Smart Grid: a race worth winning?

A report on the economic benefits of smart grid

April 2012

SmartGridGB
For an intelligent future

Ernst & Young
Quality In Everything We Do

Contents

Forewords

The members of SmartGrid GB share two common beliefs: that smart grid development will deliver more secure, sustainable, and affordable energy for future generations of British consumers; and that the development of smart grid globally represents a major growth opportunity for Britain.

Yet while the promise of smart grid is clear to see, we all know that making it happen will not be straight forward. There is no simple blueprint for the development of smart grid. Its development will be part of a major change to the way electricity is generated, transmitted, distributed and used and like any substantial change in national infrastructure the costs involved will be challenging.

Understanding the full economic case for smart grid is therefore vital and it is why we commissioned Ernst & Young to work with SmartGrid GB to develop this report. We wanted a better understanding of what the advantages would be for Britain if we pushed ahead with smart grid development and what will be needed to make it happen. In order to do this, we have looked at the benefits of smart grid 'in the round' in order to understand the wider implications that smart grid development will have for associated industries, exports, and job creation.

As you'll see from the pages that follow, the case for pushing forward the development of smart grid in Britain is compelling and has probably been underestimated by previous studies.

Initiatives like the smart metering rollout and the Low Carbon Networks Fund demonstrate that Britain is making significant strides forward, but these are simply first steps and there is a long way to go to make smart grid a reality across the country. Without further policy certainty, appropriate regulatory incentives, and more investment, Britain could quickly fall behind in what will be a new global growth market and a source of prosperity and jobs for years to come.

At a time when there is real uncertainty about future drivers of economic growth, the global shift to smart grid presents a real opportunity for Britain. This report highlights the scale of that opportunity and sets out some important recommendations to help keep Britain at the forefront of smart grid development around the world.

SmartGrid GB Executive Committee

We were delighted to have the opportunity to work with SmartGrid GB on this study. There are important developments across the value chain as we seek to decarbonise the energy industry. But smart grids are arguably THE most important development as they are necessary to facilitate multiple developments.

The way in which customers use electricity networks is changing as a result of trends such as the electrification of heat and transport, or the growth of distributed renewable generation. Distribution grids must therefore change, both to accommodate the new demands and to maintain the security and quality of supply during a period of great uncertainty.

The challenge given to us by SmartGrid GB might appear to be a simple one, but in reality it is anything but. The debate on smart grid is hugely complex, with a large number of different strands and major uncertainties around how each will evolve. With the help of a large number of interviews, we have done our very best to navigate these complexities and present our findings in an approachable yet robust way.

We recognise that there is inevitably an element of uncertainty over the individual findings quoted. However, we do not believe that these detract in any way from the key conclusion that the case for smart grid is compelling, robust across different scenarios and supported by international evidence. The report also identifies the need for a wider perspective around the GB smart grid debate, plus a degree of fresh thinking in order to recognise and realise all the smart grid benefits.

The key objective of the report was to stimulate debate, and we look forward to contributing further as the debate around smart grid intensifies.

Bill Easton
Director, Transaction Advisory Services
Ernst & Young

Executive summary

Introduction

Around the world there is strong consensus that we are about to see significant changes in the way we use and generate electricity. Innovations in areas such as renewable and micro-generation, heating and the mass commercial development of electric vehicles (EV) will place new requirements on the networks that transmit and distribute electricity. Meeting these requirements will necessitate large scale investment in these networks to make them more intelligent, efficient and secure. In time these investments will be replicated in every country around the world. The term used to describe these new networks is smart grid.

The transition to smart grid will cost billions of pounds. However, the result will be a more efficient and flexible grid that can meet the needs of business, consumers and governments in a secure and affordable way for generations to come.

There is strong consensus in the UK and internationally about the long term need to move to smart grid and a number of countries have quantified its benefits and stand ready to take advantage of the growth it might deliver. However, there is currently less clarity in the UK about how to make it happen, or the speed at which the transition needs to take place.

To make progress on these issues, it is first necessary to get a deeper understanding of the quantum and breadth of the potential benefits that smart grid might deliver and how those benefits relate to the costs. Understanding the full economic case for smart grid is therefore vital and it is the reason why the members of SmartGrid GB commissioned Ernst & Young to develop this report.

The report provides the most detailed assessment yet of the potential benefits that might accrue to the British economy as a result of the development of smart grid. As well as looking at the core benefits that will be realised from investing in a more efficient network, the report also seeks to understand and quantify the wider benefits that will accrue across the industrial supply chain, and the important downstream economic activities that will be enabled as a result of smart grid. The report also explores the export potential that could be realised if UK companies were to become global leaders in the development of smart grid technologies and services.

International evidence is strongly supportive of there being considerable benefits in smart grid development and suggests previous views on its direct benefits in Britain have been conservative.

Conclusions in brief

The report has two broad, major findings. The first is that the initial investment case for moving ahead with smart grid development sooner rather than later appears very strong: for example, the report's figures indicate that the benefits of moving in a timely fashion far outweigh the risks and appear robust across a number of different scenarios. The second is that the timely creation of a smart grid can unlock significant benefits in other industries, providing a welcome boost to growth, jobs and exports.

What is clear from the report is that if Britain is willing to take a global leadership position in smart grid development, its benefits will be larger and wider. We can draw from this that if Britain wants to continue to be a serious competitor in the global race to smart grid, it needs to be ambitious in its smart grid plans and it needs to prioritise laying the relevant ground work in order for its accelerated development to take place.

The report also explores some of the challenges that need to be overcome, as well as possible solutions to these challenges. The report's recommendations are that there is a need for some fresh thinking by government, regulator and industry, and a number of constructive suggestions are offered as to how this can be achieved.

This report has been commissioned by 23 leading companies, all with different expertise, and often with competing interests. However, they are united in the belief that accelerating the development of smart grid will be of long term benefit to Britain.

Summary of the report

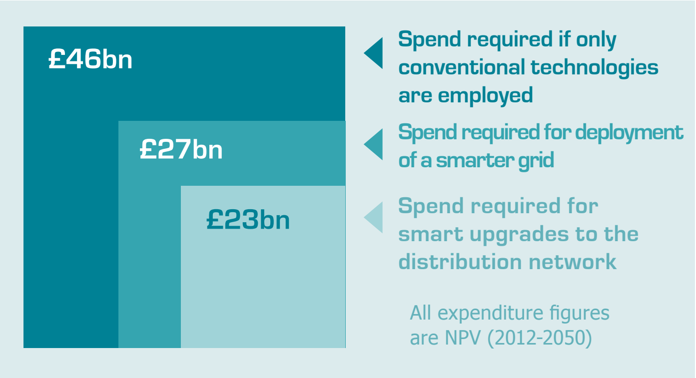
Direct benefits for networks

The analysis in this report indicates that an incremental £23 billion NPV will need to be spent between now and 2050 on smart investments to upgrade the distribution network. However, this is significantly cheaper than pursuing a conventional investment strategy in grids. Compared to that approach, the work of the DECC / Ofgem Smart Grid Forum (SGF) highlights that following a smarter grid investment strategy could deliver cost savings of as much as £19 billion.

Importantly, the savings from smart grids are projected to remain as high as £10bn even if only low levels of decarbonisation / electrification occur. And under all of the scenarios considered, the projected benefits far outweigh the potential downside of moving early which was less than £1 billion.

The report also notes that some elements of the benefits that smart meters have promised to deliver could be at risk without the parallel development of smart grids. The timely roll out of smart grid could therefore also be important from the perspective of recouping the cost and realising the full benefits from smart metering.

The figures below set out an estimate of the costs required to upgrade the distribution networks between now and 2050, based on the initial findings from the SGF evaluation framework, with some minor modifications as explained in the report.



These figures indicate that smart grid solutions will be cheaper in the long run than conventional network upgrades and that we stand to gain much, and risk comparatively little, from their timely deployment.

How the £23bn for smart upgrades is spent

Benefits across the supply chain

For the first time in a GB focussed report, we have quantified the benefits of smart grid expenditure across the supply chain and the results have been positive. We have found that between now and 2050 smart grid expenditures will lead to approximately £13 billion of GVA.

Jobs will be boosted by an average of around 8,000 during the 2020s rising to 9,000 during the 2030s. Exports arising from smart grid could be worth £5bn between now and 2050 to Britain, whilst the benefits arising from intellectual property and foreign direct investment may also result. The box left offers an example of how these benefits would flow across the value chain.

Benefits from secondary industries

The report's analysis demonstrates that smart grid will play an important role in facilitating the growth of a variety of 'secondary' industries including electric vehicles, heat, renewables and distributed generation. This will not only help Britain meet its carbon targets but could also lead to strong economic growth in these industries.

A summary of this potential value is set out below:

Value of secondary industries (undiscounted annual expenditure)

	2030	2050
Electric Vehicles	£25 - 60bn	£46 - 214bn
Distributed generation	£1 - 4bn	£3 - 41bn
Heat	£17 - 26bn	£21 - 46bn
Renewables	£7 - 25bn	£5 - 28bn

The report indicates that the enabling benefits of smart grid can be considerable. Using the EV sector as an example, the analysis of the potential impacts on the British economy suggests that the total GVA for the EV sector in Great Britain could be £17bn in 2030 and £52bn in 2050.

Britain is not the only country with a growing smart grid reputation and other nations are investing aggressively in this area. The time available to take advantage of this opportunity is therefore likely to be limited.

Maximising wider opportunities

Should Britain opt to rollout smart grid in a timely manner, the report identifies a number of additional opportunities to maximise the domestic share of smart grid and secondary industry spend, as well as to export goods, services and leverage IP potential. The timely deployment of smart grid will be important in building Britain's comparative advantage to achieve this, and will help to build on current momentum set by the LCNF trials and the smart metering rollout.

It is important to emphasise here that Britain is not the only country with a growing smart grid reputation and other nations are investing aggressively in this area. The time available to take advantage of this opportunity is therefore likely to be limited. Timely action is therefore required and the report identifies concerns that waiting until 2023, the period after the next price control elapses, may be too late.

Costs and risks of inaction

If a smart grid is not deployed in a timely manner, industries along the smart grid supply chain may not be able to benefit from these emerging industry opportunities and any 'first mover' potential that British industries may have could be lost.

A smart grid will also play an important enabling role in the smooth and timely development of the cleantech industries needed to reach GB's challenging carbon targets. If a conventional grid hinders the development of these industries, GB could end up spending large amounts of money buying international carbon credits to reach its targets: at an extreme level, the cost of this could reach £126bn NPV over the 2012 – 2050 period.

Challenges

The report finds that the benefits of pressing forward with smart grid development would be wide ranging, with a positive impact on networks, the wider supply chain and associated secondary industries.

However, the sheer complexity of the smart grid debate means that more preparatory work needs to be done. Neither an aggressive plan nor a 'wait and see' approach will be suitable. A measured, progressive approach is required.

The report identifies a number of challenges, notably a concern amongst key stakeholders about the ability of current or proposed mechanisms to deal with these complexities and expectations, and that the adoption of smart grid is likely to be slow, with little investment before 2023.

With regards to the latter point about speed of progress, there are strong differences of views on the merits of this: those DNOs interviewed were not greatly concerned about any increased degree of stress on networks before then. Other stakeholders suggested that such that a delay will not allow GB to capture the full value of the benefits that smart grid could offer, and hence that further interventions are needed.

Recommendations

To address the complexities and challenges associated with developing smart grid infrastructure, the report explored possible solutions to the challenges. The report recommendations are that there is a need for some fresh thinking by government, regulator and industry, and a number of constructive suggestions are offered as to how this can be achieved.

- Policy makers need to provide the maximum degree of policy guidance possible: creating some additional flexibility in current standards will also be important. It may also be possible to say more about what is not needed yet, and a holistic energy roadmap could be usefully constructed.
- There needs to be greater focus within the regulatory process on protecting customers by ensuring that there is sufficient network investment to protect against the risks. This could come from both the regulator and companies being expected to publish a risk review, and also a requirement to identify and evaluate what might be termed "no or at least low regrets" investments.
- The risk / reward balance faced by DNOs for innovating should include incentives to actually apply the learnings to their networks or seek to move faster than others in delivering smart grid.
- There needs to be greater focus on consumer engagement both to ensure that consumers understand the positive attributes of smart grid, and also how a smart meter will contribute to this. It will also be important to explore how best different types of customers are engaged on a day to day basis and whether a degree of automation is required.
- It is important that future projects do not take the current industry model as a given. There are some complex challenges to work through and so alternative models will need to be actively explored.
- Further investment in skills is required, for example by an extension of the workforce renewal elements of DPCR5, and a co-ordinated national approach covering the whole smart grid supply chain.
- There is a need to ensure that projects under the successor scheme to the LCNF progress to a larger scale of test, both in the sense of using a number of elements together, and to deploy them at a higher level of penetration over a larger area.

1

About this report

Purpose

Smart grid will be crucial in helping Britain realise its low carbon energy future but there remains much to be done. Whilst government and industry have achieved much already – most notably through the Low Carbon Networks Fund (LCNF) – there is a concern amongst SmartGrid GB (SGGB) members that Britain is not making the investments in smart grid that will be crucial for our country's economy and our international competiveness.

SGGB therefore commissioned Ernst & Young (EY) to conduct a short study to identify, characterise and, where possible, quantify the major economic benefits that smart grid development can provide Great Britain in order to help inform the policy making process and the wider stakeholder community.

Scope

The scope of this report's objectives are deliberately broader than current GB studies. This is because smart grids are not simply an objective in their own right but are a core component for facilitating a low carbon transformation of the entire energy ecosystem.

In order to get a true sense of the benefits that smart grid can provide, it is necessary to look across the 'smart energy system', including the elements which interact with the networks in a smart manner. Examples of this could be intermittent renewable generation, home appliances, electric heating, electric vehicles and distributed generation. We believe that it is the effective interaction of all of these broader elements with the networks that characterise 'smart' operation, and which smart grid enables.

So whereas, to date, Britain has focussed on proving the economic merits of smart grid from a networks perspective alone, this report is unique in that it takes a much broader perspective. In doing so, it aims to shift the debate by identifying the importance of the additional and wider benefits that could accrue to Britain from the deployment of a smart grid.

Approach

This report draws on existing British and international studies, interviews conducted with relevant stakeholders and EY economic analysis and its findings reflect the information available from these sources. In the occasional instance where our access to more detailed information has been limited, we have made a number of assumptions in order to conduct our analysis. These assumptions are highlighted in the report. All interviews were conducted under the Chatham House Rule and hence the focus has been on reporting overall rather than individual views. We would like to acknowledge the value of these inputs and express our thanks for the support provided.

For readers who are less familiar with smart grid, the appendix contains supplementary reading on some of the fundamental smart grid challenges and concepts.

2

Core benefits

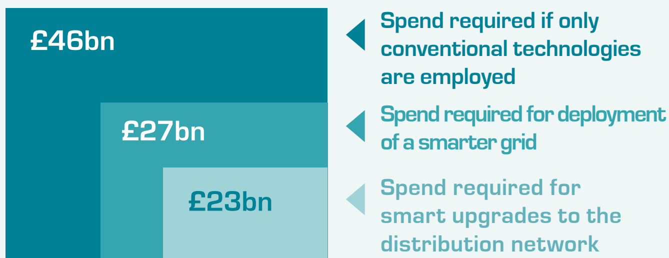
The benefits of smart grid from a network perspective

Key findings

- EY analysis of SGF early-stage research indicates that an incremental £23bn will need to be spent between now and 2050 on smart investments to upgrade the distribution network.
- The same early-stage research suggests that it is significantly cheaper to pursue a smart strategy relative to a conventional strategy for future distribution network upgrades that will be required: the savings from deployment of smart grid could be £19bn based on the same early-stage findings.
- Importantly, savings from smart grid are projected to remain as high as £10bn even if only low levels of decarbonisation / electrification eventuate.
- There is a minimal downside (£0.2-£1bn) to investing early, rather than delaying a decision until 2023.
- Estimates from other British and international studies support the findings above but suggest that these estimates are conservative.
- Some of the benefits that smart meters have promised to deliver could be at risk without the parallel development of smart grid propositions. The timely roll out of smart grid could therefore be important from the perspective of recouping the cost and realising the full benefits from smart metering.

This chapter explains the benefits of smart grid from a network perspective. These are quantified as the cost savings associated with deploying smart technologies rather than conventional technologies. It starts with a discussion of this cost saving, which is one of the primary benefits that can result from a smarter grid. This is followed by a brief discussion of the benefits of smart metering and its link to smart grid roll-out.

Approximately **£23bn** will need to be spent between now and 2050 on smart upgrades to the distribution network.



All expenditure figures are NPV (2012-2050)

2.1

Cost of smart grid

In Britain, the most comprehensive attempt to date at estimating the costs to GB of smart grid is a report commissioned by the DECC / Ofgem Smart Grid Forum (SGF). SGF were asked to produce a systematic framework to allow the estimation of the costs (and benefits) of deploying a smarter grid, sufficient to meet the energy requirements of a number of future energy scenarios.

SGF have populated their framework with an initial data set which they acknowledge requires further refinement, and this is currently underway. The analysis below is based on these initial figures that have been produced by the SGF.

The SGF evaluation framework estimates that the cost of upgrading the distribution network in a smarter way including ICT, storage and dynamic demand side response (DSR) investment costs is £27bn between 2012 and 2050 on an NPV basis. This translates into an overall cumulative investment in upgrades to the distribution network of around £75bn over 38 years.

The scenario from the SGF evaluation framework that is used in this SGGB analysis is consistent with the Government's Carbon Plan to deliver the 4th Carbon Budget without buying international credits. It assumes:

- a particularly strong uptake of heat pumps in commercial and domestic buildings
- a strong uptake of EVs (consistent with average emissions from new cars falling to 50gCO_2 / km)
- a medium scenario for solar PV installations (a tenfold increase on the 2011 level by 2030)
- high demand response and decarbonisation (consistent with the National Grid's 'Gone Green' scenario, which in turn is consistent with meeting overall carbon targets.)

This estimate includes the expenditure that would be required on conventional as well as smart technologies to build a network able to sustain this scenario. We are interested primarily in the smart component of expenditure only. However, this breakdown was not available at the time of publication. Therefore, we have made a number of assumptions to derive an estimate for this smart component of expenditure. We have estimated the amount of expenditure that would have occurred anyway[1] and assumed that what remains is capital spent on the deployment of smart grid technologies.

Under these assumptions, approximately £23bn NPV between 2012 and 2050 will be spent on smart investments specifically, which represents just over ½ of the total cumulative expenditure - £40bn over 38 years[2].

It is important to note that the primary purpose of SGF's report was to produce an evaluation framework. Although this framework has been populated with an initial data set used to produce the £27bn figure above, further refinement of these datasets is planned. These outputs nonetheless represent the most comprehensive attempt to date at estimating the costs and benefits for Britain to implement smart grids. As the box below explains, comparing this figure to other available estimates gives credibility to the broad magnitude of the expenditure estimate resulting from the SGF evaluation framework.

A number of detailed scope clarifications are useful to help explain what this figure contains:

- This figure purposely excludes the costs associated with implementing the smart metering programme, as these are considered separately by DECC. Only DSR technology costs to reduce local network costs are included.
- The SGF evaluation framework[3] looks at the costs associated with transmission and generation as well as distribution. However, their analysis focuses primarily on distribution cost aspects, as this is where the majority of smart investments will occur. We have maintained this focus in our analysis, particularly as SGF's calculations show that whether you have a smart distribution grid or not, the costs of generation and transmission are virtually identical.

1 We used estimates from past Distribution Price Controls appropriately adjusted for savings that the deployment of smart grid would generate even for conventional network upgrades to estimate the proportion of total spend on conventional investments. We recognise that this is perhaps a simple attempt to estimate the proportion of smart expenditure assumed but believe that it is likely to be valid within the large uncertainty ranges that are being considered.

2 This figure is calculated using a different time profile to the £27bn estimate. See section 3.1 for an explanation of this.

3 http://www.ofgem.gov.uk/Pages/MoreInformation.aspx?docid=44&refer=Networks/SGF

The savings from deployment of smart grid could be

£19bn

Spend required if only conventional technologies are employed

Spend required for deployment of a smarter grid

All expenditure figures are NPV (2012-2050) - decarbonised / electrified scenario

EPRI cost estimates: a US comparator

The Electric Power Research Institute (EPRI), a US non-profit organisation, has also produced a rigorous analysis of the costs (and benefits) of implementing comprehensive smart grids throughout the US which was published in 2011[4].

It has a wider scope, but stripping out the non-distribution elements of the EPRI estimate and translating the resulting figure into a British equivalent by scaling the distribution network costs on distribution line length gives an estimated spend requirement of £20-£28bn (NPV to 2030) on smart investments.

Although the scenarios for Britain and the US are not completely identical either in the details of the existing distribution networks, or the specific demand growth challenges they will face, a broad comparison is still useful.

[4] Estimating the Costs and Benefits of the Smart Grid - http://my.epri.com/portal/server.pt?space=CommunityPage&cached=true&parentname=ObjMgr&parentid=2&control=SetCommunity&CommunityID=405

The case for timely deployment is compelling

The SGF evaluation framework report also quantifies the expected benefits by comparing the costs of meeting grid requirements associated with the scenario set out on the previous page, using only conventional technologies. The costs of the conventional investment approach are estimated to be £46bn NPV between 2012 and 2050. Comparing this to the investment cost of using smart techniques of £27bn, gives a **cost saved benefit of £19bn between 2012 – 2050 from deploying a smarter grid. Smart grid development is, therefore, significantly more cost effective than the deployment of conventional technologies.**

Importantly, benefits remain as high as £10bn even if lower levels of decarbonisation and electrification are deployed.

It should be noted that the initial real-options analysis undertaken in the SGF report indicates that there is a **minimal downside (£0.2-£1bn) to starting now** rather than delaying a decision until 2023. This is due largely to the assumption that the majority of EV and heat deployment will occur after 2020, implying that there will be only limited benefits from deploying smart grids before this date.

However, on balance, the figures make a compelling case for taking action on smart grid: the available evidence demonstrates that the benefits hold across a number of different scenarios and the risks in terms of incremental costs of starting soon are low.

Other studies support this finding but suggest these estimates are conservative

A number of other smart grid studies have attempted to quantify the benefits of a smarter grid in their respective countries. Inevitably, the specific scope of each study varies, but all broadly support the findings set out above. An exception to this is the South Korean study which differs largely because of its more limited scope.

- Translating the EPRI calculated benefits into a British equivalent (pro-rating based on distribution line lengths) gives total **estimated benefits of around £66bn NPV to 2030.** This comparison is somewhat broad-brush as the EPRI study has taken both a different approach to calculating benefits, and considers a somewhat broader set of technologies. The box to the right provides more details on these points. Nevertheless, it appears that the EPRI estimate of benefits is **significantly more positive than that presented by the SGF evaluation framework, suggesting that SGF may be at the conservative end of the scale.**
- Imperial College and the Energy Networks Strategy Group (ENSG)[5] have focussed on the benefits of only a subset of smart grid: those that accrue from local demand side response technologies. This broadly falls into a subset of the scope of the SGF evaluation framework benefits calculation. Although Imperial's optimised approach is unlikely to be achievable to the degree assumed by this study, there could be **up to £10bn NPV benefits to 2030** from local demand side response measures alone, when very high levels of EV and heat penetration are assumed. But even for levels of penetration as low as 10% by 2030, Imperial estimates that there will be up to £1bn benefits.
- An Australian Government publication 'Smart Grid, Smart City: A new direction for a new energy era', (2009) estimated that a smart grid will deliver an equivalent of approximately **£3bn benefits annually.** This includes financial benefits, reliability benefits and environmental benefits of nine technology categories including smart metering. For comparison, Australia's total electricity consumption is about 2/3rd of Britain's.
- Seoul National University conducted a study on 'The benefits of a transformed energy system in South Korea' (2009). It estimated that a smart grid will deliver the equivalent of **£8bn NPV over 22 years.** The only benefits calculated relate to the financial aspects resulting from the deferral of generation, transmission and distribution costs.

Approaches to quantifying benefits:

Comparing the SGF evaluation framework to EPRI's methodology

It is important to recognise that the SGF report does not explicitly quantify the value of benefits themselves. Rather, it compares the cost of meeting projected grid requirements using only conventional investments with the cost of using smart technologies. The difference in cost is the 'net benefit' or network investment cost saving that is attributed to pursuing the smart option i.e. it is a direct financial saving only[6].

At present SGF only includes five representative technologies and so, for example, technologies associated with infrastructure to connect end-use technologies, such as PV inverters, or EV charging points will not be included in the benefits calculation.

The EPRI study has taken a very different approach to calculating the benefits. EPRI has identified a number of attributes of the energy system (cost of energy, capacity, security, quality, reliability, environment, safety, quality of life, and productivity) and developed frameworks to estimate the value of improving these attributes. So not only is the breadth of the benefits quantified different, the approach used to calculate these benefits is also different. Unlike the SGF evaluation framework, the benefits associated with end use infrastructure would be an extra benefit which would add to the overall magnitude of benefits quantified. Additionally, EPRI estimate approximately £5bn of benefits from quality improvements, however because the evaluation framework assumes that quality of supply remains constant in both scenarios, the benefit accruing to this is zero. In this sense, the SGF framework evaluation can be seen as a conservative estimate of the smart grid benefits.

Some fundamental assumptions also appear to differ. Firstly, Frontier attach a monetary cost that consumers suffer as a result of having to use DSR. Conversely, EPRI quantify £12bn of 'quality of life'[7] benefits. Similarly, EPRI estimate that there will be £18bn of benefits from more reliable networks, whereas Frontier predict a small increase in the cost of interruptions - albeit with only small monetary costs. Detailed investigation of these differences is beyond the scope of this report.

5 http://www.energynetworks.org/modx/assets/files/electricity/futures/smart_meters/Smart_Metering_Benerfits_Summary_ENASEDGImperial_100409.pdf

6 The cost differences quantified include those relating to distribution network reinforcement, distribution network interruption costs, distribution network losses, customer 'inconvenience' costs, direct CO2 emissions costs, generation costs and transmission network reinforcement.

7 Refers to integration of access to multiple services, including electricity, the Internet, telephone, cable, and natural gas.

2.2

Making the most of smart metering

Outside of the British Isles, the typical approach is to view smart meters as a significant element within a smart grid, rather than being a discrete subject. EPRI for example, includes smart metering within its smart grid assessment. But in Britain, due largely to our disaggregated market structure and resulting policy approach, smart metering and smart grids have been viewed as two separate topics.

We maintain this approach in this report in order to retain consistency with existing analysis. We believe, however, that even though the two topics can progress in parallel, it is important to recognise that there are likely to be fundamental overlaps and interactions between the two areas. The box to the right considers some of the dependencies that may exist.

In particular, realising the full benefits from smart meters could be somewhat at risk without the parallel development of smart grid propositions. At the very least, the use of a smart meter as a fundamental element of smart grid operation reinforces the rationale for the smart metering programme. The Government has committed Suppliers to a substantial investment in the smart metering programme - involving an estimated additional £6bn of costs to 2030 (excluding costs being attributable to gas smart meters)[8]. It also expects smart meters to result in substantial benefits – an estimated additional £4bn NPV to 2030[9]. The timely roll out of smart grid could, therefore, be important from the perspective of recouping the cost and realising the full benefits from smart metering.

8 DECC Smart metering impact assessment

9 This assumes that just over 50% of benefits accrue to electricity meters

Smart meters as an element of smart grid

Smart meters are an essential element of smart grid – they are a critical source of fundamental grid management data, notably detailed consumption (flow) monitoring (possibly in near-real time) and outage detection. Meters could also be enhanced, at relatively low cost to provide power quality monitoring and other smart grid data.

The relationship goes further than just the provision of grid operational data: a major driver for mandating smart meters is to encourage consumers to change their behaviour around energy usage. The Smart Metering Impact Assessment projects a small enduring reduction in consumer usage and an element of load shifting, purely as a result of the introduction of smart meters. However, it also acknowledges potential for much larger benefits from more advanced dynamic and time of use (ToU) tariff models, enabled via (smart grid) demand response (DR) techniques, which would be part of the smart grid business case. But realisation of these smart grid DR benefits depends upon smart metering to record the outcomes - if you can't measure the actual response then you can't effectively monetise and incentivise it.

So an important element of the smart grid business case effectively depends on smart meters having been fitted. Conversely, it is argued that some of the 'promise' of smart meters may not really come to fruition without the development of smart grid propositions. For example, significant benefits are assumed from reduced inbound enquiries to suppliers, but these will be at risk if network performance issues emerge. Given these strong interdependencies, there is ongoing work, within the SMIP, and with the support of the Energy Networks Association, to establish a suitable collaborative solution, including consideration of the financial aspects.

The two are also co-dependent in a more subtle way. If consumers form a negative view of smart meters, this will likely translate into a negative view towards smart grids, either through direct association or simply because their view of the entire energy industry worsens.

3

Benefits across the supply chain

The broader benefits associated with development of the smart grid supply chain

Key findings

The expenditure required to deploy smart grid is likely to result in economic benefits across the supply chain:

- Approximately £13bn of Gross Value Added between now and 2050
- An average of around 8,000 jobs will be sustained during the 2020s rising to 9,000 during the 2030s.
- Exports could be worth £5bn between now and 2050.
- Benefits from export of intellectual property and foreign direct investment may also result.

How the £23bn for smart upgrades is spent

3.1

Economic impacts across the supply chain

As the £23bn of expenditure on smart grid investments permeates throughout the economy, this will flow along the supply chain and multiply. This section outlines the possible economic impacts of this spend for Britain, based on EY economic modelling, described in the box below. It does not include analysis of the impacts that this has on enabling secondary industries such as EVs to grow, which is considered in chapter 4.

Economic impact assessment methodology

Our approach focuses on the contribution of smart grid deployment to the British economy in terms of Gross value added (GVA) – the economic value to Britain of the expenditure on smart grid.

We calculate the direct, indirect and induced impacts on the economy, as defined below:

- The **direct** impact on the economy considers the impact from increased activity resulting from expenditure on smart grid along the supply chain.
- The **indirect** impact calculates the effect of this investment on the purchases of intermediate inputs and capital goods from a variety of other British industries.
- The **induced** impact considers the personal purchases of employees and business owners from the additional income generated in the supply chain.

We use 'UK input-output tables', which set out the relationships between different sectors of the economy. This is used to capture economic interdependencies within the smart grid supply chain and the wider economy, and thus to calculate indirect and induced impact on output. In order to do so, the smart grid supply chain is divided into economic sectors included within the input-output table. These components are then adjusted for the domestic share of the supply chain.

It should be noted that this is a gross analysis. It does not assess how else this money could be spent and whether it would deliver more value put to a different use. Its primary focus is to help readers to understand how this money flows through the economy and translates into employment potential and other metrics.

At its peak the deployment of smart grid would support around 12,000 jobs annually.

Overall economic impact

Spending £23bn NPV or £40bn cumulatively (undiscounted) on smart grid investments is estimated to produce economic benefits to Britain of around **£13bn NPV over the 2012-2050 period**[10]. This assumes that a portion of the investment will be spent on imports, just over 40% in line with current import ratios.

The level and timing of these economic benefits will be very much determined by the speed and timing of smart grid deployment. At the time this analysis was conducted, we did not have access to the specific time profile that SGF had used. We instead assume that there will be a progressive deployment of smart technologies somewhat in advance of the uptake of EVs / heat and renewables / DG that is set out by the SGF evaluation framework, in order to make sure that the grids are prepared. Under these assumptions, greatest benefits will occur in the 2020s and 2030s, as illustrated on the chart 1.

Since undertaking our analysis, we have received details of the deployment profiles used by the SGF, which assume a later investment than our modelled scenario. However, we consider that our modelled profile may be more representative of a likely deployment in practice, since it aligns broadly to uptake in demand, but unlike the SGF profile it does not assume that DNOs can perfectly match their deployment to a 'just enough, just in time' schedule.

The peak annual economic impact of smart grid deployment is expected in the middle of the 2020s – around £1 billion GVA per annum. Whilst the overall economic impact is not so significant at the national level (less than 1% of total UK GVA), it represents between 1% and 3% of the total power sector GVA. Also shown above, around 44% of the benefits will accrue to the direct supply chain, with a substantial portion falling to intermediate goods and services manufacturers.

Employment impact and skills requirements

The employment benefits of smart grid deployment are shown in chart 2. As most of the jobs generated by the deployment of smart grid are related to the manufacturing and installation of grid technologies, the employment benefits are concentrated in the 2020s and 2030s. In the peak year, the deployment of smart grid would support around 12,000 jobs. Employment levels decline towards the end of the period but given the progressive roll-out assumed, a relatively substantial number of jobs will be supported throughout this period.

The direct employment impacts will be associated with the addition of new skilled labour to the utility and network sector such as engineers and IT experts and also the transition of displaced lower-skilled labour. Indirect employment impacts would be associated with consultants and contractors, manufacturers of equipment, IT, communications, software and associated materials.

Economic benefits across the supply chain

To understand which parts of the supply chain will benefit from this increased activity, we have made a preliminary estimate by taking representative cost allocations from a number of sources including the DECC August 2011 Smart Meter Impact Assessment (SMIA) as well as assumptions taken from University of California, Berkeley, on the costs of smart grid[11]. Based on these assumptions, **57% of the economic value is likely to be generated in the manufacturing part of the supply chain and 27% in the ICT sector.** This split is set out by the chart to the right.

We discuss overleaf the possibility that these sectors may be able to gain a greater share of this market by taking advantage of Britain's relatively strong position in this area.

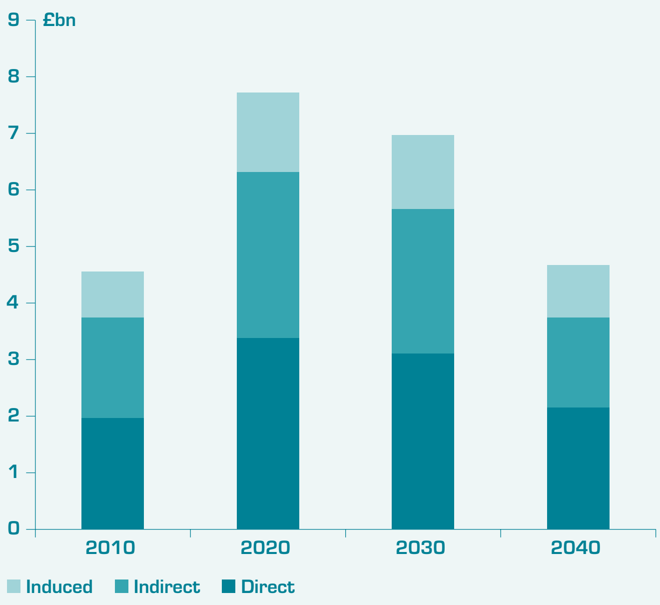


Chart 1: Total economic impact of smart grid per decade (real undiscounted GVA in £bn)

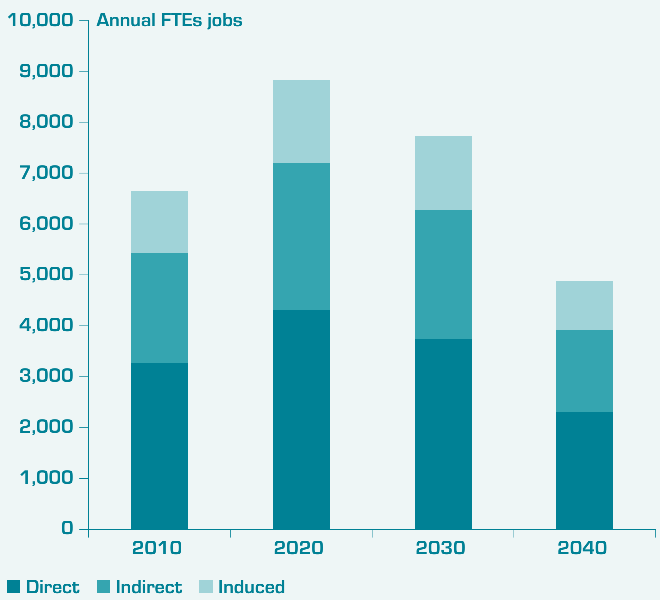


Chart 2: Employment – average annual FTE by decade and by type

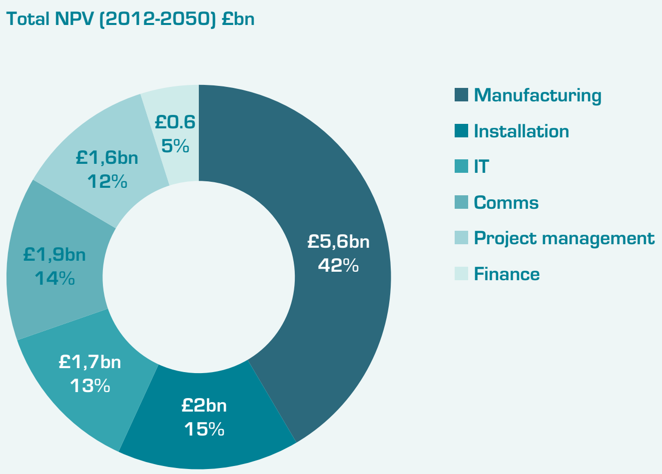


Chart 3: Total economic impact by value chain components

[10] The total NPV is calculated as the sum of all economic benefits for the entire period and discounted at the social discount rate of 3.5%

[11] http://ei.haas.berkeley.edu/c2m/MEMS_Sensors.pdf

Export potential

The economic benefits from the deployment of smart grid are also expected to translate into an increase in the level of goods and services exported: currently Britain exports around 13% of total goods and services produced, with the power sector exporting less than 1% compared to say the manufacturing sector exporting around 20%. Overall, assuming a similar propensity to export for smart grid technologies as that of the relevant supply chain sectors, we would expect a gross increase in the value of goods and services exported to around £220mn per annum over the 2012-2050 period or a **total NPV of £5bn,** with 75% of such exports coming from the manufacturing component of the supply chain.

In addition to the potential to export additional goods and services, Britain could also export Intellectual Property (IP). The nature of smart technologies is quite different from traditional traded goods and services and many interviewees cited the trading of intellectual property rights and systems based technology (e.g. demand response management systems) as some of the most significant opportunities for Britain. These potential IP benefits will be additional to the export benefits quantified above. Although we have not attempted to quantify these specifically, the potential may be large. A recent review of IP in relation to the 'digital opportunity' in Britain[12] suggested that changes to IP systems in the UK could add up to £7.9bn to the UK's economy. This highlights the potential importance of IP to Britain.

Interview results suggest that seizing this export potential will depend on Britain making a timely entry into this market, if we do not want to lose out to other countries. For example, the value of services that could be exported from the power sector specifically could be much greater than the figures estimated above if Britain has implemented smart grid at the front of the pack and can export this consultancy expertise to other countries. Equally, by gearing up early, the opportunities from IP export potential can be maximised. These opportunities are discussed in chapter 5.

Foreign direct investment (FDI) potential

Britain could also benefit from FDI. Britain already attracts the most significant level of venture capital investment in cleantech in Europe: up to 2010 around 20% of VC investment in energy efficiency and smart technologies in Europe went to Britain. We have not attempted to quantify this potential for investment into Britain on smart grid, but it should be recognised as additional to the opportunities presented above.

Britain has some key characteristics that makes it appealing to FDI. These include, but are not limited to:

- a relatively stable regulatory environment compared to other markets.
- action taken to support the low carbon agenda in Britain, and associated action on smart grids, is seen to be some of the most definitive and concrete in the field.
- Britain is a good place to do business, owing to the size of its energy market and its unique non vertically integrated, disaggregated structure, as discussed in section 5.1.
- UK could be a strong test bed for global scale, cutting edge technologies as discussed in section 8.4.

These factors, in addition to many others, mean that Britain is in a relatively good position to benefit from foreign direct investment in the smart grid sector should we move ahead in a timely manner.

[12] http://www.ipo.gov.uk/ipreview.htm

The trading of intellectual property rights and systems based technology are some of the most significant opportunities for Britain.

4

Benefits from secondary industries

The significance of smart grid for secondary industries

This chapter looks at the significance of smart grid in realising the broader benefits associated with secondary industries, in particular those which will deliver the Government's decarbonisation aims.

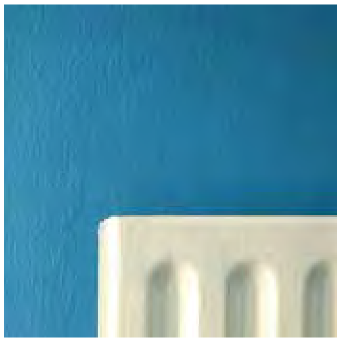
Key findings

- The smart grid will play an important role in facilitating the growth of a variety of 'secondary' industries including electric vehicles, heat, renewables and distributed generation. This will not only help Britain meet its carbon targets but could also lead to economic growth in these industries.

Value of secondary industries (undiscounted annual expenditure)

	2030	2050
Electric Vehicles	£25 - 60bn	£46 - 214bn
Distributed generation	£1 - 4bn	£3 - 41bn
Heat	£17 - 26bn	£21 - 46bn
Renewables	£7 - 25bn	£5 - 28bn

- A summary of this potential value is set overleaf.
- EY analysis of the potential impacts on the British economy suggests that the total (direct, indirect, induced) GVA for the EV sector to Great Britain could be £17bn in 2030 and £52bn in 2050.



4.1 Economic value of secondary industries

The value associated with the development of a number of secondary industries could be significant and smart grid can help to drive this value for Britain.

As discussed in the appendix, smart grid can play a significant role in facilitating the development of 'secondary' industries, particularly those which aim to deliver decarbonisation and electrification of energy.

This has two key benefits:

1. It will enable the UK to meet its carbon targets – see section 6.1 for a discussion of the risk and associated cost of the UK not meeting its carbon targets
2. There will be economic benefits from the development of these industries and associated supply chains as well as any export potential

The value associated with the development of a number of secondary industries could be significant and smart grid can help to drive this value for Britain. A lack of action on smart grid, conversely, may prevent the full value of these from industries from being attained.

Some estimates associated with the value at stake from a number of secondary industries are set out below. These are taken from the 'renewables, higher electrification' scenario in the DECC 2050 pathways cost analysis[13].

This is broadly consistent with the SGF evaluation framework estimates. The figures represent the undiscounted expenditure required only; they do not account for whether this money will be primarily spent on imported goods or on goods manufactured in Britain. They do, however, give an idea of the value associated with these industries.

There will also be value in the customer products and services industry which is likely to grow as a result of smart grid.

These numbers are relative substantial compared to the size of the smart grid direct spends, and provide a further reminder on how critical a role distribution grids play in the wider economy. However, it is important to note that this economic value in these sectors will not necessarily be additive as it will be, to an extent, replacing the existing industries. For example, the value from the growing EV industry will be at the expense of a declining traditional automotive industry. However there is a need to be on the front foot to ensure that GB continues to maintain its presence in these markets and supporting the continued growth of these industries. Smart grid is seen as an important enabling technology for this purpose.

13 http://www.decc.gov.uk/en/content/cms/tackling/2050/2050.aspx

Electric vehicles

The costs of EV uptake estimated by the DECC 2050 pathways analysis are broadly consistent with the assumptions made in the SGF evaluation framework report. The EV capital and operating costs could be between £25bn – £60bn in 2030 and between £46bn and £214bn in 2050.

Electric heat

The costs of domestic electric heat uptake estimated by the DECC 2050 pathways analysis are broadly consistent with the assumptions made in the SGF evaluation framework report. This concludes that the electric heat capital and operating costs could be between £17bn and £26bn in 2030 and between £21bn and £46bn in 2050. These figures are not discounted. They represent the expenditure required only; they do not account for whether this money will be primarily spent on imported goods or on goods manufactured in Britain.

Distributed generation

The costs of the PV panel uptake estimated by the DECC 2050 pathways analysis are broadly consistent with the assumptions made in the SGF evaluation framework report. The solar panel capital and operating costs could be between £1bn – £4bn in 2030 and between £3bn and £41bn in 2050.

Renewables

Taking the markets for on-shore and off-shore wind estimated by the DECC 2050 pathways analysis high electrification and renewables scenario suggests that capital and operating costs could be between £7-£25bn in 2030 and between £5bn and £28bn in 2050.

4.2

Economic impact of EVs on Britain

The potential expenditure that will be required to develop the industries set out will have an impact on the economy, particularly if part of the supply chain is based in Britain. Using an EY economic model, similar to that used to calculate smart grid benefits, we have analysed the market for EVs in Britain to assess the economic impact from a large scale deployment on Britain. We make assumptions about the level of imports which is assumed to be consistent with sector averages.

Our analysis is based on SGF evaluation framework's assumed EV take up over the 2012-2050 period. This assumes a total number of 6.3m EVs in Britain by 2030 and 24m by 2050, approximately 18% and 60% of vehicles on the road respectively.

Impact on the EV supply chain

£16.5bn GVA in 2030
£52bn GVA in 2050

130,000 employees in the 2020s
470,000 employees in the 2040s

+

Export potential

The implications for the impact of EV on Britain economy of such a large EV penetration are significant:

- The total (direct, indirect, induced) GVA for the EV sector is £16.5bn in 2030 (0.93% of UK GVA) and £52bn (2% of UK GVA) in 2050.
- There could be 130,000 employees in this sector during the 2020s and up to 470,000 employs in the 40s.
- Similar to the impact of smart grid, the economic impact of the electric vehicles market is going to be incremental and increase over time - as the deployment and penetration of EV increases.
- The economic activity generated by the maintenance and operation of EV represents approximately 58% of total value against a manufacturing share of around 39%

This demonstrates that there could be significant value to Britain from the establishment of an EV industry in Britain. We would expect to see similar benefits from the emergence of other secondary industries.

5

Maximising wider opportunities

Additional opportunities that the British supply chain could capture from the timely roll out of smart grid

Key findings

- Great Britain has additional opportunities to maximise the domestic share of smart grid and secondary industry spend, as well as to export goods, services and IP potential.
- A timely deployment of smart grid will be important in building Britain's comparative advantage to achieve this and will help to build on current momentum built by the LCNF trials.
- Britain is not the only country with a growing smart grid reputation and other nations are investing aggressively in this area. In turn, the time available to take advantage of this opportunity is likely to be limited. Timely action is therefore required.
- These opportunities to benefit supply chain players need to present a good investment case for the economy as a whole. Two factors move the debate in this direction. Firstly, that major opportunities for Britain are likely to be service based and therefore have lower associated start up costs. Secondly, that in the current financial climate, deployment costs are likely to be minimized and may also spur economic growth.

5.1

Increased opportunities from timely action

The economic benefits set out in the previous two chapters are those which could accrue to Britain assuming that Britain undertakes domestic activity and exports in line with current import / export ratios. However, Britain has an opportunity to develop these sectors to a point where it is surpasses these standard import / export ratios. In particular there are opportunities to:

- **Maximise** the domestic share of Britain's smart grid and secondary industry deployment
- **Maximise** the level of export goods, services and IP potential to other countries as they deploy smart grids and related industry opportunities.
- **Maximise** inward investment from overseas companies (knows as foreign direct investment or FDI).

Facilitating the opportunities: timely deployment of smart grid is fundamental

How well Britain is able to do in these areas will depend to some extent on the existing comparative advantage that Britain has in the sectors that are required to deploy smart grids and secondary industries relative to other countries. This will be influenced by factors such as relative labour and capital costs, expertise and reputation. Some of these will be more or less fixed, such as employment costs. For others, the Government could play a proactive role to enhance Britain's comparative advantage, through for example, subsidization and the creation of clear and coherent policies.

But probably the most important element that is likely to determine the extent to which Britain benefits from these additional opportunities is the timing of the nation wide roll-out of smart grid.

A timely roll-out of smart grid would enable a number of things to occur:

- **Expertise can be gained:** companies can research, develop and commercialise their products and export products or IP, a light manufacturing base could be established, and consultants can export implementation or operational expertise
- **Skills can be developed:** smart grid requires a range of technological, engineering and ICT skills.
- **Global reputation can be built:** a timely roll-out will encourage other countries to look to the UK for best-practice and advice.
- **Secondary industries will be enabled.**

These will all help to build Britain's comparative advantage in this sector. Conversely, a delayed roll out will allow other countries to take advantage of these opportunities and Britain could end up being a net importer rather than exporter of smart grid expertise, technology and services. By prioritising smart grid rollout, Britain could become a net importer of smart grid technologies.

Britain's current strengths and the momentum that this could bring

Interview results suggest that Britain enjoys a number of strengths which could stand it in good stead to benefit from the timely deployment of a smart grid.

1. Positive Government and regulatory initiatives are underway

- The Government has recognised the potential need for Britain to progress with smart grid and is starting to address this area of policy.
- The LCNF continues to provide a very significant support for further innovation, research and trialling. British networks have good access to funding to help them progress. The introduction of RIIO, with its emphasis on innovation should provide some further support.

2. Legally-binding carbon budgets seen as strong intention to deliver decarbonisation and electrification

- The Government's energy strategy and carbon plan create a very strong expectation that smart grid drivers will increase at a pace greater than most other markets. Renewable generation, energy efficiency, electrification of transport are all policies which can be facilitated by smart grid approaches.

3. Structure of British energy market

- The complexity of the British energy market drives the development of the most advanced solutions, both in terms of regulatory / market rules and operations and in the technology solutions that support them. These factors combine to create a perception among the global industry that if something can be made to work well in Britain, then it will readily meet the needs of any other market. Britain is therefore perhaps the ultimate development site and the ultimate reference for a successful deployment.

4. Specific areas of expertise and capability

- Britain has very strong academic research capabilities, with a global reputation, particularly in relation to electricity networks. British academics are also commercially minded and understand innovative business models and customer engagement which can be used to develop skills in overseas markets using academic rigour backed by commercial integrity.
- Data and grid management is viewed by interviewees as presenting some interesting opportunities for British companies to develop and export. This includes visualisation of data management and how you engage with consumers such as through GIS mapping.
- Selling of services and consultancy in this area will also create value for Britain; becoming specialists in smart grid will enable GB's talent hub to be exported elsewhere.
- Britain is also second worldwide in services exports (with 5% of the global market following the USA), and third in exports of royalties and licensing fees (with 7% of global market - $14.2bn annually - Britain is the largest European service exporter, but is behind USA and Japan).

There is a sense that there is significant momentum in the UK at the moment from the LCNF projects which has helped to boost the UK's reputation on smart grid. The LCNF is known internationally, and is regarded by many as a leading example of how a Government should encourage smart grid development. There is a perception that Britain is a market in which opportunities will arise early, and in which solution providers may be able to develop and test their ideas.

International progress towards smart grid

Britain is not the only country with a growing smart grid reputation and other nations are investing aggressively in this area. Over the last few years, smart grid has become a topic of discussion around the world. Governments and organisations are developing their smart grid strategies or plans. Therefore if Britain wants to be in the strongest position to benefit from these opportunities, we need to consider timely action.

Against this global backdrop, GB is currently in a healthy position, sitting amongst the leaders as a result of initiatives such as the LCNF. But despite this, it is clear that a select few other countries are also starting to focus on smart grid, and could easily take a substantial lead if GB rests on its laurels. See the boxes below for selected international examples of progress.

South Korea

The South Korean Government aims to implement a nationwide smart grid by 2030, with several precisely defined targets around network reliability, household energy sufficiency and EV roll out. There is also a large smart grid demonstration project on Jeju Island. South Korea has an ambition which goes beyond energy security and efficiency, and sees the development of smart grid technology and IP as a major opportunity to further developing its technology exports.

China

Smart grid development is being driven by government investment, as laid out in Five-Year Plans, with approximately £400bn to be invested by 2020. The massive ongoing and anticipated growth in electricity demand, and the consequent need to build largely new generation and transmission / distribution infrastructure, provides very large incentives to optimise grid investment via smart approaches. China is also rapidly becoming the global leader in smart meter implementations. Industry figures for 2011 suggest that over two-thirds of global smart meter installations were in China, and analysts report that the State Corporation of China will reach a cumulative figure of 300M by 2015.

USA

The US Government has identified smart grid as a key element in both energy strategy and the economic prospects for the country. Smart grid was given an immense boost by the provision of $4.5Bn of matched stimulus funding for smart grid investments under the American Recovery and Reinvestment Act. This money, awarded under a competitive mechanism has created a surge of activity in smart grid trials and implementation projects, which in turn has enabled large investments within the technology supply chain.

The Government's energy strategy and carbon plan create a very strong expectation that smart grid drivers will increase at a pace greater than most other markets.

If Britain wants to be in the strongest position to benefit from these opportunities, we need to do more now.

How strong is the case to move quickly?

As demonstrated in chapters 2, 3 and 4, the benefits are compelling and the case for moving forward is strong: To recap:

- The direct benefits of moving now on smart grid development could deliver £19bn NPV to 2050 whilst the potential downside to starting now ranges from £0.2bn to £1bn. These figures alone make a compelling argument in favour moving forward.
- The expenditure required to deploy smart grid in the UK could result in economic benefits across the supply chain of approximately £13bn GVA, an average of around 8,000 new jobs throughout the 2020s and 2030s and additional exports of around £5bn.
- Smart grid will play an important role in facilitating the growth of industries including electric vehicles, heat and renewable generation which have significant economic value. For example, benefits across the EV supply chain alone could generate £17bn GVA in 2030 and £52bn in 2050 to Britain.

However it is necessary to consider the economy-wide picture to determine the overall merits of immediate action. This requires the benefits of a particular deployment scenario to be weighed up alongside the costs and the overall impact on the economy considered.

- First mover benefits including export opportunities and associated supply chain development are likely to be relatively high. On the other hand, costs will include those associated with R&D, learning, piloting, making mistakes and developing industries.
- Being a 'fast follower', could allow a nation to build on other's learnings in order to generate a superior product or service offering at lower cost which could then still have export or deployment potential.
- However, being a 'late adopter' would eliminate most export potential and may mean that Britain imports most of its solutions. All the first mover costs will be eliminated but so will be benefits in terms of building a supply chain in Britain and the wider economic benefits of that.

From all of these findings, it is relatively clear that failure to move ahead with smart grid development could result in Britain losing out on many of its wider benefits. What is less clear, is determining how quickly Britain should take action to ensure the relative cost-benefit trade-offs are maximised. This will depend on factors discussed on the previous page such as Britain's comparative advantage. There are two further factors that lend support to early action on smart grids.

- Interview respondents believe that the major opportunities for Britain lie in IP and services export potential. The cost of setting up a service industry is low relative to, say, a manufacturing industry. This suggests that the net benefits associated with taking early action to deploy smart grids will be relatively strong compared to a decision to try and lead the field in a heavy manufacturing-based industry, for example.
- With the current weakened economic climate, now would be a relatively cheap time to deploy smart grids: Wages are lower and there are economic resources available in the economy so expenditure is unlikely to drive inflation. This expenditure will also help to spur economic growth in the economy.

6

The costs and risks of inaction

The missed opportunities or potential risks of delaying the development of smart grid

Key findings

- If a smart grid is not deployed, industries along the smart grid supply chain may not be able to benefit from these emerging industry opportunities and any 'first mover' opportunities that British industries may have could be lost.
- A smart grid will play an important enabling role in the smooth and timely development of the cleantech industries needed to reach GB's challenging carbon targets. If a conventional grid stunts these industries GB could end up spending large amounts of money buying international carbon credits to reach its targets: At an extreme level, the cost of this could reach £126bn NPV over the 2012 – 2050 period.
- The cost of energy is likely to be higher with a conventional grid: indicative estimates suggest cost could be greater by approximately £20 per household in 2030 and £65 per household in 2050.
- Due to the changing pattern of electricity consumption, simply building a bigger network could have very significant drawbacks including huge cost, major disruption, and the risk of making unnecessary investments.

The previous few chapters have considered the benefits that could be achieved through implementation of smart grid. This chapter takes the alternative view of looking at the possible consequences of not investing, in an attempt to ensure that a fuller picture is revealed. We have very deliberately taken a different approach in order to minimise the risks of the "double counting" that could arise if the issues looked at here were simply the opposite of the benefits previously analysed. We have adopted an alternative lens of looking particularly at the risks, and we believe that this does highlight aspects that are not apparent in the 'baseline' approach intrinsic in benefits modelling.

In principle, a number of risks associated with the non-deployment of a smart grid can be identified. These include four specific risks:

- We fail to meet our carbon targets
- The cost of energy will rise with only conventional investment
- Network performance deteriorates without a smart grid
- Lack of a smart grid inhibits the growth of secondary and supply chain industries and associated export potential - this was already discussed in chapter 3,4 & 5.

In the pages below we discuss the remaining three of the four risks identified above. In practice, it is far from easy to establish the degree of risk they pose and what cost may be associated with this. Indeed, our interview process has found opposing views as to whether one specific risk – power outages – would increase or decrease as a result of having smart grid. This situation is further complicated by the fact that Britain is starting from a relatively strong position in terms of its grid capabilities and reliability which makes the risks associated with non-deployment of a smart grid less obvious, particularly when the probability of some of these events is relatively low but the possible impact is high.

6.1

Failure to meet British and European carbon targets

If customers do not have faith that their EV can be connected to the grid without problems they may be less inclined to take up that option.

The British Government has committed to reducing its carbon consumption by 80% on 1990 levels by 2050. To achieve this, Britain is likely to need to almost totally decarbonise its energy system via a move towards renewable and distributed generation and significant electrification of heat and transport. DECC has acknowledged the importance of a smarter grid in this process:

transforming our electricity system lies at the heart of these changes. Integral to this transformation will be an electricity grid that is fitted with more information and communications technology progressively over time" and that "we will need a modernised electricity grid with larger capacity and the ability to manage greater fluctuations in supply and demand, while maintaining security of supply[14].

If secondary markets such as renewables or electric heat do not develop, or are delayed because a smart grid is not deployed, then this challenging and time-critical target may become unattainable. There are a number of specific links between the emergence of smart grid and meeting our carbon targets, including that smart grid will:

- facilitate a quicker connection of renewable generation onto the network
- facilitate more low carbon technologies to connect with less complications
- facilitate the connection of distributed generation to the low voltage network
- be able to better manage the fluctuating demand and supply on the network

With a conventional grid, however, there are a number of issues:

- **Reliability of network:** Without a sophisticated monitoring system on the low voltage network, it will be difficult to detect when the network will overload as more consumers connect distributed generation or switch to electric heat or vehicles.
- **Timing of connection:** A conventional grid's ability to react to any overloading in a timely manner is limited. Reinforcing the grid in this manner has a long lead time.

These two aspects could make the take up of these low carbon technologies, both on the demand and the supply side, less attractive. For example, if customers do not have faith that their EV can be connected to the grid without problems they may be less inclined to take up that option. Equally, renewable energy companies may shift their investment from GB to another country if they perceive GB to be higher risk in terms of connection times, costs and reliability.

Without these industries, it will be incredibly difficult to meet the Government's challenging carbon target. Of course, if GB fails to meet the necessary carbon reductions domestically, the Government has the option of buying international credits to cover their carbon obligation, but this is likely to be extremely expensive, and far outweigh the cost of implementing a smart grid.

As an indicative illustration of the cost implications of this, we have compared the emissions associated with SGF's smart scenario of high electrification / decarbonisation, which we believe to be consistent with the Government's 2050 vision, with the projected emissions within SGF's conventional low uptake scenario[15]. Using DECC estimates of future CO2 prices to calculate the costs of missing the targets, the cost of covering the 'emissions gap' between the two scenarios would be £25bn (undiscounted) in 2050, or a total NPV of £126bn over the 2012 – 2050 period[16].

This is clearly a broad brush estimate, but it gives a sense that the quantum of expenditure required to meet the Government's targets in the absence of these industries and assuming no emissions reduction occur outside the power sector, could far outweigh the costs of smart grids. Moreover, this money would flow out of GB rather than being used internally to promote economic growth.

In additional to the cost implications noted above, failure to progress smart grids in a timely fashion could also have an adverse effect on security of supply. Failure to progress smart grids could impact on the growth of renewable and distributed generation, potentially resulting in a less diversified energy mix and a greater reliance on imported fossil fuels.

14 http://www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/futureelectricitynetworks/1_20091203163757_e_@@_smartergridsopportunity.pdf

15 To do this we compared the energy demand and generation mix under two different scenarios and estimated the CO2 emissions implied in each scenario. We then assessed the gap that other non-power sector technologies in the conventional scenario would have to fill to meet the targets. Note that these estimated costs are not necessarily reflected in the final household energy bill as some of the costs savings would be accrued in the commercial and industrial sector (in 2010 residential electricity consumptions was only 35% of total). Our estimate, on the other hand, shows the savings in 'system cost' per household.

16 In the conventional scenario by 2050, emissions from the power sector would be equivalent to 140MtCO2 whilst in the smart scenario emissions would be 15MtCO2.

6.2

Higher cost of energy

Britain spent approximately £30bn on the electricity system in 2010. Using DECC assumptions with regard to future demand and prices, the total electricity system costs in 2030 are estimated to be approximately £63bn by 2030 and £103bn by 2050.

As set out in chapter 2, building a larger conventional grid will be significantly more costly than deploying a smart grid to meet energy requirements. As a simple illustration of the magnitudes of savings involved, if the deployment of smart grid were to reduce final consumption in 2050 by 1%, system costs would be £1bn lower in 2050 or a total NPV of £5.7bn between 2012 and 2050. Similarly, if the deployment of smart grid were to reduce the unit costs of electricity prices by 1% over the same period, system costs would be around £1bn lower in 2050 or a total NPV of £6bn over the period.

Based on SGF evaluation framework scenarios, continuing to deploy conventional rather than smart technologies will increase total system costs by around £1bn in 2030 and £4bn in 2050. This translates into approximately £20 per household in 2030 and £65 per household in 2050 assuming cost pass through and that costs are spread across both household and non-household grid users[17]. To the extent that the SGF evaluation work proves conservative, so does this estimate.

The additional costs to Great Britain of higher energy prices will be compounded by the additional effect that an increase in energy prices will have on the commercial and industrial sectors – increasing input factors cost will decrease productivity and therefore economic activity. There is a wide literature on the economic impacts of a change in energy prices – see for example a recent working paper by the Bank of England on the subject[18]. It shows that the final impact on the economy from changes in energy prices is very much dependent on the size of the shocks and particularly on the response by monetary policy authorities. It is therefore difficult to estimate the final impact that changes in electricity prices due to a smart grid may have on commercial and industrial productivity and on the final output. We would expect, however, the impact to be positive.

[17] All these figures are real undiscounted figures.

[18] Bank of England, The impact of permanent energy price shocks on Britain economy, 2011.

6.3

Possible impacts on network performance standards

As discussed in the appendix, the essence of the smart grid challenge is the change in the way that consumers are forecast to use electricity in the future. Energy demand is predicted to grow significantly and usage patterns will change, but exactly how and when this will happen is extremely uncertain. As a result of these factors, what might seem the obvious solution - to simply build a bigger network - could have very significant drawbacks including huge cost, major disruption, and the risk of making unneeded investments.

A range of themes are being explored via the LCNF projects in order to find alternative approaches. Improved measurement, monitoring and control techniques can all help to reduce the number of faults and reduce the impact of those that do occur. Alternatively, other aspects of smarter grids might result in some increase in outages, for example if demand side response failed to materialise as expected. And irrespective of which approaches are chosen, the way in which consumers actually use the grid and the speed with which this changes, will also have a major bearing on the performance that actually results. This underlines how difficult it is to predict how smarter grids will impact on performance standards relative to today's circumstances.

However, the comparison needed here is arguably different. The relevant question is what might happen if the changes in the quantum and pattern of energy take place without the investments in smarter grids having been made.

Ideally, it would be possible to project the cost of inaction as follows:

Expected cost of inaction =
probability of adverse events x cost of each event.

Given the myriad uncertainties and limited time available for this report, we have not attempted to explore the probability of adverse events in any depth. However, there is some useful comparative data on a number of major outages in OECD countries over the past ten years. For example:

- The North East USA blackout of 2003 is perhaps the most memorable, having impacted 50 million consumers at an estimated cost of US$6.4bn. Although caused by transmission rather than distribution network issues, and of an exceptional scale that compares with blacking out the entire British mainland, it serves as a useful point of reference.
- Perhaps more comparable still is a 12 hour outage in San Diego in 2011, which affected approximately two million customers and was estimated to cause a permanent local economic loss in the region of US$100M[19], consisting of food spoilage, Government overtime costs and lost productivity. This feels more akin to the size of impact that could be expected in the event of a severe blackout in GB.
- Another interesting data-point comes from an EPRI (2009) study on the benefits of smart grid. They estimated the cumulative avoided costs of interruption from the smart grid to the US to 2050 would be £39bn (undiscounted) or £7bn (discounted at 3.5%). However, given the US has a significantly less reliable grid than ours, due to much lower redundancy and higher target utilisations, it is difficult to attach any degree of confidence to this number.

19 National University System Institute for Policy Research's "Back of an envelope" analysis

7

Challenges

How to make progress despite complexity and uncertainty: a summary of interview responses

7.1

The dominant challenges: complexity and uncertainty

Key findings

- The dominant challenge is the sheer complexity of the smart grid debate and the uncertainty that surrounds most aspects of it.
- A measured, progressive approach is required; neither an aggressive plan nor a 'wait and see' approach are suitable
- There is concern about the ability of current or proposed mechanisms to deal with these complexities and uncertainties.
- Given current initiatives, expectations are that the adoption of smart grid is likely to be slow, with little investment before 2023.
- There are strong differences of view on the merits of this: Those DNOs interviewed were not greatly concerned about any increased degree of stress on networks before then. Other stakeholders suggested that such that a delay will not allow GB to capture the full value of the benefits that a smart grid could offer, and hence that further interventions are needed.

Concerns are not about the best destination but how we get there.

The interviews explored a number of questions about the challenges that were perceived to exist and the barriers that needed to be overcome in order to realise the economic potential of smart grid. The responses covered a very wide range of aspects, but looking at the responses as a whole, one specific theme dominates - the sheer complexity of the smart grid debate, and the uncertainty that surrounds most aspects of it. While we recognise that some readers might views this as a somewhat obvious conclusion, we think that it is nevertheless important since it has a strong bearing on what can or should happen next.

Multiple complexities

Some of the multiple strands highlighted included:

- The technologies that will be adopted by customers that will influence the demands they make of networks;
- The technologies that influence what networks can provide to customers;
- Interactions with other elements of energy policy;
- Understanding of the benefits created and whether they align with the costs incurred;
- The best market models and network service definitions to adopt.

Major uncertainties

Regarding the uncertainties, responses emphasised a number of themes such as:

- How quickly technologies will be adopted by customers;
- How quickly new technologies will provide new capabilities on grids;
- Future changes to energy policies, and whether the regulatory regime can adapt sufficiently quickly;
- The location and extent of clustering impacts on the networks;
- How smart meters and smart grids will interact and co-develop.

It is important to re-emphasise that despite the concerns on complexity and uncertainty expressed, all the interviewees believed that smart grid would deliver very substantial benefits – although perhaps unsurprisingly, no one was at all confident in quantifying these at this point. Those interviewed after the SGF evaluation framework was published saw the report as providing strong confirmation of this belief. And a number of interviewees also suggested that the early-stage results from LCNF projects were already adding a degree of further support to this view. So the concerns are not about the best destination but how we get there.

7.2

Are current mechanisms up to the challenge?

The challenges of relying on strong policy direction

A number of interviewees expressed a clear preference for strong direction from policy on smart grid, with some favouring a similar degree of mandate as has been used on smart meters. However, given the issues of uncertainty and complexity noted in the previous section, it is far from clear how this could be achieved.

Even if policymakers or regulators were minded to mandate the introduction of smart grid, the uncertainties observed mean that it is not yet possible for them to articulate exactly what this would mean on either the nature or timing of any requirements[20]. In any event, this would also run counter to the historic preference to let markets find their own solutions. (See box)

So partly through preference and partly through the lack of clarity on what smart grid actually requires, the focus will have to remain on using market and regulatory approaches for the time being. However it is important to recognise that this does not remove the uncertainties, it just transfers the immediate responsibility for trying to resolve them onto the regulatory process.

[20] For the avoidance of doubt, we should also make clear that we are not suggesting that either policymakers or regulators are presently so minded.

GB policy preference for market based solutions

GB energy policy has historically shown a clear preference for market based solutions rather than directive policies.

Inevitably, the existence of price control regulation and the natural monopoly status of networks has attenuated the extent to which market forces operate on networks. Overall however, the regulatory focus has been on efficiency and performance standards, rather than directing network developments.

One recent policy decision was to mandate the roll-out of smart meters for domestic customers. However prior to deciding on mandation, there was very serious consideration given to allowing the market to roll-out at its own pace. This reflected an expectation that there would be a "tipping point" after which having a smart meter became the norm and customers would self-select this option. So even here, the policy preference towards market based solutions was still present to a degree.

Information quality issues

Network regulation has often focused on the idea of an information asymmetry between the network companies and regulator. In the case of smart grid however, there are so many uncertainties around which no one yet knows the answers that the challenge for the regulatory process arguably becomes one of dealing with uncertainty, not asymmetry.

The new RIIO regulatory apparatus places significant onus on customer engagement, both to give the customer a more direct voice and to reduce some of the perceived asymmetries. Early feedback from network companies confirms the merits of this direction for the regulatory process as a whole. However, it is difficult for customers to understand how the transition to a low-carbon energy sector will impact on them and hence what their future needs of networks might be. Hence, the ability of further customer engagement to help deal with the complexity and uncertainty around smart grid is still something of an open question.

Adopting new regulatory mechanisms

Interview responses highlighted two particular themes here, the use of uncertainty mechanisms (sometimes also called re-openers) or adopting specific output targets on connection times for low carbon technologies. In principle, both of these types of mechanism can mitigate some of the uncertainty issues to a degree. However, a number of interviewees were rather doubtful about the practicalities of this.

As one interviewee observed, "What information will the regulator and companies use to set the connections targets, and what happens if they get them wrong?". Other interviewees observed that the uncertainty mechanisms did not really deal with uncertainty, they simply waited until the uncertainty went away. While this might be a somewhat harsh characterisation, it is certainly true that since the triggers for activating the uncertainty mechanisms also rely on the discovery of further information, their ability to anticipate rather than react to events is necessarily somewhat compromised. Hence overall, neither mechanism appears wholly convincing as a remedy for uncertainty.

7.3

Implications

It is clear that Britain is not yet in a position to go "full steam ahead". However, there are also significant concerns about not waiting unnecessarily.

"Full steam ahead" is not yet possible

Overall, there is a very positive outlook and strong confidence in the direction of travel. But as the interview results and supporting research indicates, the complexity and uncertainty surrounding smart grid means that at this point it is not yet possible to articulate what a policy decision to mandate smart grid actually means. And by a similar token, it remains extremely difficult for networks to know what will be required, or for the regulator to know what to approve.

Concerns over the current approach

The most significant smart grid investments are anticipated after 2023

The interviews showed an approximate consensus that in the absence of new events over and above current initiatives, the industry is gravitating towards major smarter grid developments being planned after the RIIO-ED1 period (i.e. after 2023). It is recognised that the work of the Smart Grid Forum will continue and that follow-on LCNF like mechanisms are expected, such as the Network Innovation Competition. Since networks are not starting from exactly the same situation or facing exactly the same challenges, some differences of approach between DNOs are also likely. However, the prevailing sense is more "steady as she goes" than "it's time for change".

Strong differences of view on whether this would be a good result

While there was approximate consensus about the likeliest path, there were strong differences of view about the merits of such an outcome. Those DNOs interviewed, tended to view this as a natural progression of regulatory requirements to demonstrate need ahead of investment and were not greatly concerned about any increased degree of stress on networks before 2023. They also expected there to be significant focus on uncertainty mechanisms within RIIO-ED1 to cover unexpected developments, and noted there was potential to revisit smart grid issues at the mid-point review. This would come at a time by which the smart meter roll-out would have progressed significantly, providing further information on grid usage. It was also suggested that the DNOs would be given new output targets for connection times for low carbon technologies, and these targets would ensure that low carbon developments were facilitated.

Other interviewees expressed rather greater levels of concern. There was a sense – particularly amongst the technology companies interviewed – that the relative leadership position of GB would be eroded and that an opportunity to capture potential export value would be lost. There was also some concern that a "wait and see" mindset would create risks to network reliability and power quality, and would make it even harder for industries such as EV and electric heat to realise their potential – with consequential impacts for the ultimate cost of achieving the GB carbon reduction goals.

The complexity and uncertainty surrounding smart grid means that at this point it is not yet possible to articulate what a policy decision to mandate smart grid actually means.

Concern whether current initiatives will build enough momentum

Given the observations that mass take up of those demand technologies with the most potential to disrupt current networks appears some way off, it is possible to argue that the best approach is one of "wait and see", continuing with the current cautious evolution path. With existing grids delivering high levels of security and performance, it is not easy to argue that they are currently delaying progress in decarbonising energy.

The interventions that have been made to date have been regarded favourably by interviewees, in particular the LCNF, which is seen as a key contributor to the favourable standing of GB in terms of international smart grid progress. The key question however, is whether additional interventions are required.

In this regard, the interview results highlighted a number of areas of concern. We suggest that three in particular stand out:

1. Concerns that the collective mindset remains one of "proving need and seeking optimal solutions" - which given the level of uncertainty and the challenges around the predictability and controllability of the smart grid, may unnecessarily delay the development of smart grid especially in the context of a newly extended eight or nine year price control review period;
2. Doubts as to how the types of output targets or uncertainty mechanisms being contemplated can be configured, and whether they can in fact be suitably scoped for an issue of this degree of significance;
3. Concerns that the overall approach may not recognise asymmetric risks, with the consequences and disbenefits of not progressing sufficiently being potentially an order of magnitude greater than the disbenefits of investing a little too early.

8

Solutions

Network standards, changes to the industry model, the perceived need to change mindset within the regulatory process and the development of capabilities

In discussion about how to move forward, four themes have emerged around network standards, changes to the industry model, the perceived need to change mindset within the regulatory process, and the development of capabilities.

Key findings

- Changes to current standards and rules are seen as an important avenue to explore, and one that need not incur major costs. Indeed some interviewees felt that they had the potential to deliver major financial benefits. These ideas may need to be progressed in tandem with other initiatives such as demand side response.
- Changes to the industry model need to be contemplated. For example, there are some complex questions around how demand side response can be made to work for energy and network purposes at the same time, and how this is shared between suppliers and DNOs.
- Changes to the mindset in the regulatory process also need to be contemplated. There is concern that the mindset will remain one of seeking the optimal solution and investing only once need has been proven.
- Some interviewees noted that risks are asymmetric with the consequences of doing too little potentially much larger than investing somewhat early. Interviewees therefore suggested that there needs to be additional focus on protecting customers by ensuring that there is sufficient investment in smart grid.
- Interviewees highlighted the importance of developing smart grid skills, both within DNOs and more widely along the smart grid supply chain.
- Interviewees suggested that it was important for there to be a step change in the scale of projects, with major pilot programmes using a number of approaches together, at a higher level of penetration and over a wider area.

8.1

Revisiting network standards

One interesting theme raised by several interviewees was the possibility of creating some additional flexibility within the current standards and rules without necessarily incurring major investment costs. There were several related ideas here:

- Non-firm connections are currently part of some of the LCNF trials, and it was suggested that such an approach could be extended to a much wider range of customers;
- The LCNF trials of revised network standards under fault conditions could be a further development in this direction, although that potentially differs in the degree of choice offered to customers;
- Modifications to the universal service obligations to create stronger processes to require notifications to DNOs before some types of equipment are connected – although again this differs in that it controls, rather than directly facilitates, new connections.

It was felt that some or all of these ideas could be progressed without necessarily incurring major costs. And even where the long-term case for implementation remains uncertain, they could provide the basis of time-limited derogations to allow space for additional learning.

Some interviewees expressed the view that the second of these ideas – operation under fault conditions - had the potential to deliver major benefits since it would effectively allow the spare capacity that provides resilience to faults to be used to carry increased network loads. As observed in chapter 7, this might be a more acceptable proposition if there is confidence that demand side reduction can also be used to ensure that consumers on a lower redundancy network do not experience a sizeable increase in outages.

8.2

Contemplating changes to the current industry model

A number of interviewees raised suggestions about the need to contemplate some changes to the way in which the industry currently works. For example, some of the early stage results from LCNF projects start to raise questions as to whether demand-side response to Time of Use (ToU) tariffs can deliver sufficient predictability and reliability to underpin decisions not to reinforce networks. The box to the right explores some of these issues in more detail.

These issues appear far from easy to resolve, especially since the DNOs are not currently organised to maintain frequent contact with a large number of consumers. So in addition to looking at the boundaries between the traditional supplier and network roles, there may also be a need to consider the potential for some form of new intermediary role around management of particular parts of network capacity.

Whilst the case for smart meters focuses on the benefits to energy suppliers, the smart grid case focuses on the benefits to networks.

Demand side reduction – for energy or for networks?

Demand-side response (DSR) forms an important part of the business case for the mandatory roll-out of smart meters, and is arguably also one of the most promising elements of smart grid. Whilst the case for smart meters focuses on the benefits to energy suppliers, the smart grid case focuses on the benefits to networks. It is therefore important to consider how DSR impacts each differently.

Energy suppliers will encourage a consumer to smooth their consumption via a price signal, in order to reduce the overall cost of wholesale energy purchase or to bid into the imbalance mechanism. In the event that a specific response is expected but does not materialise, the impact of this non-performance is relatively minor as adjustments can occur via the System Operator and imbalance mechanism. There may be a financial penalty as a result of the unexpected exposure to imbalance cash-out prices, but there should be no impact on the security or quality of supply.

Demand-side reduction also offers benefits to networks, but for quite different reasons. Networks are more concerned about reducing peaks at a localised level - for individual circuits under stress - rather than at a national level. Their benefits arise from maintaining reliability and quality of supply and from avoiding network upgrade investments. There are however two key differences with this approach:

- The impact of non-performance could be significantly greater, as it could impact on quality or even security of supply. So rather than sending a price signal and "hoping" that a consumer responds, the network may also want the option to make response a contractual requirement and / or to have this under its direct control. Alternatively, there will need to be a substantial period of response monitoring before they can have sufficient confidence to base future investment decisions on this.
- Locational granularity may need to be greater, requiring different prices at specific locations to reflect the specific local circumstances. Current DUoS charges vary slightly between the DNO areas, but the differences are small compared to the sorts of price signals that might be necessary to achieve demand response.

These issues highlight four questions as to how demand side response will work in future:

- Should the demand side response be under the control of the Supplier or the DNO, and how are the signals given to the consumer?
- How locationally specific should signals be?
- Should network signals come via ToU tariffs or other mechanisms (such as differential connections charges or period discounts on DUoS)?
- And finally, how can demand-response for energy and network purposes co-exist at the same time?

8.3 Changing regulatory mindset

Given the level of uncertainty already noted, the concern is that trying to find the optimal solution may unnecessarily delay the development of smart grid.

A number of interviewees expressed concern around the thought process that they expected to see in the RIIO-ED1 regulatory process. Their expectation was that the collective mindset would remain focussed on making investments only after the need to do so is absolutely certain. Moreover, the mindset would focus on seeking THE optimal solution and waiting until it became apparent what this would be.

As the box to the right explores, some elements of the historic Distribution Price Control Review (DPCR) approaches have focused particularly on protecting customers by authorising investments only once need is proven. And while this approach has worked reasonably well, the historic circumstances have arguably been very different from those now facing networks.

Given the level of uncertainty already noted, the concern is that trying to find the optimal solution may unnecessarily delay the development of smart grid, especially in the context of the newly lengthened eight or nine year revenue control period. Moreover, there is also a view that the approach may not recognise the potential for asymmetric risks – where the consequences and disbenefits of not progressing sufficiently could be an order of magnitude greater than the disbenefits of investing a little too early.

So the suggestion is that the regulatory process should adapt the mindset around customer protection to ensure that there is sufficient investment to protect consumers from potential materially adverse outcomes. For clarity, this should not replace the historic focus on efficiency and need, but work in tandem with it. Without this additional element of consideration, doubts as to whether even the new RIIO regulatory apparatus will adequately facilitate future smart grid develop seem likely to continue.

Historic regulatory approaches

Despite some degree of evolution, the five historic editions of distribution price controls have been based around a consistent core approach: protecting customers by seeking to ensure that investments are made only once the regulator is convinced of the need to do so.

This was visible not only in the overall review process around the company business plans, but also in some of the specific mechanisms used. The information quality incentive for example, created an incentive regime which rewarded or penalised the companies if their capex forecasts were below or above the regulator's own forecasts. The LCNF in DPCR5 did represent a degree of departure from this, but since the LCNF funding equates to only about 7% of total projected capex for the DPCR5 period, it is only a relatively small step.

This historical approach does seem to have worked reasonably well. Network quality standards have been maintained or improved, and while there may not have always between agreement between DNOs and Ofgem, disputes have rarely escalated to a Competition Commission referral. An acceptable balance seems to have been found.

However, these outcomes must be seen in the context of the circumstances faced during each review. Historically, DNOs have largely focused on using existing capacity headroom and improving asset management approaches to maximise usage of existing assets. It is only relatively recently that the majority of DNOs have started to focus on major increases in investment programmes to replace aging assets or increase headroom. And DNOs have also been operating in circumstances where demand growth has been relatively modest or at times even falling.

Access to innovation funding and the risk/reward balance faced by DNOs

There were also some suggestions during the interviews that companies other than DNOs should be able to access the innovation mechanisms. However, we think that there are formidable difficulties in facilitating this given both the absence of licencing controls, and the issues raised around public safety and network protection. In any event, a notable feature of the LCNF has been the extent to which it has encouraged partnerships to form on the projects. We also understand that Ofgem is already planning to sharpen the obligations on DNOs to consider approaches by interested parties.

There may however be a case for looking further at the way in which DNOs are rewarded for innovation. The LCNF encourages innovation by providing a degree of reputation enhancement from the award of LCNF projects, and by de-risking the financial consequences of experimentation for DNOs. This does not however incentivise the DNOs to actually apply the learnings to their networks or seek to move faster than others in delivering smart grids.

DPCR4 saw a limited mechanism to provide a degree of reward to those DNOs who invested in anticipation of future renewable generation connection. While recognising that developing an analogue for smart grid would be a formidable challenge even using the increased flexibility of the RIIO approach, such a device could encourage more rapid progress.

8.4 Developing capabilities

Interviewees highlighted two particular themes regarding future capabilities – ensuring that the necessary skills were available within the GB workforce, and considering how the LCNF (or its successor) might evolve in order to provide more complete and more expansive testing.

Availability of smart grid skills

Interviewees were generally very positive about the capabilities and potential of British firms (or British subsidiaries of international firms) in terms of developing smart grid technologies and techniques. However, there was a common concern about the challenges of resourcing smart grid developments and finding staff with the necessary mix of engineering, ICT and commercial skills. A number of interviewees observed that there are already significant shortfalls of experienced candidates across the entire smart grid supply chain (including the utilities) and a concerted, coordinated effort to develop the necessary skills would be highly beneficial to the overall development of smart grid.

While it was recognised that DPCR5 provided some funding for workforce renewal for the DNOs, there was concern that this was not designed with the challenges of smart grid in mind, nor does it help non-DNOs. As a result, issues about the mix of skills, and the speed with which they might be required were not addressed and so further focus would be needed. Some interviewees also suggested that a co-ordinated national approach covering DNOs and other firms was needed and that elements of Government support would be needed to achieve this.

Major pilot programmes – a step change from LCNF projects is needed

The second theme around future steps was considering how the LCNF might evolve. LCNF projects are designed to trial particular elements of smart grid in chosen trial locations. A number of interviewees emphasised that it will become necessary to progress to a larger-scale, both in the sense of using a number of technologies or approaches together, and deploying them at a higher level of penetration and over a larger area. It was suggested that this sort of broader test would take smart grid learning to the next level in GB, giving insights as to how a future smart grid roadmap could be developed. It was also suggested that this sort of transition would provide a further stimulus for investment in the smart grid supply chain and help maintain the position of relative international leadership in GB.

9

Recommendations

How to move forward whilst balancing risks and opportunities

Recommendations

To address the complexities and challenges associated with developing smart grid infrastructure, the report explored possible solutions to the challenges. The report recommendations are that there is a need for some fresh thinking by government, regulator and industry, and a number of constructive suggestions are offered as to how this can be achieved.

- Policy makers need to provide the maximum degree of policy guidance possible: creating some additional flexibility in current standards will also be important. It may also be possible to say more about what is not needed yet, and a holistic energy roadmap could be usefully constructed.
- There needs to be greater focus within the regulatory process on protecting customers by ensuring that there is sufficient network investment to protect against the risks. This could come from both the regulator and companies being expected to publish a risk review, and also a requirement to identify and evaluate what might be termed "no or at least low regrets" investments.
- The risk / reward balance faced by DNOs for innovating should include incentives to actually apply the learnings to their networks or seek to move faster than others in delivering smart grids.
- There needs to be greater focus on consumer engagement both to ensure that consumers understand the positive attributes of smart grid, and also how a smart meter will contribute to this. It will also be important to explore how best different types of customers are engaged on a day to day basis and whether a degree of automation is required.
- It is important that future projects do not take the current industry model as a given. There are some complex challenges to work through and so alternative models will need to be actively explored.
- Further investment in skills is required, for example by an extension of the workforce renewal elements of DPCR5, and a co-ordinated national approach covering the whole smart grid supply chain.
- There is a need to ensure that projects under the successor scheme to the LCNF progress to a larger scale of test, both in the sense of using a number of elements together, and to deploy them at a higher level of penetration over a larger area.

We think there needs to be greater focus within the regulatory process on protecting customers by ensuring that there is sufficient network investment to protect against the risks.

Provide clearest policy signals possible

This report has described the challenges of setting detailed policy at this time. It also shows that investment in smart grid could provide a degree of stimulus for economic recovery. However, the scale of benefits does not appear to be so transformational that it should dominate other policy considerations such as the risks created by the multiple uncertainties.

A second theme touched on by a number of interviewees was the need to give clarity and certainty over all of the various aspects of energy policies that will impact on the way in which consumers use networks. However, this appears less than realistic given the number of different policy elements currently under development and the long duration of the period of focus.

So neither of the "ideal" asks of policymakers appears realistic, but across the various themes suggested in the interview responses, a number of ideas may still be possible:

- Firstly, even though it is not yet possible to say exactly what is required, it may be possible to say more about what is not needed yet;
- Secondly, there is still a view that more could be done to provide a holistic "energy road-map", covering in particular how the interplay between electricity and gas is intended to evolve. The evolution of heat in particular could have a major bearing on the quantum of energy the distribution networks need to deliver;
- Finally, the potential to create some additional flexibility within the current standards and rules was seen by many as a key area, particularly as it was felt that these ideas can be progressed without necessarily incurring major early investment costs.

Change the mindset around the regulatory process

Protect consumers by ensuring sufficient network investment

Given the circumstances now faced and the asymmetric risks noted above, we think there needs to be greater focus within the regulatory process on protecting customers by ensuring that there is sufficient network investment to protect against the risks. We are not for a moment suggesting that the regulator should cease to protect customers by seeking to enhance efficiency and test need. But we do think that there does also need to be some consideration of the possibility that even the new RIIO regulatory apparatus could result in too little investment to facilitate future smart grid development.

This could come from both the regulator and companies being expected to publish a risk review, and also a requirement to identify and evaluate what might be termed "no or at least low regrets" investments. For example, given the major uncertainties noted in the previous narrative, is there a case for progressing a substantial enhancement of measurement and data-handling capabilities as a foundation activity? With the eventual benefit of hindsight, it might prove to be the case that these could have been delayed for a few years – but the degree of disbenefit from progressing early is unlikely to be major and could be viewed as something of an insurance premium.

Revisit the risk / reward balance faced by DNOs

The LCNF encourages innovation via reputation enhancement from the award of LCNF projects, and by de-risking experimentation. This does not however truly incentivise the DNOs to apply the learnings to their networks, or seek to move faster than others in delivering smart grids.

So the recommendation arising is to use the flexibility of the RIIO approach to create an incentive mechanism to encourage rapid application of the learnings from LCNF and successor projects, and to encourage more rapid progress towards smart grid. We recognise that this in itself will be a formidable challenge – but one which we feel is more than justified by the importance of smart grid.

Strengthen focus on consumer engagement

The scope of work and time constraints for this project meant that interviews with energy customers were not undertaken. However, given the diversity of views expressed amongst industry participants, we strongly suspect that customers are currently less than clear as to what smart grid is and how it relates to smart meters. While we recognise that some elements of the smart grid may be about technical elements of grid design which should remain entirely opaque to customers, we think that there is still a real need to articulate the broad shape of the smart grid proposition to customers as a matter of priority.

As things stand, there is a risk that the debate on smart grid comes across as customers having to pay more, but receive less. We think that it is important to emphasise the positive attributes such as the recognition of the value of flexible energy usage, fewer restrictions on how customers can use distribution grids and of course the significant avoided costs suggested by the SGF evaluation framework results.

Two other aspects could be important to customers. Firstly, as noted in the appendix, the GB model of progressing smart meters largely independently of smart grid is somewhat atypical. So it will be important to explain how the smart meters are expected to contribute to smart grid development and how this separation impacts on the pattern of costs and benefits.

Secondly, it will be important to explore how different types of customers are best engaged on a day to day basis. Demand side response is expected to be a key future development, but the way in which customers chose to, or are able to participate, will be important. The degree of automation could be an important factor here, providing of course issues around trust and the security of data can be overcome.

Challenge current industry, business and commercial models

As described in section 8.2, a number of interviewees raised suggestions about the need to contemplate changes to the way in which the industry currently works. For example, there are some difficult questions as to how demand side response can be used by suppliers and networks at the same time. The issues raised appear far from easy to resolve, especially since the DNOs are not currently organised to maintain frequent contact with a large number of consumers.

So the recommendation arising is that future thinking on smart grid, and in particular future projects under the LCNF (or its successor mechanism), needs to ensure that the current industry model is not taken as a given, and that alternatives are actively explored.

Build capability across the smart grid supply chain

Further investment in skills and resources to innovate

Interviewees observed that DNOs seemed to be facing some challenges in resourcing LCNF projects, both because of limited numbers of staff available, and the fact that the skills required were evolving. DPCR5 contained a degree of additional funding for workforce renewal to help DNOs deal with underlying demographic issues. A similar approach focused on smart grid would send very positive signals to those contemplating investments in the GB smart grid market, especially if accompanied by some additional funding to recognise that the DNOs do need to increase staff numbers to ensure that progress is not unduly constrained.

The skill issues are not limited to the DNOs and hence there is a strong case for a co-ordinated national approach covering DNOs and other firms.

Major pilot programmes

Questions about how the successor scheme to the LCNF is framed are already under consideration. There is a clear need to progress to a larger-scale of test, both in the sense of using a number of technologies or approaches together, and to deploy them at a higher level of penetration and over a larger area.

10

Appendix A

Background and supporting notes

This appendix provides some background details on smart grid and the nature of benefits that it might deliver, providing some supporting details for the body of the report. It is intended to serve two purposes:

- **As a guide to those who are less familiar with some of the fundamental smart grid aspects.**
- **To provide some additional guidance on interpretations or considerations that we have applied in the development of the main body of the report.**

It covers the following topics:

- **Definition of smart grid**
- **How smart grid could evolve**
- **Direct benefits of smart grid**
- **Smart grid as an enabling technology for secondary industries**
- **Smart grid and its impact on future performance standards**

Definition of smart grid

Concisely and clearly defining smart grid is almost impossible. Many people have tried and consequently there are many definitions to choose from. The most widely-adopted definition in Britain to date was developed by the Electricity Networks Strategy Group (ENSG), chaired by the Department of Energy and Climate Change (DECC) and the Office of Gas and Electricity Markets (Ofgem):

[A smart grid is] an electricity power system that 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.

DECC has adopted this wording as its formal definition. But whilst this definition helps to explain the concept of smart grid, it does not help with defining its scope or the elements within it.

More detailed definitions of smart grid are significantly influenced by the context and purpose for which they are created, and in Britain by the structure of a number of energy policies. Smart metering has been established as a discrete initiative in Britain, with its own policies, targets and implementation programme, and most importantly its own budget. So in Britain, unlike most other countries, smart metering does not fall cleanly inside the Government's scope for smart grid and tends to be treated as a complementary, albeit closely-linked, topic.

Similarly, the Government has individual policies covering renewable and distributed generation, energy efficiency, and energy market reform. The Government would reasonably consider these also to be outside their working definition of a smart grid, although they clearly relate to it.

The Smart Grid Forum (SGF) Evaluation Framework, which is a key input into this report, explores the DNO investment case for smart grid. SGF's approach aligns with that of DECC: essentially limiting scope to elements built into the transmission and distribution infrastructures; the assets and solutions owned and operated by the network companies. For example, this would include elements such as sensors and communications, advanced management and control systems and substation automation, but would exclude items which are connected to transmission and distribution networks by other parties and which operate in a smart manner. Importantly, the costs and benefits of smart meters are also excluded, on the basis that this will happen as part of 'business as usual' given that the Government has already committed to their roll out. This does result in a narrower interpretation of a smart grid than is typically used in some other countries. **This is the interpretation of 'smart grid' that is used within this report,** although we also explore a broader scope of 'smart energy systems'.

In Britain, unlike most other countries, smart metering does not fall cleanly inside the Government's scope for smart grid and tends to be treated as a complementary, albeit closely-linked, topic.

How smart grid could evolve

Developing a vision of how smart grid could evolve is one of the most uncertain and complex challenges facing the development of a smart grid investment case. Whilst this report does not consider this question explicitly, as our analysis utilises the scenarios and technologies set out by the SGF evaluation framework and other studies, we believe that there are two fundamental elements to the evolution:

- We do not see smart as an on / off condition. Smart grid will be created progressively over an extended timeframe, not based on dramatic step changes and according to an initial master-plan. The US Department of Energy has presented a concept of 'two grids' – whilst their distinction is not fully clear, we think this nicely illustrates the point above:

  The first – we'll call it "a smarter grid" – offers valuable technologies that can be deployed within the very near future or are already deployed today. The second – the smart grid [...] – represents the longer-term promise of a grid remarkable in its intelligence and impressive in its scope, although it is universally considered to be a decade or more from realization[21].

  The sense that was conveyed from our interviews of likely technology evolution also mirrors this idea of gradual change. The truly game changing technologies are thought to still be some way off. For example, storage is still costly and has limited functionality and performance. Equally, EV roll out has been markedly slower than expected and this trend doesn't look set to change in the near term. However, incremental technologies such as those required to improve measurement, monitoring and communications are more or less 'ready to go' and are likely to be the earliest elements to be deployed.

- Not all smart grids will be the same. The transmission system in GB is already widely regarded as being smart. And while there may be some future increase in the degree of smartness, this is seen as a much less significant change than making distribution grids smart – and hence the focus of this report is firmly on distribution. Even amongst distribution grids, it is also important to highlight that no two smart grids will be the same. Network operators will vary in their choices of which solutions to implement, the extent to which they implement them and the order in which they do so. This will be driven by differing starting positions, different geographical particularities and customer demographics, differing expectations of external drivers and possibly different strategies. Therefore the evolutionary paths of each distribution network may well be different.

[21] US Department of Energy – The Smart Grid: An Introduction - http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/DOE_SG_Book_Single_Pages(1).pdf

Direct benefits of smart grid

The economic benefits analysis in this report does not attempt to fully specify, analyse or individually quantify the many varied benefits that smart grid may offer. Many (but not all) of these are encompassed within the independent analysis which we have utilised as bases for our broader assessment, and some others are listed where particularly relevant.

For the benefit of less experienced readers, we think it may be helpful to summarise some of the benefits which smart grid can present here. A review of existing studies highlights the main direct benefits of a smarter grid as:

- Reduced total energy use and reduced peak demand (largely through changing consumer behaviour)
- Reduced energy losses
- Greater power reliability, safety and quality
- Reduced capital and operating costs
- Reduced carbon emissions

Benefits accruing to the wider energy system include:

- Opportunities for the British smart grid supply chain to capture the domestic spend on smart grids and for this spend to multiply through the economy.
- Opportunities for the British smart grid supply chain to export intellectual property and smart grid technologies abroad and to attract foreign direct investment.
- Facilitation of the decarbonisation and electrification of energy
- Economic benefit to the UK from developing a secondary industry supply chain including servicing the domestic need and generating export opportunities
- Lower energy prices
- Impacts of a reduced energy price on British firm's competitiveness

A wide range of stakeholders stand to benefit from a smarter grid the whole way across the value chain of a smart energy system. Examples of ways in which each of the key groups of stakeholders may benefit are listed below.

- Network operators have an opportunity to modernise existing networks and to use existing infrastructure far more efficiently
- Energy retailers can use smart grid to access consumers and expand their offering into the energy services market
- Customers are likely to benefit from lower prices and the emergence of new tailored service propositions from energy providers
- Generators will benefit from a better network to feed generation into, improving the utilisation of existing generation capacity or enabling investment in additional plant
- The wider energy system supply chain may benefit through the development and associated economic value of secondary industries
- Society / Government will benefit from the reduction of GHG emissions, increased security of supply and greater energy efficiency

We do not see smart as an on/off condition. Smart grid will be created progressively over an extended timeframe, not based on dramatic step changes and according to an initial master-plan.




Smart grid as an enabling technology for secondary industries

At its core, smart grid will enable a more cost effective, reliable and higher quality energy supply to customers as set out in prior sections. Additionally, they can play a significant role in facilitating the development of 'secondary' industries, particularly those which aim to deliver decarbonisation of energy. These include:

- Electric vehicles
- Electric heat
- Renewables
- Distributed generation
- Customer products and services

Smart grid will enable the development of these industries via two fundamental mechanisms:

- **Lowering or avoiding barriers:** there could be a number of actual or perceived restrictions associated with a non-smart grid that could create adoption barriers and either slow or reduce take up of demand in secondary industries.
- **Maximising impacts and benefits:** a smart grid also has a fundamental role to play to ensure that GB captures the full benefits that could result from the timely growth of secondary industries. Without a smart grid, the full potential value of many of these technologies could be lost.

Although conceptually different, in practice these two mechanisms can be difficult to distinguish or separate, with many smart grid solutions directly addressing both aspects at the same time. Some brief examples of how smart grid solutions can impact on a range of other energy system components are given below.

- **Electric Vehicles** – Smart grid techniques can allow faster home EV chargers to be connected without physical network reinforcements, allowing consumers to buy EVs without a potentially long delay (and potentially high cost) to be allowed to install such a charger. Smart grid demand response technologies can allow Electric Vehicles to charge off-peak at a substantially lower cost than would be possible in a conventional grid. This enduring cost saving will be key in encouraging more consumers to buy EVs rather than traditional vehicles.
- **Vehicle to Grid** – V2G techniques, another smart grid solution, could allow EV owners to take advantage of varying energy demand and price differentials to make money from their vehicle's battery, thus subsidising the total cost of vehicle ownership. Although not yet fully proven in a truly commercial scenario, the potential subsidies could be very material in some scenarios, and will further reinforce the case for consumers to invest in EVs.
- **Electric heat** – Similarly to basic EVs, smart grid solutions allow electric heaters (with some form of heat storage) to use cheaper electricity at off-peak times, making them more cost-competitive against other heating options. Smart grid techniques can also allow connection of a greater heating load without fear of overloading the network, or the cost and delay of physically reinforcing it. These two aspects will materially influence the uptake of electric heating solutions.
- **Energy storage** – Just like V2G, static energy storage solutions are another smart grid solution which allows the consumer to arbitrage the varying price of electricity over time, and to use this to reduce their overall cost of energy supply. Without smart grid techniques, the financial value for 'time-shifting' of energy would be lower, and networks may have to object to significant storage levels due to the uncontrolled impacts it could have on their networks.
- **Renewable generation** (including distributed generation) – Intermittent renewable generation varies with the natural energy source that drives it (wind, sun, water, etc), creating various macro-level supply / demand balance issues and localised network capacity and power quality challenges. Smart grid techniques can mitigate all of these at a lower cost than traditional alternatives, reducing the barriers to connecting generation and allowing projects to be more economic.

Smart grid can play a significant role in facilitating the development of 'secondary' industries.

Smart grid and their impact on future performance standards

At present, GB customers benefit from some of the most reliable electricity distribution networks in the world. The average customer experiences just over one hour of lost supply per year[22]. This is about half the US average, and also compares favourably with many European countries, although it is about four times higher than in South Korea.

This strong GB performance arguably reflects four factors:

- Network planning standards that require a significant element of redundancy so that when faults on the network do occur, it is often possible to maintain supply;
- Network control approaches which emphasise protection, ensuring that any potential overloads are prevented from resulting in damage which would create safety issues or require lengthy repairs;
- Strong focus on regulatory incentives to reduce both the number of interruptions and their duration;
- Historic growth in demand has been modest and relatively predictable.

The essence of the smart grid challenge is that the fourth of these factors is no longer true. The way that consumers use electricity is starting to change. Strong encouragement for change is coming from policies to encourage the electrification of heat and transport. These sit alongside other policies which simultaneously encourage consumers to place more emphasis on energy efficiency.

The overall effect of the policies has several important consequences for distribution networks:

- The quantum of electricity that has to be delivered is likely to increase as electricity displaces gas heating and is increasingly used for transport, and this increases demand by more than energy efficiency reduces it;
- The pattern of electricity usage may also change, both in respect of the timing of usage and where on the network it is used;
- Perhaps most importantly, the confidence around predictions on the future quantum and pattern of demand will greatly reduce given the multiple uncertainties around how policies will work and how consumers will behave.

As a result of these factors, what might seem the obvious solution - to simply build a bigger network - could have very significant drawbacks including huge cost, major disruption, and the risk of making unneeded investments. So as has been seen in the range of LCNF projects emerging, there is a need to explore alternative solutions and approaches.

The LCNF projects and also international evidence suggest five broad themes with the various approaches being explored:

- Influencing consumers usage of the networks – for example encouraging demand side reduction in response to tariff signals;
- Controlling consumers usage of the networks – for example via non-firm connections which allow the customer to be disconnected, or arrangements which require customers to notify or seek approval from networks before connecting particular types of equipment;
- Enhancing network control capabilities – for example adopting dynamic line ratings which allow increased power to be delivered in some circumstances, or enhancements to the measurement and control systems used by networks;
- Increases in network capacity – which despite the potential drawbacks noted above may still be the best option in some circumstances;
- Refining network planning standards – for example exploring the circumstances in which the best economic solution might be to reduce the degree of redundancy or fault tolerance.

Although we have highlighted the five themes separately, very often there will be strong linkages between two or more of them. For example, a reduced degree of redundancy may be a much more acceptable proposition if there is confidence that demand side reduction can also be used to reduce the number of circumstances in which consumers on a reduced redundancy network actually experience outages.

As a result of the range of approaches that may be used to make the distribution grids smarter, it is far from easy to predict what will happen to performance standards and the number of outages. Indeed this was very evident from the range of interview responses received.

Improved measurement, monitoring and control techniques can all help to reduce the number of faults and reduce the impact of those that do occur. Alternatively, other aspects of smart grid might result in some increase in outages, for example if demand side response failed to materialise as expected. And irrespective of which approaches are chosen, the way in which consumers actually use the grid and the speed with which this changes, will also have a major bearing on the performance that actually results.

22 Council of European Energy Regulators. 4th benchmarking report on quality of electricity supply.

1.

2.

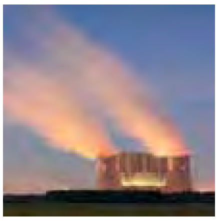
3.

4.

5.

6.

7.

8.

9.

10.

11.

12.

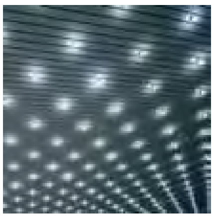
13.

14.

15.

16.

17.

18.


The above images sourced from PHOTOCASE (www.photocase.com)

Photographer credits: 1. cocaline / 2. combo / 3. designritter / 4. misterQM / 5. grenzverkehr / 6. Knuppi / 7. kin kohana / 8. AndreasF / 9. himberry / 10. himberry / 11. silver / 12. jortgies / 13. zettberlin / 14. suze / 15. krockenmitte / 16. neophoto / 17. seraph / 18. himberry

Design by NOT PRETTY (www.notpretty.net)

Authors

If you would like to discuss any of the issues presented in this paper, please feel free to contact our authors:

Bill Easton
Director, Transaction Advisory Services
Ernst & Young

Tel: +44 (0) 20 7951 5463
Mobile: +44 (0) 7920 297 548
Email: beaston@uk.ey.com

Jenny Byars
Assistant Director, Economic Advisory
Ernst & Young

Tel: +44 (0) 20 7951 5686
Mobile: +44 (0) 7769 650 533
Email: JByars@uk.ey.com

If you would like to find out more about SmartGrid GB, please feel free to contact Robert McNamara by phone on +44 (0)20 7331 2017 or by email at Robert.McNamara@smartgridgb.org. Alternatively you can visit the SmartGrid GB website at www.smartgridgb.org for more details.

The opinions set out in this publication are not necessarily the opinions of the global Ernst & Young organization or its member firms. Moreover, they should be viewed in the context of the time they were expressed. This publication contains information in summary form and is therefore intended for general guidance only. It is not intended to be a substitute for detailed research or the exercise of professional judgment. Neither Ernst & Young LLP nor any other member of the global Ernst & Young organization can accept any responsibility for loss occasioned to any person acting or refraining from action as a result of any material in this publication.

SmartGrid GB is a cross-industry stakeholder group acting as the national champion for smart grid development in Britain. We provide the Department of Energy and Climate Change (DECC) and Ofgem with an independent, cross-industry view on what kind of smart grid Britain will need and how it might be achieved. We also act as focal point around which the value chain can come together and share ideas and experiences on how we can make smart grid a reality. We were launched by Charles Hendry, Minister of State for Energy and Climate Change, in June 2011.

SmartGrid GB members*:

Accenture
Airwave
Arqiva
British Gas
BT
Cable & Wireless
EDF Energy
Elexon
GE
Hitachi
HP
IBM
Intellect
Oracle
Power Plus Communications
SAP
Scottish Power
Sensus
Siemens
Toshiba
UK Power Networks
Utiligroup
Wipro

* DECC, Ofgem and Consumer Focus are observer members of SmartGrid GB

SmartGrid GB, 2nd Floor, Russell Square House, 10-12 Russell Square, London WC1B 5EE, UK
www.smartgridgb.org | +44 (0)20 7331 2017 | Robert.McNamara@smartgridgb.org