this could be done.

This could cover the sharing of data from trials. For example, is there a need for central analysis and comparison of project findings rather than just the sharing of data?

Once smart grids are operational, this may be as much a data protection and/or commercial sensitivity issue as a technical issue.

Appliance standards

Barriers: Disaggregated value chain, Uncertainty, Interoperability

Many smart grid solutions require active control of load or distributed generation, which in turn requires load, storage or generation capable of remote communication.

If there were sufficient demand, it could be expected that equipment manufacturers would develop remotely controllable solutions independently, driven by their commercial interests (although this may not address all issues associated with interoperability). However, as a result of policy uncertainty and the disaggregated value chain, there may be barriers to this occurring which can only be solved through a policy intervention.

At one extreme, this could involve the imposition of specific appliance standards. Less interventionist would be policies of greater engagement with relevant equipment manufacturers, information provision and support to groups developing interoperability standards.

Intervention in this area may be linked to decisions on the appropriate role of networks (discussed above), as a more strategic or directing role for networks may need to be accompanied by policy change in this area to ensure networks are able to undertake a more central role. Either way it is likely to be something that will be decided on an international basis and so it is not clear this is an area where the Forum needs to focus effort in its first year.

3.4 Outputs

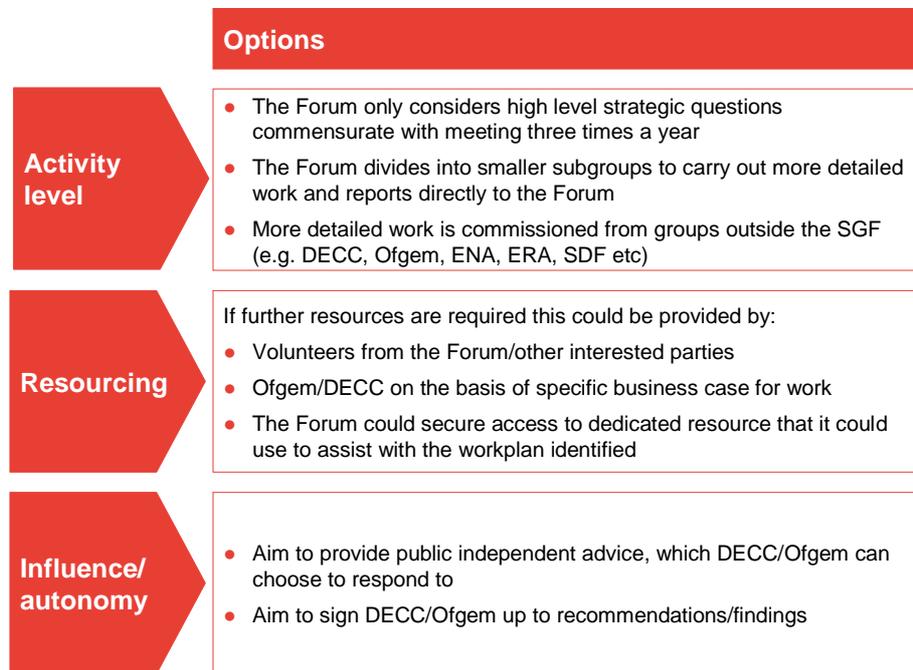
To make sure that the Forum does not just become a talking shop, it is important that it identifies the outputs it intends to produce as part of any work activity that it undertakes and agrees the timeline for delivery. That way, the overall work package that the Forum signs up to for its first 12 months can be agreed, and linked to the resources that the Forum has available to it.

The outputs may take the following forms.

Framework for the Forum

- Implementation plan with allocated actions.
- Recommendations of actions that Ofgem or DECC should take.
- Shared forecast assumptions for use in business plans for RIIO-ED1 and for Government planning more generally.
- Discussion papers to be issued by the SFG.
- Input to smart meter discussions.
- A framework for undertaking economic evaluation.
- Economic evaluation of particular aspects of a smart grid.
- Input into NIC and IA development.
- Recommendations to changes in Codes, engineering planning standards etc.
- Dissemination to wider community via an annual public event or summary report.

It is also necessary to recognise the link between the work programme that the Forum can deliver and the resources available to it and the control it has to direct those resources. We illustrate the questions to be addressed in Figure 10.

Figure 10. Resource and Governance issues of the Smart Grids Forum

Source: Frontier

The work programme and these resource and governance issues will need to be agreed in parallel. Since the intention is that the Forum meets just three times a year, if further resources are not available, the work programme will need to be narrow and focussed to fit with these constraints. If there is resource to undertake additional work that the Forum has the authority to direct, then the scope of output can clearly be increased.

We understand that the Forum will debate the appropriate outputs, and who is best placed to take forward the work, as part of the first meeting.

Annexe 1: Background reading

Document	Source
UK background	
DECC (2009), <i>Smarter Grids: the opportunity</i>	http://www.decc.gov.uk/assets/decc/What%20we%20do/UK%20energy%20supply/futureelectricitynetworks/1_20091203163757_e_@@_smartergridsopportunity.pdf
ENSG (2010), <i>A Smart Grid Routemap</i>	http://webarchive.nationalarchives.gov.uk/20100919181607/http://www.ensg.gov.uk/index.php?article=126
ENSG (2009), <i>Our Electricity Transmission Network: a vision for 2020</i>	http://webarchive.nationalarchives.gov.uk/20100919181607/http://www.ensg.gov.uk/index.php?article=126
DECC (2011) <i>Smart Metering Implementation Programme: Response to prospectus consultation</i>	http://www.decc.gov.uk/assets/decc/Consultations/smart-meter-imp-prospectus/1475-smart-metering-imp-response-overview.pdf
Key documents on European activities	
European Commission Smart Grid Task Force (2009), <i>Mission for the task force for the implementation of smart grids into the European Internal Market.</i>	http://ec.europa.eu/energy/gas_electricity/smartgrids/doc/mission.pdf
European Commission Smart Grid Task Force (2011), <i>Standardization Mandate to European Standardisation Organisations (ESOs) to support European Smart Grid deployment</i>	http://ec.europa.eu/energy/gas_electricity/smartgrids/doc/2011_03_01_mandate_m490_en.pdf
ENTSO-E and EDSO (2010), <i>European Electricity Grid Initiative Roadmap and Implementation Plan</i>	http://www.smartgrids.eu/?q=node/170
Other Background	

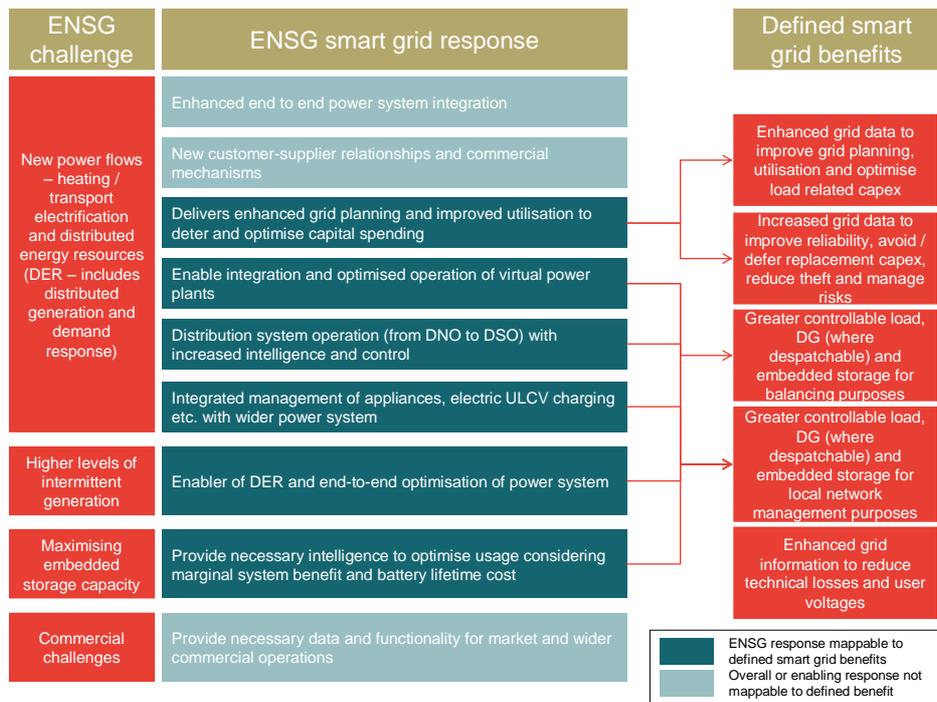
ENARD (2009), <i>Regulatory frameworks and business models conducive to the development of smart grids</i>	http://www.iea-enard.org/Resources/h/v/0/Report%206447%20Annex%20I%20Information%20sub-Task%20Report%20Regulatory%20Frameworks%20and%20Business%20Models%20Conducive%20to%20the%20Development%20of%20Smart%20Grids%20Issue%202.pdf
EREG (2010), <i>Position Paper on Smart Grids</i>	http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_PUBLICATIONS/CEER_EREG_PAPERS/Electricity/2010/E10-EQS-38-05_SmartGrids_Conclusions_10-Jun-2010_Corrige.pdf
Eurelectric (2009), <i>Smart Grids and Networks of the Future - EURELECTRIC Views</i>	http://www.eurelectric.org/CatPub/Document.aspx?FolderID=1573&DocumentID=26620
Eurelectric (2010), <i>Report on Regulation for Smart Grids</i>	http://www.eurelectric.org/CatPub/Document.aspx?FolderID=1573&DocumentID=29869
European Commission (2009), <i>Communication on Investing in the Development of Low Carbon Technologies (SET-Plan)</i>	http://ec.europa.eu/energy/technology/set_plan/doc/2009_comm_investing_development_low_carbon_technologies_en.pdf
European Commission (2009), <i>Communication on Investing in the Development of Low Carbon Technologies (SET-Plan) – a technology roadmap</i>	http://ec.europa.eu/energy/technology/set_plan/doc/2009_comm_investing_development_low_carbon_technologies_roadmap.pdf
European Commission Smart Grid Task Force (2010), <i>Functionalities of smart grids and smart meters</i>	http://ec.europa.eu/energy/gas_electricity/smartgrids/doc/expert_group1.pdf
European Smart Grid Technology Platform (2006), <i>Vision and Strategy for Europe's Electricity Networks for the Future.</i>	http://ec.europa.eu/research/energy/pdf/smartgrids_en.pdf
European Smart Grid Technology Platform (2007), <i>Strategic research agenda for Europe's electricity networks of the future.</i>	http://www.smartgrids.eu/documents/sra/sra_finalversion.pdf

Annexe 1: Background reading

Gridwise Alliance (2009), <i>Handbook for assessing smart grid projects</i>	http://www.gridwise.org/resources_gware_sources.asp
KEMA (2011), <i>CUE report 1: The opportunity for demand response</i>	http://2010.energynetworks.org/reports/
KEMA (2011), <i>CUE report 2: Strategic Issues and action planning</i>	http://2010.energynetworks.org/reports/
Major Economies Forum on Energy and Climate (2009), <i>Technology Action Plan, Smart Grids</i>	http://www.majoreconomiesforum.org/images/stories/documents/MEF%20Smart%20Grids%20TAP%2011Dec2009.pdf

Annexe 2: Mapping of benefits to ENSG Smart Grid Vision

Figure 11. ENSG Smart Grid Vision challenges and smart grid response



Source: Frontier Economics using ENSG analysis

Annexe 3: Policies impacting on the value of smart grids

Details	
Cross cutting	
Carbon targets and budgets	The UK has set itself legally binding targets to reduce carbon emissions by at least 34% by 2020 and 80% by 2050. The UK has also committed to meeting carbon budgets which cap the total quantity of UK greenhouse gas emissions over three five year periods from 2008-2022.
Renewable Energy Target	The UK has signed up to the EU Renewable Energy Target which includes a UK target of 15% of energy from renewables by 2020. The overall energy target is likely to require around 30% of electricity, 12% of heat and 10% of road transport fuels to come from renewable sources.
EU Emissions Trading System (EU ETS)	The EU ETS is a Europe-wide cap and trade scheme. Since 2005, the scheme has set a limit on the total amount of certain greenhouse gases that can be emitted by the installations in the system. Within this cap, companies receive emission allowances which they can sell to or buy from one another as needed. The scheme covers electricity generation and the main energy-intensive industries. Combined, these account for around 48% of UK CO ₂ emissions.
Green Investment Bank (GIB)	The GIB aims to increase available funding for green infrastructure. In Budget 2011, initial capitalisation of £3 billion was announced. The bank will begin operation in 2012-13. Government estimates that with additional private finance, the GIB will bring on around £18 billion of investment in green infrastructure by 2014-15.
Enhanced Capital Allowances (ECAs)	ECAs enable a business to claim 100% first-year capital allowances on their spending on qualifying plant and machinery, including energy-saving plant and machinery, low carbon emission cars and natural gas and hydrogen refuelling infrastructure.
Zero carbon homes and non-residential buildings	These policies aim to ensure all new homes are zero carbon by 2016 and that all new non-domestic buildings are zero carbon by 2019. Achieving zero carbon standards will involve much greater uptake of onsite renewables and heat pumps, and very high levels of energy efficiency on new buildings.
Electricity generation	
Electricity Market Reform	In late 2010, Government launched a consultation on electricity market reform, including proposals to introduce a carbon price floor,

feed-in tariffs based on a contract-for-difference for renewables, nuclear and carbon capture and storage, a capacity payment mechanism and an emissions performance standard. The Government will announce its final decisions for reform in late spring 2011.

Feed-in tariffs for small-scale generation	From April 2010, feed-in tariffs for small-scale (<5MW) distributed generation including wind, solar PV, hydro, anaerobic digestion and domestic scale micro-CHP have been available. Around 90 MW of small-scale generation has come onto the system since their introduction.
Renewables Obligation	Since 2002, the Renewables Obligation has incentivised investment in renewables generation. Government's aim is to increase generation of renewable electricity to 30% of generation by 2020, from around 7% today. Under current electricity market reform proposals, Government is proposing to replace the Renewables Obligation with an alternative mechanism.
Heat	
Renewable Heat Incentive	From April 2011, feed-in tariffs to support a range of renewable heat technologies, including air and ground source heat pumps, across all scales and sectors will be introduced. This policy aims to help increase penetration of renewable heat to 12% by 2020.
Energy efficiency	
Carbon Emissions Reduction Target (CERT)	CERT requires all domestic energy suppliers with a customer base of more than 50,000 to promote the uptake of low carbon energy solutions to household energy consumers. In July 2010, CERT was extended from March 2011 to December 2012 with a new higher target and was significantly refocused around supporting insulation.
Community Energy Saving Programme (CESP)	CESP targets energy efficiency improvements to households in 4,500 low-income areas across Great Britain. The policy was launched in 2009 and the first project went live in early 2010. The Government is committed to replacing CERT and CESP when they expire at the end of 2012 with a new Energy Company Obligation.
Carbon Reduction Commitment Energy (CRC)	The CRC was introduced in 2010 to incentivise emissions reductions from large public and private sector organisations. Organisations covered by the scheme must purchase allowances to cover their CO ₂ emissions.
Green Deal	Government is proposing to introduce a new financing mechanism which will allow consumers to pay back for energy efficiency improvements through their energy bills. The policy is likely to be in place by Autumn 2012.
Climate Change	CCAs allow energy-intensive businesses to receive up to an 80%

Annexe 3: Policies impacting on the value of smart grids

Agreements (CCAs)	discount from the Climate Change Levy in return for meeting energy efficiency or carbon-saving targets. They cover a range of sectors from major energy-intensive processes such as steel, chemicals and cement, to agricultural businesses, such as intensive pig and poultry rearing.
Climate Change Levy (CCL)	The CCL is a tax on the use of energy in industry, services and the public sector. All revenue raised through the levy is recycled back to business through a 0.3 percentage point cut in employers' national insurance contributions, introduced at the same time as the levy, and support for energy efficiency and low carbon technologies.
Transport	
Plugged in Places	From 2011, DfT offers match-funding to support the installation of electric vehicle recharging infrastructure in pilot areas across the UK. This policy aims to both directly develop infrastructure, and to collect data on how drivers use and recharge vehicles to inform the design of a national system of recharging infrastructure. Three Plugged-In Places in London, Milton Keynes and the North East are already installing recharging points in their areas. In December 2010, funding for five additional Plugged-In Places projects in Northern Ireland, Scotland, Greater Manchester, the Midlands and the East of England was announced.
Plug-in Car Grant	From January 2011, motorists purchasing a qualifying ultra-low emission car will receive a grant of 25% towards the cost of the vehicle, up to a maximum of £5,000.

Annexe 4: Further details on international smart grid organisations

Organisation	Type of organisation	Key activities on smart grids
Electricity Networks Analysis, Research and Development (ENARD)	Network of Governments collaborating through an IEA Implementing Agreement - includes the UK	ENARD's mission is to provide an international forum for information exchange, in-depth research and analysis and collaborative R&D in relation to T&D networks. Previous work on smart grids includes a report in October 2009 on regulatory frameworks and business models to incentivise smart grids and a workshop on smart grid financing in September 2010. A new project to collate and disseminate information on international smart grid demonstration projects has recently been proposed.
Eurlectric	European electricity industry association	Eurlectric produced a survey on the state of play in smart grids in May 2008, and a paper on regulation of smart grids in January 2011.
European Commission Smart Grid Task Force	Chaired by the EC, includes representatives from Government, consumers and industry	The Task Force produced a mandate on coordination of technology standards in March 2011, with the aim of introducing EU-wide standards for smart grids by the end of 2012. It will publish a Communication on proposed wider activities in the policy and regulation of smart grids for consultation in April 2011.
European Distribution System Operators (EDSO)	Industry body for European DSOs	EDSO is involved in the planning of the European Electricity Grid Initiative (EEGI), including jointly producing the EEGI roadmap with ENSTO-E in 2010.

Organisation	Type of organisation	Key activities on smart grids
European Energy Research Alliance (EERA)	Association of European research institutes	EERA supports the EC's Strategic Energy Technology Plan by pooling and integrating activities and resources and combining sources of funding. EERA also runs a Joint Working Group on Smart Grids.
European Network of Transmission System Operators for Electricity (ENTSO-E)	Industry body for European TSOs	ENTSO-E is involved in the planning of the EEGI including jointly producing the EEGI roadmap with EDSO in 2010.
European Regulators Group on Electricity and Gas (EREG)	EC's advisory body on internal energy market issues made up of representatives of Member States' energy regulatory authorities	EREG consulted on a position paper on smart grids in 2009-10.
Global Smart Grid Federation (GSGF)	International umbrella association for national public-private initiatives or stakeholder groups	The GSGF aims to facilitate collaboration in research, establish itself as the global centre for competency on smart grids, foster the international exchange of ideas and best practice and create avenues for dialogue and cooperation between the public and private sectors on smart grids. It works closely with ISGAN. The UK Smart Demand Forum and Gridwise are members.
Gridwise	US stakeholder group	Gridwise promotes smart grids in the USA and is a member of the GSGF.
International Energy Association (IEA)	Autonomous international organisation promoting reliable, affordable and clean energy	The IEA is currently producing a roadmap for smart grids to 2050.

Annexe 4: Further details on international smart grid organisations

Organisation	Type of organisation	Key activities on smart grids
International Smart Grid Action Network (ISGAN)	Network of Governments including the UK and the European Commission	ISGAN aims to foster cooperation between Governments on smart grids. It was set up at the first Clean Energy Ministerial in July 2010. Key elements of the work plan include: establishment of an inventory of smart grid enabling programmes and policies, collation of case studies; development of policy assessment methodologies, and regular high-level synthesis of insights from projects. ISGAN is in the process of being established as an IEA Implementing Agreement. ¹⁶
International Council on Large Electric Systems (CIGRE)	International NGO	CIGRE aims to facilitate the exchange of information between engineering personnel and specialists in all countries and to develop knowledge in power systems. Since 2004, CIGRE has had a Study Committee on Distribution Systems and Dispersed Generation which aims to synthesise state of the art practices on smart grids .
Joint Energy Research Council, Smart Electricity Systems (SES)	EC funded research council	SES provides scientific and techno-economic support to support European Commission work on smart grids, working closely with the IEA and CIGRE.

¹⁶ IEA Implementing Agreements aim to enable countries, businesses, industries, international organisations and non-government organisations to share research on breakthrough technologies, to fill existing research gaps, to build pilot plants and to carry out deployment or demonstration programmes. Their work can comprise any technology-related activity that supports energy security, economic growth, environmental protection and engagement worldwide. A new initiative may be created at any time, provided at least two IEA member countries agree to work on it together. (www.iea.org)

Organisation	Type of organisation	Key activities on smart grids
Joint Working Group on Standards for the Smart Grid	Technical working group mandated by the EC's Smart Grid Task force	The Joint Working Group is made up of three EU standards organisations: Cen, Cenelec, ETSI. In March 2011, the group was requested by the EC's Task Force to produce a set of consistent standards for smart grids by 2012.
Joint Research Council Institute for Energy	Research institute providing support to the EC	The Institute is currently building a catalogue of smart grid related projects with a view to carrying out a qualitative and quantitative cost-benefit analysis of pilot projects in Europe and beyond.
Major Economies Forum on Smart Grids	Network of Governments, including the UK and the EC	The Forum produced a technology action plan in December 2009, led by Italy and Korea. One of the recommendations of this report led to the setting up of ISGAN and the Global Smart Grids Federation.
Smart Energy Demand Coalition (SEDC)	International industry association for utilities, electricity retailers, and other companies in the areas of demand response, smart meters and smart grid technologies	The SEDC was officially launched in March 2011. Its aims include education of policymakers on behalf of the demand side industry, gathering information for its members, raising awareness about demand response and providing opportunities for networking. The UK's Smart Demand Forum will be a member.
Smartgrids Technology Platform Forum	Stakeholder group, sponsored by the EC	The Forum aims to set strategy and coordinate between European stakeholders. It produced a vision for smart grids in 2006, and a strategic research agenda in 2007.
Steering Group on Strategic Energy Technologies (SET-Group)	Group of Government representatives, chaired by the EC	The SET group oversees the EC's Strategic Energy Technology Plan, which includes the European Electricity Grid Initiative (a nine year programme of smart grid demonstration across Europe).

Annexe 4: Further details on international smart grid organisations

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FRONTIER ECONOMICS EUROPE

BRUSSELS | COLOGNE | LONDON | MADRID

Frontier Economics Ltd 71 High Holborn London WC1V 6DA

Tel. +44 (0)20 7031 7000 Fax. +44 (0)20 7031 7001 www.frontier-economics.com