



Rachel Fletcher
Acting Senior Partner
Smarter Grids and Governance: Distribution
Ofgem

IBM United Kingdom Limited
North Harbour
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16 December 2011

Dear Rachel,

Re: Smart Grids Evaluation Framework – A Smart Grids Forum Consultation Report

IBM is pleased to respond to the consultation. We have focused our comments on those areas where we have relevant experience and which we hope will aid in the development of the Smart Grids Evaluation Framework.

We would first like to commend Frontier Economics and ea technology on the development of a comprehensive *Framework* document. We agree with the approach, scope and objectives set out in the document. We agree with the definitions of the policies and the consequential challenges for demand side and supply side. We agree that it is extremely difficult to accurately predict the variables and the complex interactions between them that will impact smart grid strategies out to 2050.

In our response we first give our views on the inevitability of smart grids within the context of what is happening across the wider, Smarter Planet. We then highlight our relevant experience before making our comments on smart grids in the GB market.

Specific areas upon which we have commented include:

- the value chain: the need to include all market participants (end-to-end) and technologies - including smart meters and other non-DNO smart devices and systems;
- the need to consider the impacts on business models of market participants and the impact driven by changes to market arrangements;
- the reduced validity of the “Business-As-Usual” investment scenario over the longer term;
- the advantages of modelling also the costs associated with smart grids, using a real options approach;
- the possibility of including additional operational benefits; and
- the use of 2023 as a key decision point – we suggest that particularly for costs, an earlier decision point should be considered.



If you would like to discuss IBM's response in more detail please feel free to contact me.

Yours sincerely

A handwritten signature in blue ink, appearing to read 'J Willsmore', with a long horizontal stroke extending to the right.

Jeremy Willsmore
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Introduction

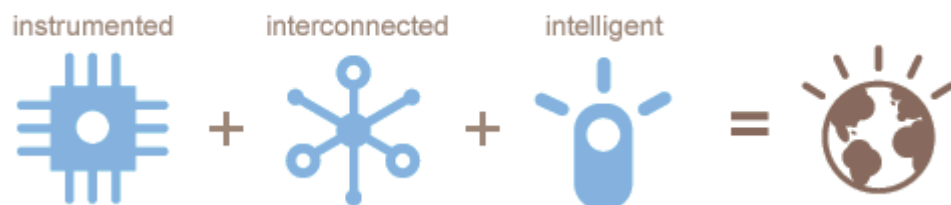
Below we have given our views that relate specifically to the proposed *Framework* for the evaluation of smart grids in the GB market. By way of introduction we have first addressed the wider issue of what IBM has termed a Smarter Planet¹; we believe that there are wider social, political and technical drivers behind making all “things” smarter. By first briefly looking at what a Smarter Planet is and the inevitable journey toward one, we believe it helps put smart grids into the appropriate context. The next section provides an overview of the Smarter Planet. The footnote references in the document provide more specific details and examples.

IBM's vision of a Smarter Planet

We are living in a time of turbulent change, putting pressure on businesses and organisations of all sizes and across all industries. The world is also changing in other fundamental ways: It is becoming smaller, flatter and smarter.

As a result, leaders across all types of enterprises are faced with new challenges in order to remain successful. Those organisations who address these challenges are best positioned to outperform in the "Decade of Smart."

By smarter, we mean the world
is becoming:



The signs of a smarter planet are all around us.

A Smarter Planet: The world is becoming **instrumented**. There are now more than a billion transistors per human, each one costing one ten-millionth of a penny. The world is becoming **interconnected**. With a trillion networked things—cars, roadways, pipelines, appliances, pharmaceuticals and even livestock—the amount of information created by those interactions grows exponentially. All things are becoming **intelligent**. Algorithms and powerful systems can analyse and turn those mountains of data into actual decisions and actions that make the world work better. **Smarter.**

Data is being captured today as never before. It reveals everything from large and systemic patterns—of global markets, workflows, national infrastructures and natural

¹ <http://www.ibm.com/smarterplanet/us/en/overview/ideas/>



systems—to the location, temperature, security and condition of every item in a global supply chain.

At IBM, we want that intelligence to be infused into the systems and processes that make the world work—into things no one would recognize as computers: cars², appliances³, roadways⁴, power grids⁵, clothes⁶, even natural systems such as agriculture⁷ and waterways⁸.

Since 2008⁹, we've talked about what it takes to build a Smarter Planet. We've learned that our companies, our cities and our world are complex systems—indeed, systems of systems. Advancing these systems to be more instrumented, intelligent and interconnected requires a profound shift in management and governance toward far more collaborative approaches.

IBM's credentials in Smart Energy – Smart Grids and Smart Metering

To establish that our views in this response to the consultation are based on real experience we have provided a brief summary of our relevant credentials in smart grids and smart metering. In our opinion a smart grid is comprised of all devices and systems interacting to optimise the energy value chain; this includes smart meters, smart devices within the home/business as well as distribution network monitoring and control devices.

A smart grid is more than the collection of these smart devices, each operating more efficiently and more intelligently. It is the orchestration and interaction of these devices such that the system as a whole works better and achieves different, smarter outcomes. A smart grid will include distribution technologies that are able to protect themselves from failure and signal that there are problems. It will also include the intelligence to dynamically balance supply and demand and to influence the behaviour of energy market participants – energy users and energy suppliers and those that do both.

IBM is a leader in the smart metering and smart grid market, being involved in more projects, in more roles, in more countries, than any other consulting and technology company. IBM has:

- played a lead role in the majority of the announced second-generation smart metering deployments in the world;

² http://www-01.ibm.com/software/rational/announce/volt/?cm_sp=MTE15914

³ <http://www-01.ibm.com/software/success/cssdb.nsf/CS/CCLE-8DMT4B>

⁴ http://www.ibm.com/smarterplanet/us/en/traffic_congestion/ideas/index.html

⁵ http://www.ibm.com/smarterplanet/us/en/smart_grid/ideas/index.html

⁶ http://www-03.ibm.com/innovation/us/outcomes/pdf/full-stories/retail.pdf?lnk=master_agenda_outcomes-q22011&lm=S&lsr=retail_full_story_pdf&lot=A&lpg=smarterplanet_agd_outcomes

⁷ <http://www.ibm.com/press/us/en/pressrelease/31995.wss>

⁸ http://www.ibm.com/smarterplanet/us/en/water_management/ideas/index.html

⁹ http://www.ibm.com/ibm/ideasfromibm/us/smartplanet/20081106/sjp_speech.shtml

- worked on some of the world's most advanced smart grid projects, including the Olympic Peninsula GridWise project¹⁰, the EDISON project¹¹, distribution network monitoring at DONG Energy in Denmark¹² and EnergyAustralia¹³. IBM holds a leadership position within the GridWise Alliance¹⁴;
- created the Intelligent Utility Network (IUN) coalition¹⁵ a coalition of innovative utility companies to accelerate the use of smart grid technologies and move the industry forward through its most challenging transformation, the IUN coalition developed the smart grid maturity model¹⁶ which has been used by hundreds of energy companies world wide to help them plan their route to a smart grid;
- successfully supported seven US energy companies during 2009 in their bids for US Stimulus funding for projects similar to the LCNF projects in GB, total value \$610 million;
- played a lead role in support of Intellect in the foundation of Smart Grid GB, a group committed to bringing together all smart grid stakeholders in Great Britain and acting as an advocate for the accelerated roll out of smart grids for the country;
- led the creation of the world's first nationwide energy and water smart grid in Malta; and
- worked with many of the GB energy market parties, including: DNOs, Suppliers, government and Ofgem to help move forward the adoption of and to realise the value from smart metering and smart grids.

IBM's view on the need for collaboration and new business models to enable smart grids

There are several changes in society and technology that are likely to have an impact on the way in which energy distribution networks may have to operate in the future. Three global surveys¹⁷ from IBM indicate that there is increased interest by energy users in self generation and supply of energy into the grid.

¹⁰ http://www.pnl.gov/main/publications/external/technical_reports/PNNL-17167.pdf

¹¹ <http://www.edison-net.dk/>

¹² http://www.neplan.ch/html/e/pdf_e/Full%20paper%200037%20Peter%20Vinter.pdf

¹³ <http://www-03.ibm.com/press/us/en/pressrelease/32684.wss>

¹⁴ http://www.gridwise.org/gridwisealli_leadership.asp

¹⁵ <http://www-03.ibm.com/press/us/en/pressrelease/34006.wss>

¹⁶ http://www.ibm.com/smarterplanet/us/en/smart_grid/nextsteps/solution/V199738C72509R68.html

¹⁷Three papers: 1) Plugging in the consumer – 2007 <http://www-03.ibm.com/industries/utilities/us/detail/landing/S459155G43893F90.html> ,

2) Lighting the Way – 2008 <http://www-935.ibm.com/services/us/index.wss/ibvstudy/gbs/a1030951?cntxt=a1000051%20>

and 3) 2011 IBM Global Utility Consumer Survey <http://www-03.ibm.com/press/us/en/pressrelease/35271.wss>

This would change the shape of energy distribution from a single direction supply network into a *participatory network*¹⁸, where the distribution network provides a critical role in the support of optimal energy balance. Clearly the current networks were not designed with this objective. Pre-requisites for a *participatory network* include deployment of smart grid and smart metering technologies. Developments in Information and Communications Technologies (ICT) and next generation monitoring and control devices, combined with higher bandwidth communications are enabling cost effective end-to-end digitisation of energy grids - the deployment of smart grids.

To realise the potential benefits of a smart grid will require a degree of coordination. At the very least a set of clear objectives and principles of operation for the market, the interaction of market participants and a framework of standards for the technologies and systems to interoperate are required. In this regard IBM leads the development of the smart grid interoperability framework for the GridWise Alliance.

The GridWise Architecture Council (GWAC) is sponsored by the US Department of Energy. The GWAC's mission is to establish broad industry consensus in support of the technical principles that enable the vast scale interoperability necessary to transform electric power operations into a system that integrates markets and technology to enhance our socio-economic well-being and security of supply.

The diagram below provides an overview of the layers upon which the smart grid interoperability framework is based; from energy policy setting through to detailed technical specifications. The block to the right shows the gradual transformation from the Energy (E) domain to the Information (I) domain.



GridWise Architecture Council - smart grid interoperability framework

¹⁸ refer to plugging in the consumer: <http://www-03.ibm.com/industries/utilities/us/detail/landing/S459155G43893F90.html>

Key points for smart grids in the GB energy market.

Having looked at the wider context of a Smarter Planet and IBM's experience of helping to implement smart grid and smart metering solutions both in GB and other countries let us now look at smart grids for GB.

The first point that we would make is that we believe the introduction of technology that enables smart grids is inevitable. The price : performance ratio of Information and Communication Technology continues to improve at an exponential rate.

The market will drive: (1) innovation and improvements in the capability of electrical monitoring and control devices, and (2) reductions in the cost of production and operation.

We believe that "smart" distribution network equipment will become increasingly embedded within the distribution networks, capable of enabling a smart grid. The cost and the inhibitor is not the technology, it is the cost of:

- installation (particularly for retrofit of devices);
- changing of processes within all market participant organisations; and
- adaptation of business models - collaboration by all market participants will be essential to make a smart grid work.

In Great Britain the energy value chain, from end to end, is by design more fragmented than most other energy markets world wide and it includes a number of intermediaries and service providers to ensure the effective operation of the value chain.

On the assumption that the GB market model remains fundamentally as it is today – with the emphasis on the minimum level of regulation to protect consumers and overcome market failures whilst maximising the benefits of market forces and competition – then the challenge is to optimise investment and to enable appropriate collaboration to realise the benefits of a smart grid. For example, in the proposed *Framework*, four options for the realisation of ToU tariffs are defined which exploit varying levels of smart meter functionality to enable Demand Side Response (DSR).

Whilst we agree with the options as defined we believe that the business model for the interactions between the market participants is even more important. To take this example further, in *Option 1*, *"it is assumed that the smart meters alone will allow dynamic supplier led ToU tariffs, and additional investment by DNOs (which could take place at either the feeder level or for the whole of GB) is required to allow DNOs to directly influence demand"*. We believe that to optimise all parts of the network additional monitoring will be required in parts of the DNO networks that are not currently monitored, particularly the 11kV and LV networks; but the more important question is: does the DNO interact directly with the customers to realise DSR or does it interact via the Supplier?

To answer the question there are many use case scenarios to consider, some of which may require immediate positive action by a DNO, but for many scenarios it may be possible for the DNO to optimise performance of the network by interacting with the Supplier to realise DSR. Equally information gathered by the Supplier may be of value to the DNO in the execution of its role to ensure quality of supply. And there may be aspects of DSR which can be effected by interaction between generation markets, suppliers and customers without the active involvement of the DNOs.

Hence the requirements for interoperability must be defined in a revised set of market arrangements. In turn these changes will need to be reflected in changes to the business models of the market participants. With this construct understood the allocation of costs and benefits across the value chain can be determined. The technological capabilities of the smart meters (for example) are a potential enabler or inhibitor to smart grid operations, but to optimise costs and energy flows across the value chain it is the market arrangements that need to be first addressed. In this context, decisions relating to the operation and scope of the DCC within smart metering will have more impact on the eventual success of smart grids in GB than the capabilities of the meters themselves.

Comments on the proposed Framework for the evaluation of smart grids

In the remainder of our response we will comment on specific points which we hope will aid in the further development of the smart grids evaluation *Framework*.

The real options approach to the CBA is undoubtedly a good way of dealing with the many complexities associated with assessing the costs and benefits of smart grids against the backdrop of much uncertainty. In fact, we believe that alternative positions on the overall cost of smart grid implementation could also be usefully modelled as real options as we outline below.

The costs

In simple terms, the costs associated with a smart grid implementation fall in the following five categories:

- device costs for a given technology;
- installation costs;
- communication costs;
- IT costs for the DNO; and
- costs of adapting to new market processes not only for the DNOs, but also potentially for Suppliers and their agents, generators, customers and other entrants to the future energy market such as Energy Service Companies and co-operative community grids.

It seems reasonable to assume that many smart technologies are still in the early stages of their product life-cycle. With further R&D by the manufacturers and with increasing field experience, one could reasonably expect better and more reliable devices produced at lower costs. In addition to the expected product innovation, considering the relatively small production runs to date, one could expect a large order to unlock significant production economies of scale. Both product innovation and production efficiency will be driven by increased market certainty – such as that provided for smart meters by the government's mandate.

At the moment, neither the impact of innovation nor the true scope for economies of scale can be assessed with any degree of certainty. However, in our view it would be an ideal candidate for real option analysis.

Installation costs constitute a significant proportion of the overall costs. Work needs to be planned and staff need to be trained and DNOs will need to consider, in advance, what device type can be fitted at a given location. The UK distribution networks have a large variety of equipment of different makes, types and vintages. The installation of a type of smart device may in itself be the trigger point for equipment replacement. Today,

many pieces of new equipment are already shipped with embedded smart capabilities but are not operated in a smart way. There may well come a point when it is more cost-effective to replace old equipment, e.g. MV/LV transformers and LV feeder equipment, with smart enabled equipment as part of a smart grid programme. It is also clear that a well-planned network-wide installation programme of a given device type will have lower average installation costs compared to installations on an ad hoc basis, a form of economies of scale. Likewise, there may be further reductions in overall smart grid costs if more than one device type can be installed during the same site visit, a form of economies of scope.

Communication costs need to consider both initial investment and future operating costs. Different communication technologies will have different characteristics in terms of data capacity and speed, and some may be more easily expanded over time than others. There is probably not at this point in time a clear view on the required data capacity and latency; not least since it is not decided what packages of smart technologies should be included in the UK smart grid solution, and by when. However there are clearly different requirements for real time control and longer term network planning.

Currently most DNOs can, with modest investment in their IT, support smaller trials of smart grid technologies but few, if any, have IT systems capable of supporting network-wide implementation of smart grid technologies. In order to support a data rich environment, DNOs will need to make early investments in IT systems and data analytics to enable smart grids to be operated and to maximise the benefits.

Finally, but not least important, we suggest that there will be substantial costs for the DNOs, Suppliers and their agents, and other parties in implementing revised market arrangements and the consequent changes to their own business models. For instance, as noted earlier, if both Suppliers and DNOs have a role in instigating DSR; this will have a major impact on the market arrangements and the business model of all DNOs, Suppliers and their agents. Given the fragmented nature of the GB electricity value chain, changes are likely to be costly but it is difficult to assess with certainty just how costly.

Overall, on the costs we expect the device costs and communication costs to lower significantly over time, in part helped by much new equipment already being shipped as smart (or smart-ready) equipment. Installation costs are high and play a critical role in determining the choice between “top-down” vs. “incremental” implementation strategies. The investments required for IT may constitute perhaps just 10% or less of the total costs. We believe that the costs of implementing revised market arrangements and the consequent changes to participants’ business models are of much greater importance.

Consideration of additional operational benefits

We agree that significant benefits to DNOs should be realised through the avoidance or deferment of network reinforcement. This has been borne out in engagements that IBM has undertaken for DNOs in GB and other countries. There are additional operational savings which we believe should be considered in the CBA proposed by the *Framework*. There are potential benefits in reductions in Customer Minutes Lost and Customer Interruptions, although investment by DNOs in basic but effective 11kV feeder monitoring and control over the past decade may reduce this benefit when compared to other European DNOs. It may also be possible to operate “safe” overloading of circuits if sufficient pre-load conditions are well understood by the operators and their systems.

The use of 2023 as a decision point and the options for cost

In the report it is suggested that with scenarios built upon the three value drivers¹⁹ (electrification of heat and transport, increase in distributed generation, increase in intermittent and inflexible generation), there may only be a real impact on distribution networks by around 2023. Hence it is proposed that real options could use that year as an appropriate decision point. However we would suggest that the impact of clustering of both local demand (e.g. electric vehicles or heat pumps) and local generation (e.g. photovoltaic or wind) may result in an increasing number of localised network hotspots earlier than 2023.

Given the level of innovation, the on-going trialling of technologies on a global basis and the potential for significant economies of scale and of scope at many levels as outlined above, we find it quite likely that the costs of implementing packages of smart grid technologies could reduce much within the next few years. This would in itself argue for a decision point earlier than 2023 for options on the cost side. We would suggest the focus for the modelling should be the next 10-15 years instead of the 40-year period.

As part of the methodology, it is assumed that there is always a BAU solution ("more copper") that can meet the challenges of the future and that there is always a BAU option to compare to a chosen smart grid strategy. It is clear that traditional network reinforcement can deliver more load capacity but it is not clear to us that a BAU approach is also the answer to all issues related to power quality and flow control and, especially, not to dynamic market balancing of supply and demand, both of which are becoming more variable and unpredictable.

If there are limitations in terms of whether a BAU approach can meet the challenges posed by the three value drivers, it follows that there may be a point in time, significantly earlier than 2050, when BAU is no longer a valid alternative, and we believe this to be the case.

It might therefore be worth modelling by when smart technologies must be introduced at the latest. We think that the point at which a BAU solution cannot meet the challenges could be reached well before 2023, or put another way, we think that the value drivers may have a real impact on distribution networks considerably earlier than 2023. Again this speaks in favour of modelling primarily the next 10-15 years.

In summary, we suggest:

- including real options for key cost components of smart grid implementation;
- focusing the modelling effort on the next 10-15 years;
- modelling alternative points in time when BAU can no longer meet the challenges of the value drivers;

¹⁹ "value drivers" as defined in table 3, page 66 of the proposed Framework.



- modelling alternative assumptions on the cost of installation of smart devices given assumptions on the proportion of equipment that is already smart or smart enabled; and
- recognise the cost of changing business models, business processes and market arrangements.



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