

# Workshop report: Policy, regulatory and social aspects of smart grids and applications

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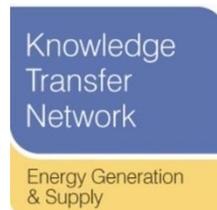
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# Introduction

The workshop was jointly organised by the UK Government's Science & Innovation Network the UK Energy Research Centre (UKERC) and the UK Energy Generation and Supply Knowledge Transfer Network (EG&S KTN).

The objective of this workshop was to bring together experts from Europe to discuss the key policy, regulatory and social issues associated with the development of smart grids. This aim was to deliver several valuable outputs:

- To gain a broader perspective on what is driving and hindering the large-scale development of smart grids
- To gain a greater awareness of the various policy and regulatory initiatives introduced by European countries to promote the development of smart grids and share best practice
- To gain a better understanding of the potential social impact of smart grids and the research required to tackle this challenge
- To create a network of experts engaged in smart grid activities in Europe

The workshop was attended by 54 participants representing a diversity of nationalities, specialisms and interests.

The workshop programme and presentations can be found on the EG&S KTN website.<sup>1</sup>

This report is a summary of the presentations and discussions during the workshop. The workshop was run under Chatham House rules, which means we report what was said during discussions, but not who said it.

If you would like further information about this event, please contact:

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<sup>1</sup> <https://connect.innovateuk.org/web/future-and-emerging-opp/eu-smart-grids> - you will need to be a member to read the material; membership is free.

## Key messages arising from discussions

To some the term smart grid remains a mystery and others freely abuse the term to serve their own needs. Decision makers should be demanding a high standard of proof about smart grid claims in order to present a compelling case to customers about the benefits and opportunities.

Consumers are expected to pay for the smart grid, but they may not realise cost savings if they do not understand or use the information available to them to reduce their energy demand or switch to the most cost effective tariff. Transparency of information and education are important in unlocking consumer benefits.

It is common practice to socialise energy network costs, however, with a smart grid it may be possible to charge customers the exact amount for the costs of the infrastructure to deliver their energy.

There are opportunities for consumers arising from the smart grid including reduced bills through demand management and becoming active 'prosumers' (generating and selling their own power). However, in order to realise these opportunities institutional change will be required.

The smart grid offers several potential benefits to society. It should improve the reliability of energy supply. It is an enabler of the low-carbon energy system, and as such also has the benefit of assisting in climate change mitigation and reducing air pollution.

The regulator has an important role to play in the smart grid. Whether hands-off, or hands-on, regulators should stick to regulating the functions of the smart grid, not the technological solutions to achieve the function.

For energy retailers, the smart grid offers an opportunity for new business models including the possibility of moving towards offering energy services, such as light and warmth, or acting as aggregators and providing system services such as balancing. The smart grid may also offer unforeseen business opportunities, akin to the internet, which may encourage new entrants to the market, however, new business opportunities may be limited by data access issues, a regulatory framework that prohibits them and a lack of consumer trust.

There are a myriad of actors developing aspects of the smart grid. The actors are at different stages of development and may be in competition – certainly they are not all speaking the same technical language. There isn't a common forum for all actors to share information, nor any agreement on how such a forum should operate.

There are several levels upon which information could be shared: technology development, technology integration, system integration, market integration and full smart grid rollout. At a number of these levels, European and international initiatives exist that aim to share information. However, a number of participants noted it is rare for events to share the policy, regulatory and social best practice and as such this workshop was welcome.

# Plenary session

## **Gareth Evans – Ofgem**

The Office of the Gas and Electricity Markets (Ofgem) regulates the electricity and gas markets in Great Britain. Because of the lack of market competition, Ofgem directly regulates the gas and electricity networks and as a consequence is active in the smart grid area. Its role is to ensure that customers benefit from the opportunities smart grids bring.

Aligned with this role, Ofgem has been, and remains active in the GB and European smart grid strategy, policy and regulation. In April 2011, The Department of Energy and Climate Change (DECC) and Ofgem created a “Smart Grid Forum”. The Forum brings together key opinion formers, experts and stakeholders to provide strategic input to help guide DECC and Ofgem’s thinking and leadership in this field. The Forum focuses on the role that the electricity network will play, both technically and commercially, in the low carbon transition. The Forum is currently engaged on three key tasks:

- Task 1 – to establish the benefits of smart grid solutions using an agreed view of the future and the likely network solutions
- Task 2 – to identify near/medium-term developments that could have future network impacts and provide advice and guidance
- Task 3 – to establish effective communication and dissemination strategies

Ofgem has recently reengineered its regulatory framework for networks. The new framework, RIIO (revenue = incentives + innovation + outputs), is output driven allowing Ofgem to incentivise the right sort of commercial behaviour, including that which will deliver the future smart grid. The regulation also requires network businesses to think longer-term through a requirement for eight-year business plans.

Ofgem believes that innovation is key to achieving its goals. An important mechanism for supporting innovation is the Low-Carbon Network Fund (LCNF), which is a £500 million fund that allows companies to trial the technological and commercial arrangements that is required to deliver smart grids capable of supporting electric vehicles, distributed generation and low-carbon heat. The LCNF, operating since 2010, has so far funded 10 projects, covering all levels of the smart grid.

## **Michele de Nigris – RSE**

The smart grid is in essence an information layer on top of the existing steel and copper transmission and distribution infrastructure. International collaboration for the development of the smart grid is a must. The future development can be sub-divided into five key steps and at each step there is a requirement for collaboration.

1. Technology development – this is the laboratory scale testing of various components of the smart grid. There is a need to ensure that there is collaboration on simulation and modelling and also on characterisation and testing. International collaborations are often between universities/research institutions at this stage.
2. Technology integration – this is making sure everything works together under controlled conditions in pilot plants and test beds – at this stage projects can afford unexpected results, and in fact these can be quite valuable if they iron out potential future issues. International collaborations already exist at this stage, including the EU FP7 project Distributed Energy Resources Research Infrastructure (DERRi)<sup>2</sup>, the European Energy Research Alliance (EERA)<sup>3</sup> and Smartgrids International Research Facilities Network (SIRFN). The first two are at the European level and the last one is at the international level.
3. System integration – this typically involves demonstration with real customers, developing the business case and reducing the risk for full-scale deployment. Examples include the Italian AEEG projects, the Ofgem LCNF projects and the eco-grid project.
4. Market integration – these are large scale (1000's consumers) projects and represent a fantastic opportunity for collaboration. Examples of collaboration include the European Electricity Grid Initiative (EEGI)<sup>4</sup> – an European Industrial Initiative, Grid+ – and EU Coordination Action to increase collaboration between key players<sup>5</sup> and an operators programme aligned with the EEGI.
5. Full smart grid rollout – rollout to millions of consumers and a worldwide opportunity for collaboration. The key collaboration is the International Smart Grid Action Network (ISGAN) which aims to “bring high-level government attention and action to accelerate world-wide development and deployment of smarter electricity grids”.

Ultimately, each country will determine the kind of smart grid that they require to meet their needs, however, there is value in having common (and rigorously tested) frameworks, methodologies, and tools available for all.

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<sup>2</sup> <http://www.der-ri.net/>

<sup>3</sup> <http://www.eera-set.eu/> - note, UKERC coordinates the UK academic input into the EERA (see <http://www.ukerc.ac.uk/support/tiki-index.php?page=EERA%20Project%20Development>)

<sup>4</sup> <http://www.smartgrids.eu/node/20>

<sup>5</sup> <http://www.smartgrids.eu/node/61>

## **Miguel Angel Sánchez Fornié – Iberdrola**

There are numerous European and international working groups and reports on the smart grid, including the European Smart Grids Technology Platform<sup>6</sup>, the EU Commission Task Force for Smart Grids<sup>7</sup> and the MIT report “The Future of the Electric Grid”<sup>8</sup>. However, smart grid remains an abused term by many.

A smart grid is necessary in Europe because of the strong environmental policy, in particular: a 20% reduction in greenhouse gases; a 20% share of renewable energy; an aspiration towards a 20% improvement in energy efficiency (all targets are to be met by 2020 and have a 1990 baseline). The outcomes of these targets will mean the grid will need to be able to integrate distributed and intermittent generation, integrate electric vehicles and electric heating, incorporate demand-side management and improve quality and security of supply of energy. As a consequence the smart grid will need to operate at all levels, from the generator all the way through to the consumer.

Clearly, some aspects of the smart grid will need to be regulated – particularly the transmission and distribution elements where typically there is no market competition. However, other aspects should remain open to market competition.

To facilitate the large scale roll-out of the smart grid there are a number of challenges to overcome:

- Whilst the technologies are available, R&D is still required to prove that it can all work together. The European SRA on smart grids notes R&D challenges up to 2035.
- Standards and interoperability – the first set of European standards will be published in 2012. These must allow for communication between devices and facilitate real competition between equipment suppliers.
- Privacy and data security is crucial but should avoid issues that impact on operation and maintenance of the system.

On the subject of regulation, it was felt that the EU was still lagging some way behind the USA. There are also some internal issues in the UK in the way that data will be collected compared to the way in which it will happen in the EU more widely. In the EU, data will be aggregated at sub-station, whereas in the UK it will be taken direct from meters to a data communications centre (DCC).

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<sup>6</sup> <http://www.smartgrids.eu/node/28>

<sup>7</sup> [http://ec.europa.eu/energy/gas\\_electricity/smartgrids/taskforce\\_en.htm](http://ec.europa.eu/energy/gas_electricity/smartgrids/taskforce_en.htm)

<sup>8</sup> <http://web.mit.edu/mitei/research/studies/the-electric-grid-2011.shtml>

There are a number of active demonstration projects globally. For example, in California, smart meters, smart appliances and energy information has been rolled out to five million customers with a view to reducing the need to build new generation capacity through demand-side management. It was noted that a serious training and education programme was required alongside the roll-out. The project is expected to deliver a net PVRR of \$304 million.

### **Panel discussion**

*Do politicians have enthusiasm for the smart grid?*

There is evidence from the UK, Spain and Panama of genuine political enthusiasm for the smart grid. In Spain the fact that there is now 4GW of solar connected to the grid with no real-time data is providing a political imperative to the smart grid development.

*The smart grid will cost money - who will pay and who benefits?*

Consumers will pay for the smart grid, however, it is unclear whether the benefits that companies will realise will be passed through. It was suggested that in the USA, vertically integrated companies would be unlikely to pass through cost savings to customers. In the EU, it was suggested that competition would be needed to drive through savings to consumers.

*Is the smart grid creating economic growth?*

There are start-ups being pulled through in some EU countries - there are particular opportunities for electrical engineers.

# Session 1 – Policy, regulatory and future aspects of smart grids

## **Maik Wolf, Freie Universität Berlin**

Dr Maik Wolf kindly provided a transcript of his entire presentation. Below are the conclusions from the paper.

Many elements of the smart grid are not new. Demand Side Management in the energy sector has been discussed intensively in the U.S. since the 1980's. New are the technical toolbox and the challenges for the grids caused by the energy revolution. Now there are new users like “prosumers”, supplying and consuming energy at the same time, highly volatile producers, like wind and solar power stations, and new kinds of consumption units like electric vehicles. Since not only the world of technology, but also the legal world of energy markets is more complex, numerous regulations have to be coordinated to establish a consistent regulatory strategy. Germany has taken some steps to prepare the nationwide roll-out of smart meters and set up incentives for competitive use of them – it couldn't be the last. Finally it should be noted that the measurement as well as the supply markets are not natural monopolies, but (potential) competitive markets. Standardisation and interoperability is needed, over-regulation has to be avoided.

## **Marcello Capra, Italian Ministry for Economic Development**

The Italian smart meter programme aims to supply all electricity customers with automatic meter management systems by the end of 2011 – that's 33 million meters. The Italian SME sector, which represents 90% of the economy, has been heavily involved in the smart meter roll-out programme. The smart meter programme is a major part of the Italian Energy Efficiency Action Plan.

There are three major public funding initiatives on smart grids in Italy. The first is an R&D programme, which has €120 million over six years, funded through funding from bill revenue. The second is a demonstration programme (described below), and the third is a pilot programme with €16.5 million funding for eight projects from the Italian network regulator.

The demonstration programme, called the Interregional Operation Programme (IOP), is co-financed by National resources and EU Structural Funds and has a budget of €1.6 billion. Its objective is to increase the share of energy consumption derived from renewable sources and improve energy efficiency, promoting local development in the Convergence Regions. A key challenge is to integrate up to 23GW of solar power into the grid by 2020. Therefore a key sub-objective is to upgrade energy transmissions networks in order to promote the use of the distributed generation from RES and small

& micro co-generation. Several smart grid projects are funded under the IOP, including a project to maximise MV grid receptivity to distributed power and also projects to strengthen local-based networks.

The Italian regulator, AEEG has recently approved an additional 2% weighted average cost of capital (WACC) on investments related to smart grids and energy efficiency in order to incentivise investments in smart grids – more work is needed to present a compelling business case to network operators to ensure they make the investments required.

### **Francois Moisan, ADEME**

In 2010 ADEME launched a national loan scheme, “Investments for the Future”, which included schemes for smart grids (€250 million), electric vehicles (€1 billion) and circular economy/low-carbon energy (€1.6 billion). The scheme focuses on demonstration projects and industrial experimentation and includes refundable loans and venture capital.

The smart grid scheme was based on a smart grid roadmap produced by a working group of experts from companies and the R&D sector. The roadmap proposed four functions for the demonstrations:

1. Facilitate the insertion of distributed generation
2. Enable significant action to manage demand
3. Anticipate changes in the grid environment
4. Test new business models that contribute to structuring actors in smart grids

A call from an older programme funded nine projects from 32 applications, and a second call under Investment for the Future has just closed.

The projects from the first call focus on four key areas:

- **Network management, storage and renewable energy.** Two projects are funded. The first, SMART ZAE, focuses on smart grid at the scale of an industrial zone. The second, IPERD, focuses on active network management associated with different storage solutions in a zone with more than 30% of renewable energy.
- **Aggregation.** Two projects are funded. The first, ENR POOL, focuses on aggregation of the flexible demand from industrial electricity consumers and balancing with solar and wind electricity production. The second, REFLEXE, focuses on power aggregation from renewable production and tertiary consumers.
- **Prosumers.** Two projects are funded. The first, MILLENER, focuses on management of electricity demand and renewable integration for smart grids in

an island context. The second, NICEGRID, focuses on the management of large PV generation with several hundred small consumers.

- **Dynamic demand.** Three projects are funded. The first, GREENLYS, focuses on the experimentation of new business plans for dynamic demand. The second, MODELEC, focuses on consumer demand response for 1000 households in different regions of France. The third, OMERE, focuses on distribution optimisation and smoothing of the consumption peak.

The aim of the projects is to better understand the commercial design of smart grids. However, it is likely that further and larger demonstration projects will be required to understand all the uncertainties.

### **Panel discussion**

*Do smart grids require smart meters?*

It depends on how a smart meter is defined and how smart it is – information will need to be passed to consumers in order for them to make decisions. Big industrial energy users are already familiar with demand response contracts; the question is how we can best use the smaller end users, particularly households as they already seem reticent to switch energy suppliers even though it makes financial sense.

*Are we any closer to understanding the value of the deferred cost of investment? Is there sufficient value to be shared with the consumer?*

Such projects are just beginning in France – the negawatt will be taken into account in an experiment with 1000 households; it is unsure how representative this will be of the general population. Whether the value will be shared with the consumer is a regulatory issue.

## **Session 2 – Smart meters**

### **Debbie Stockwell, DECC**

The Department for Energy & Climate Change (DECC) is the Government Department responsible for the Smart Metering Implementation Programme in Great Britain. There are various benefits in rolling out 53 million electricity and gas smart meters to domestic and small and medium sized enterprise (SME) in Great Britain. It will help manage supply and demand, increase the efficiency of the network and provide new services to consumers, who will be empowered with the ability to save energy and money. The net value benefit of this implementation has been estimated to be worth around £7.1bn (€8.6bn) to the UK economy.

The Government has a key role to play in guaranteeing that the right regulatory and policy framework is in place and the overall system is interoperable. To ascertain that the benefits are fully realised, the Government is working to ensure that consumers are positively engaged and appropriate consumer protections are in place and is making sure that industry has the right obligations and incentives to deliver the programme successfully.

DECC has developed a roll-out strategy, divided into three phases: Policy Design (phase 1), Foundation (phase 2), and Roll-out (Phase 3).<sup>9</sup>

Phase 1 ended in March 2011 with the publication of the Government Response to the Prospectus Consultation, which sets out the Government's conclusion on the strategy and timetable for the rollout and, in particular the strategy for establishing the communications and data services.<sup>10</sup>

As part of Phase 2, DECC has, to date, launched several consultations on a number of issues such as the licence conditions and technical specifications for the rollout of gas and electricity smart metering equipment.<sup>11</sup> In September 2011 DECC launched a consultation on the detailed policy design of the regulatory and commercial framework to support the establishment of a new data and communications body – referred to as the Data Communications Company (DCC) – which will coordinate communications between smart meters in domestic consumers' homes and authorised smart meter data users.<sup>12</sup> DECC is currently analysing the responses to this consultation, and plans to release the findings in early 2012.

DECC is also currently working with industry to develop technical specifications – essential to ensure interoperability – and published the industry's draft in August 2011.<sup>13</sup> DECC is intending to publish specifications for smart meters in March 2012. In the meantime, DECC is planning to launch two more consultations in early 2012 on consumer engagement strategy and data access and privacy. Mass Rollout (third and last phase) is expected to start in 2014, once the readiness model needed to enable the mass rollout to start successfully has been established, and will end in 2019.

There are a number of challenges associated with rolling out smart meters in Great Britain. First of all, it is the largest changeover programme in the energy industry since

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<sup>9</sup> [http://www.decc.gov.uk/en/content/cms/tackling/smart\\_meters/smart\\_meters.aspx](http://www.decc.gov.uk/en/content/cms/tackling/smart_meters/smart_meters.aspx)

<sup>10</sup> [http://www.decc.gov.uk/en/content/cms/consultations/smart\\_mtr\\_imp/smart\\_mtr\\_imp.aspx](http://www.decc.gov.uk/en/content/cms/consultations/smart_mtr_imp/smart_mtr_imp.aspx)

<sup>11</sup> [http://www.decc.gov.uk/en/content/cms/consultations/cons\\_smip/cons\\_smip.aspx](http://www.decc.gov.uk/en/content/cms/consultations/cons_smip/cons_smip.aspx)

<sup>12</sup> <http://www.decc.gov.uk/assets/decc/11/consultation/smart-metering-imp-prog/2883-cons-detailed-policy-design-of-dcc.pdf>

<sup>13</sup> <http://www.decc.gov.uk/assets/decc/11/tackling-climate-change/smart-meters/2393-smart-metering-industrys-draft-tech.pdf>

the introduction of North Sea gas. The UK is planning to roll out smart meters for both gas and electricity and the Government strategy implies the development of a multi-billion euro communication company. Finally, for it to work and deliver a real benefit to Great Britain as a whole, a structured stakeholder engagement is required.

### **Marco Cotti, Enel**

Italy is the first country in the world to roll out smart meters on a large scale.

In 1999, Enel (the dominant utility in Italy with over 33 million customers) made the in-company investment decision to replace all its customers' traditional electromechanical meters with modern electronic devices allowing remote meter reading in real time. Between 2001 and 2006, Enel invested over €2.5bn in the deployment of smart meters across its entire customer base, making it the world's first large-scale smart meter programme. All customers in Italy (37 million in total) are now equipped with smart meters following a decision from the Italian Regulatory Authority for Electricity and Gas (AEGG) to achieve 100% penetration by the end of 2011.

The main drivers for Enel's major roll-out programme were to improve efficiency, create higher margins, reduce power theft, and help customers reduce their energy bills. This major investment is today saving Enel over 500 million EUR/year in the areas of revenue protection (i.e. fraud), purchasing and logistics, customer service and field operations. Of particular importance, the Enel Automated Meter Management (AMM) solution allows the company to carry out remotely 100,000s of readings and operations per day, thus saving on expensive manual field visits.

Enel is convinced that, thanks to their smart meter system, they are now able to provide a significantly better service to their customers. Benefits to the consumer include: (1) flexible rate structures with the possibility of daily, weekly, monthly and seasonal modulation and tailored billing periods; (2) remote and fast contract changes (e.g. connections, disconnections, rates) eliminating customer inconvenience of on-site visits; (3) spot reading on request, ensuring faster resolution of complaints and disputes; (4) reduction of power disruption events and repair time; (5) increased comfort and consumption optimization; and (6) increased energy efficiency and environmental sustainability. Nevertheless, a change in people/companies' mindsets is clearly required as this not all about technology.

In 2010, Enel, together with Spanish utility Endesa Distribución Eléctrica, founded *Meters and More* – an international not-for-profit association aimed at promoting the deployment of smart meters and developing open standard pan-European smart metering solutions.<sup>14</sup> The Association brings together electricity distribution system

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<sup>14</sup> <http://www.metersandmore.eu>

operators, electronic industries and telecommunications companies. *Meters and More* provides its members with the opportunity to use and contribute to the improvement of Enel's communication protocol, which promotes the bidirectional exchange of data between the electronic meter and the central management system.

According to Mr Cotti, the key to the success of the ENEL smart metering programme is five-fold: (1) strong support by top management; (2) significant investment in technology innovation; (3) technology requirements driven by business goals; (4) cost effectiveness of the solutions; and (5) economy of scale allowing full scale deployment in a short time scale.

### **Panel discussion**

*Have you looked at the economics of rolling out smart gas meters – particularly as in the future there may not be such a demand for gas as heating transitions to electric?*

The roll out of gas meters will obviously cost money to the tax payer but the benefits clearly outweigh the costs. This might not be the case for other countries, which do not use as much gas as the UK does.

*Who will run DCC?*

DCC's licence will be awarded through a competitive licence application process. The EU Commission has been notified.

*Could you tell us more about the interactivity of the Enel smart meter technology?*

The Enel smart meter is very basic. Consumers cannot make changes but the benefits of having an interactive (and therefore significantly more expensive) display have not been proven. It might be worth mentioning that data gathered through smart meters in Italy helped Italian Authorities better regulate the market.

## **Session 3 – Social aspects of smart grids**

**Sarah Darby, Environmental Change Institute, University of Oxford**

When it comes to analysing an energy system you have to consider the hardware, software and practices. The hardware is the technologies and the wires, the software is the codes of practice, regulation and know-how and we are all involved in the practice. The UK policy background is the 2009 Low-carbon Transition Plan.<sup>[1]</sup> The plan has three drivers: demand reduction, electrification and decarbonisation, however, these drivers are not always in step. For example, it is expected that domestic space heating will switch from gas to electric through heat pumps. However, this transition is not straightforward for consumers (because heat pumps produce water at lower

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<sup>[1]</sup> [http://www.decc.gov.uk/en/content/cms/tackling/carbon\\_plan/lctp/lctp.aspx](http://www.decc.gov.uk/en/content/cms/tackling/carbon_plan/lctp/lctp.aspx)

temperature and thus require larger radiators or under floor heating), or for networks (there will be a higher electricity demand, often 'clustered' in small areas – a particular problem for the low voltage network).

One way in which variable supply could be counteracted would be through hot water storage in homes. However, since the 1970's UK householders have been slowly ripping out hot water storage tanks in favour of combination boilers give hot water on demand. A similar trend has been seen for electric storage heaters (where a thermal mass is heated at night using cheap electricity), where the penetration has reduced from 20% in the 1970's to 8% today.

So which of the factors – hardware, software and practices – are the most important for understanding the middle ground in domestic electricity demand? Studies in California indicate that the social variables (comfort, daily routines and preferences) dominate; in fact electricity demand in similar buildings can vary by up to three times due to such factors. We can probably expect similar variability in response to smart grid applications.

There are four broad options for active demand, from the user's point of view: 1) Demand reduction via conservation and efficiency; 2) Static time-of-use tariffs (TOU), for predictable peaking and predictable supply; 3) Real-time pricing (RTP), with or without direct load control, for less predictable demand and supply; and 4) Dynamic demand for frequency response, with smart appliances. Each of these requires a different householder activity, from simple options such as choosing your appliances, through to active behaviour such as changing practices towards energy efficient behaviour.

The impact of visual displays on demand reduction (overall and peak) has been found to vary from trial to trial, as might be expected. For overall demand, responses between 3 and 15% have been recorded; not surprisingly, small-scale trials with volunteers give higher figures than whole-population trials. For peak demand reduction, responses are of the order of 10%. Customers with more than one channel for feedback, e.g. a display and an informative bill, or a phone alert when usage is specially high, show greater responses than those with only one.

### **Alastair Scott – EnCT**

The SmartRegions project monitors smart meters in Europe, identifying the best practices, pilot projects in regions and advising EU policy makers. It is funded through the Intelligent Energy Europe programme.

The EU landscape, if defined in a two by two matrix focusing on progress in implementation and policy and regulatory status can be divided into 4 different actor groups: Dynamic Movers; Market Drivers; Laggards/waverers; and Ambiguous Movers. Germany falls into the Market Driver category. It sets out roll out should take place, but leaves the market to achieve this. It has had a fully liberalised market since 2008 and is creating an open and flexible environment for smart metering.

The consumer is important in a fully liberalised market and therefore it is important to know whether they will be interested in smart meters. Without marketing solutions it is possible that only those consumers interested in high technology devices could be interested, not the whole market.

EnCT is a spin-off from the Fraunhofer Institute for Solar Energy Systems and focuses on market research for communication technology. They have recently carried out a Smart Marketing Solutions survey identifying customer interest and market potential for nine fictitious smart energy products. The survey involved 1100 participants in which they were asked to rank the different smart energy products. The report provides a segmentation of the customers which could inform which smart energy devices would best suited different customer segments.

The survey asked customers whether they would be willing to pay for different smart metering products (prices were not mentioned).

One surprising result of the study was that customers with no smart phones, a low level of education, low income were actually quite interested in smart energy products. The study also found that data protection is a big issue.

### **Catarina Naucler – Fortum**

The Stockholm Royal Seaport is a project to create a district for sustainable living, business and recreation. The Royal Seaport will be redeveloped into 10,000 new housing units for 25,000 residents, and 30,000 new jobs in various sectors. The project has ambitious environmental goals as it aims to be a fossil fuel free district by 2030 with CO<sub>2</sub> emissions per person of <1.5 tonnes/person, and also adapted to climate change. The smart grid is seen as one tool to help the energy system meet these targets. The project also has an emphasis on social goals and interaction such as public participation, accessibility, children's enjoyment and use, historical and cultural sites preservation, and reuse of old structures.

Their smart grid challenges includes: active homes with demand response; integration of local energy production; use of electric vehicles and smart charging; energy storage for customers and grid; and a smart and electrified port.

A key aspect of the project is to integrate all the aspects of the smart grid into a working market concept – including new market rules and commercial applications. A number of key questions will be examined during the project. Can we have a market where end consumer is more active? Can we move consumption? Can we drive low carbon? Can we empower consumers with power to make the choices on CO<sub>2</sub>? This presents a number of challenges to the existing regulation and ultimately some substantial changes to force the regulation into the right direction.

The project aims for houses and consumers to become active partners. Consumers will be able to use their own devices, such as smart phones, to be connected and integrate into the electricity circle and the market. Getting active houses will make the impact of the environmental objectives softer and will have a benefit for the society. The key is to make consumers more active, make them part of the smart grid.

### **Dr. Geert Verbong – University of Eindhoven**

Why do we need smart grids? We have a number of challenges that a smart grid could offer a solution for, including intermittent generation, new demand side loads such as electric vehicles, an aging grid (in Netherlands), and an increasingly complex system. Put simply the new low carbon energy system may not be reliable in the absence of a smart grid.

Why should users (this was a deliberate term as “customers” gives the impression of someone inactive at the end of a value chain) be interested in participating in a smart grid? It was suggested that there are financial, emotional and value propositions. However, these propositions will not be accepted automatically. For example demand side response, which has been used extensively in industry, could be important, but relies on users accepting intervention in their daily routines and practices and also a resolution of data and security issues.

The economic proposition, whereby users act economically rationally to price signals, is flawed because people want to do ‘stuff’ on their own timetable. Additionally, there is a lack of trust between users and the suppliers.

The emotional proposition assumes that users will act environmentally in response to information, such as that from a smart meter/visual display. However, trials have shown that only 5–15% energy is saved from such information, and that the saving is very much dependent on the individual. A study by Tom Hargreaves (University of East Anglia) has also noted that people do not automatically accept the intervention of a smart meter in their life.

The value proposition indicates that new energy services will offer value to users, however, there is too little attention paid to energy sector intermediary technologies,

practices between generation and consumption. The result is that efficiency gains in technologies have led to unsustainable practices, for example the widespread rollout of air conditioning.

To understand the user better projects should be designed with real user involvement. There is still time to do this before the mass rollout of the smart grid.

## Session 4 – Applications for smart grids

**Yvonne Hübner, Newcastle University**

The Switch-EV trial is taking place in North East England, funded by the Technology Strategy Board's Ultra-Low Carbon Vehicle Demonstrator Programme. They are currently testing 44 electric cars in the region. These are commercially-available vehicles, including the Nissan LEAF, Peugeot iOn, Avid CUE-V, Smith Electric Vehicles Edison Minibus and the Liberty Electric Cars E-Range. Information is collected from the vehicles using data loggers which transmit data via a GPRS link to a central server. This allows the project to know where people are driving, charging, how long they charge, and their patterns of usage. Most charging events happen at home, work and installed public infrastructure – 90% of journeys are within 5km of a charging post. Most people charge at work and most of the vehicles in the trial are currently hosted by companies.

One observation from the trial is that public charging posts generate trips, because these charging points offer both free charging and public parking. Many charging events at public charging posts are therefore quite short. Home sees some longer charging events. At work, charging events are often short – this is due to companies keeping a 'pool' of charged vehicles. Most charging happens during the day, as there is no information or incentives for EV users to encourage them to charge at night. Therefore, the project found that most charging events happen at times of high demand on the energy grid. The carbon content of the electricity used was therefore quite high, and due to the times of day, the CO<sub>2</sub> footprint of charging at work is a higher than at home. A large CO<sub>2</sub> saving could be generated by charging during the evening or overnight. The next phase of the Switch-EV trials will inform customers about the emission difference of charging at day compared to at night.

In general, early adopters of electric vehicles tend to be from affluent areas and are able to pay for the higher purchasing cost of an electric car. This means that economic incentives for night time charging may not change charging behaviour significantly in this group of users.

### **Maja Felicia Bendtsen – Ecogrid EU**

Ecogrid EU is an EU-funded FP7 project taking place on Bornholm Island in Denmark. It is a four-year project which began in March 2011, and aims to produce a prototype working smart grid on the island. Bornholm Island has 30,000 energy customers and is connected to the Nordic power grid by a single 70MW AC sea cable. The island has an installed capacity of 30MW of wind, along with a 16MW CHP plant, which burns a combination of coal and biomass. In 2008, 63% of Bornholm's generation came from wind power, with most of the rest imported from the mainland. In 2015 the prediction is that 72% of electricity will be supplied from wind with much of the rest from biomass. The Transmission System Operator in Denmark spends 10% of its costs on regulating the power market. Therefore, a new power market model is needed. The Ecogrid EU market being developed on Bornholm will allow a gate-closure time of 15 minutes ahead, with changes in electricity price every 5 minutes. The market will also allow the direct participation of small units, including domestic customers and demand-side participation. The tariff levied by the grid will be dynamic, with locational pricing being utilised. This could lead to different electricity prices even on neighbouring streets depending on the constraints on the grid at that time. If the market fails to produce enough electricity to satisfy demand, a local cell controller takes over to ensure demand is met.

The project will see 500 ordinary households equipped with smart meters that will provide daily price predictions and price warnings. A further 700 houses will be equipped with IBM/Powermatcher smart home technology and 500 households will use Siemens technology. These smart homes will be allowed and able to respond to the market. In Denmark, the average energy consumption is 2% of annual income, which gives small economic incentives to save money. However, these incentives may be greater with larger bases of installed heat pumps and EVs, as these technologies will affect peak demand for electricity and therefore pricing.

### **Goran Andersson – ETH Zurich**

The concept of a socio-economic infrastructure system, first conceived by T.P Hughes from the University of Pennsylvania, was introduced. The concept can be visualised as a series of concentric circles, with authorities and universities in the outside circle, manufacturers and power companies in the middle circle and hardware and software in the inner circle. In the past, the power system flowed energy from generation to transmission to loads, which were non-controllable. However, we are presently witnessing rapid growth in both RES and innovative power market activities. The physical grid has a slow capacity expansion for coping with increasing and changing demands. In the future, we will have both conventional and variable generation, as well as controllable and non-controllable loads. We need a power system which is more transparently observable and more controllable, which is why smart grids are important.

The transmission grid has been getting 'smarter' over the last decade. We are now introducing more control components on the distribution level, which leads to more feedback loops in the system. Therefore, an important component is feedback control – this needs an installed base of sensors and actuators throughout the system. We also need to create detailed models of the system and control laws. Communication and controller management also needed. To overall system control a smart meter is a sensor-actuator at the load level.

The Energy Hub concept allows unified modelling of energy networks, looking at the synergies and interactions of electricity, gas and heat networks. The modelling would include power node modelling, a unified framework for modelling power system units including operation constraints. The goal of this approach is to improve performance and flexibility of the operation of the power system, including modelling the integration and usage of storage, distributed generation and demand-side management. A smarter grid can increase the flexibility of the power system through hourly power markets. Technology, regulation and system analysis must all interact, and that flexibility is important. Lock-in effects by installing technology and by designing the system a certain way are important to avoid, and improved unified modelling of power and communication systems is needed to confront this challenge.

#### **Blanca Losada – Gas Natural Fenosa**

We live in a rapidly changing world, and energy networks and infrastructures need to be able to handle these changes. Energy infrastructures are mostly invisible in a developed country – people are mostly unaware of the complexities of power systems and use them in a passive manner. For smart grids to be successful, we need to make grids and energy usage visible to the consumer again, but with very different ways of engaging consumers compared to those used before. There are also changes in business paradigm occurring – there are more functional levels in a smart grid business model, with ESCOS, data aggregators and manufacturers of smart vehicles and appliances entering the market.

Many new technologies are entering the grid infrastructure. Gas Natural Fenosa is dividing these technologies into four levels – power infrastructure, ICT infrastructure, applications and the underlying smart grid platform. As a Distribution Network Operator (DNO), they are deploying a communication solution that will support smart metering, as well as monitoring and control systems. They are developing and implementing an open, public and non-proprietary telecoms standard to support smart metering as well as wider smart grid technologies. They are also working on a live market solution, which once again will be open and interoperable. For their demonstration projects, they are installing and testing smart metering systems from three different vendors.

Interoperability is a major problem – there are still issues with components from different vendors communicating with each other.

Gas Natural Fenosa is currently collaborating with Iberdrola on an on-going project named PRICE. This project will deploy an intelligent electrical management system over a large geographical area covering 500,000 inhabitants and 200,000 customers. The aim of this project is to gain experience and knowledge in managing and deploying smart energy systems, and will integrate smart metering systems, smarter distribution networks, distributed energy resources and smarter, more active customers.

### **Albert van den Noort – KEMA**

The EU FP7-funded PowerMatching City project is designed to demonstrate the feasibility of a smart energy system in the Dutch town of Hoogkerk. The project started in 2007, and aims to explore power-system optimisation based on local energy markets. The project integrates local generation and demand response, and the aim is to develop an application independent solution for optimisation. The town has had 350m<sup>2</sup> of PV panels installed, as well as hybrid heat pumps in 13 houses and micro CHP in 12 more. Smart appliances and smart electric vehicles in the town are also being trialled. They aim for a multi-goal optimisation solution, ensuring energy is used cost-effectively, renewable energy is effectively integrated, there is capacity management to reduce peak loads and increase system flexibility and that there is commercial optimisation, utilising virtual power plants to provide new commercial opportunities.

The project operates a personal energy market in the home. In home appliances and domestic generation participate automatically, based on their needs, usage patterns and power usage. There is no central computer the appliances themselves are intelligent participants. This then leads into neighbourhood trading – homes can trade with each other to form local energy markets, which can then aggregate into a smart energy system. This is designed to be a generic scalable concept, as the markets can aggregate at many levels.

The first results show that the coordination systems work as intended, and that it is possible to treat the city as a virtual power plant, able to help reduce peak loads. Larger scale demonstrations of this concept and technology are planned in the next few years. Phase 2 of the PowerMatching City concept will introduce billing based on real-time pricing and will extending the demonstration to incorporate electric transportation. This work is feeding into the Smart Energy Collective project – five pilot projects spread across the Netherlands, connecting more than 5000 commercial and residential end-users.

## Panel discussion

*What would an impartial observer who hasn't heard the term 'smart grid' make of the last two days of presentations?*

The panellists agreed that the range of issues surrounding the grid were astounding, covering a huge range of technologies and disciplines. There have been some important questions raised – Should the grid work on community structures or individual consumers? Has there been a parallel in the development of the smart grid with other technology advances such as the internet? Are the projects and initiatives involving the right people, and have they identified the right skillsets required to move the smart grid forward?

It was agreed that it was always good to let people feel the benefits – they get more interested when they play with the new technologies and appliances. Electric vehicles especially are a lot more fun to use than people expect. Customers and end-users need to be involved in the development of the social aspects of the grid technologies, and customer viewpoints need to be taken on board early.

*We've socialised historically a lot of costs with energy supply. In a smart world, we'll understand a lot more where costs will fall. Does the smart grid open up a 'Pandora's box' of true cost reflectivity?*

Bornholm Island is implementing per-street charging. It remains to be seen if this will be popular with customers. The Switch-EV trial has identified that the demand curve for vehicle charging is surprisingly flat in the evening. Quick charging will increase CO<sub>2</sub> emissions as it occurs at the margins of the electricity demand curve. However, quick charging allows greater demand flexibility as you don't need such a long time to charge. Smart systems need to evolve to cover these factors. It is up to the regulator whether true cost-reflective pricing should be allowed, as traditionally we have socialised a lot of these costs. It will probably open up some unintended consequences.

*Is there a possibility we may end up with a proliferation of solutions that won't interconnect with each other?*

Standardisation is a hot issue – it is important to use the right standards for the right society and energy system. There are lots of standards available, there needs to be fewer, more common standards. This lack of common standards is a big problem for the Bornholm system – some components, for example, use Zigbee, some don't. It is important to think in terms of the entire system when choosing standards and technologies. It was noted that NIST in the USA are active in designing standards for intelligent energy systems, but Europe could almost certainly do more to speed up active design and adoption of standards.

# Summary of break-out session

**BREAKOUT 1: What are the social barriers to the smart grid? Who should do something about them and what should they do?**

**Host – Maarten Wolsink, University of Amsterdam**

The group immediately set about rephrasing the question into something they considered more representative. The new question was “**What institutional changes are needed to use the social opportunities to establish smart grids**”. Phrased this way the question recognises the existence of many unused opportunities rather than expressing a view of society as a collection of barriers. It also focuses on the key issue in social acceptance of innovation, which is institutional change.

In addressing the question, it is not possible to only consider the consumer; all other actors in the entire energy generation–supply–consumption chain must also be considered. The development of the smart grid is being driven by policy makers and by energy and ICT businesses and it is within these that the majority of the barriers exist. There is a lack of trust between consumers and these bodies – in both directions – on issues of confidentiality and energy bills. For example consumers might expect to see a reduction in their energy bills because of the smart grid, possibly because suppliers make such promises that cannot be fulfilled; however, companies will pass through the costs of delivering their version of the smart grid to consumers. For consumers the smart grid might become an opportunity to act as a ‘prosumer’ generating power for their own consumption, but for achieving that they are facing many institutional barriers in the existing power supply system and in policy and regulatory frames.

The smart grid is a social opportunity, but how can consumer enthusiasm be raised when people and – all other actors alike – don’t understand what a smart grid is. It is important to understand the social–cultural roots of the demand (of all different engagement in energy) in order to understand the current demand, future demand and artificially created demand for a smart grid. Until this is understood we have neither a basis for understanding why customers should wish to collaborate in the smart grid, nor why supply–side actors and policy actors would be engaged in developing it. It was suggested that decision makers should be demanding a high standard of proof about claims for smart grids in order to inform customer of the evidence for benefits. Are we prepared to create an entirely new and differently organised energy system, including crucial shifts in power and challenging vested interests? Finally, the group concluded that the main barrier for smart grid development may be our inability to consider these major institutional changes.

**BREAKOUT 2: Does the smart grid represent a change of business model for energy companies? If so, what is the change and what are the opportunities for new business models and new businesses?**

**Host – María Gradillas, Imperial College London**

Addressing the first part of the question, the group focused on unbundled energy companies as this seems to be the trend in EU policy.

For network companies it may not be necessary to change the business model, although the smart grid does offer the opportunity to change business processes (for example increased efficiency in managing assets).

For retailers the smart grid does offer an opportunity to change their business model. The group identified three types of opportunities:

1. Moving towards offering **energy services** as opposed to just offering electricity (selling light or warmth and not just electrons). It was noted this model seems already to be working for commercial customers but has not been tested at the individual consumer level yet.
2. Acting as aggregators and offering system services (ancillary services) – one participant noted that here is where the real money was to be made for retailers and possibly for some generators, moving upstream.
3. New services that we still can't envision now, although new services don't necessarily need to be provided by current energy retailers, new players might come in.

The scope of the opportunities for companies to offer new services will be determined by:

**Access to data from smart grids** – in this sense: who owns the data; who can access it; and what it can be used for.

**Regulatory framework** – whether the framework allows or prohibits commercial activities and whether these regulations could be changed. For example in Denmark, energy storage units are not able to resell the electricity they store. Also in Denmark, consumers cannot be locked into a deal for more than six months – in a particular project it was considered helping consumers fund heat pumps then aggregating that demand to offer services upstream; however it was considered too risky as after six months consumers could stop paying bills but keep the heat pump.

**Trust:** which organisations will consumers trust with this data – utilities at least in the UK typically are not trusted by consumers, however, consumers do seem to trust other companies such as Google or Facebook with personal information.

**Consumer demand for the services** – this is requisite for a successful commercial venture, yet the market data does not exist for a number of novel services.

**BREAKOUT 3: What’s in it for the consumer? They are going to pay for the smart grid, what will they get in return?**

**Host: Yvonne Hübner, Newcastle University**

The group concluded that the benefits for a smart grid are more for society than for individuals.

Key societal benefits include security of power supply – a smart grid should increase the reliability and stability of power supply and increase the power quality. The smart grid is also an enabler of a low-carbon energy system, which has significant local, national and global societal benefits including mitigation of climate change and reduced air pollution. Smart meters will provide consumers with more information about their energy use and empower them to make smarter decisions. They would also put an end to estimated bills and provide the consumer with more transparency to energy prices.

The smart grid was described as a “drug prescribed by a doctor” – if we don’t go for it, the worst might happen (e.g. high energy prices, increased pollution, etc.). The cost of doing nothing will be higher than the cost of implementing smart grids. The smart grid itself does not necessarily mean cost savings for consumers; in fact the cost of installing the smart grid is likely to be passed through to consumers, increasing bills. The smart grid and smart meters does provide information through which consumers could take action to reduce their bills. It was suggested that this information alone isn’t sufficient and that education (how to save energy) and transparency (clear billing indicating potential and actual savings) were also important facets.

It is assumed that the cost of the smart grid will be socialised, however, not all society will necessarily benefit from it. Different models could be used to pay for the infrastructure, for example no upfront payment but how about pre-load depreciation 3% to 2%, or back load depreciation 1% to 4% over the next 20 years.

Finally, it was asked whether there are entertainment opportunities associated with the deployment of smart meters?

## **BREAKOUT 4: What needs to be regulated in the smart grid and what should be left to the market?**

**Host: Aidan Rhodes, UKERC**

The question was asked – what do we need a regulator to do? There are two broad models of regulation. One takes a ‘hands-off’ approach to policy and development, simply attempting to provide a level playing field for private enterprise which takes consumer interest into account and works to avoid the build-up of monopoly power and excessive market distortion. The other model takes a more active role in the development of the energy system, including ensuring that technologies work to interoperable standards, working to harmonise standards internationally, and ensure that innovation in the system is supported and incentivised. This is a far more long-term planning aspect to regulation, and the regulator is necessarily more integrated into policymaking and strategic thinking. Ofgem in the UK began at the first type of regulator, but in recent years has shifted towards the second. An important point raised was that regulators should seek to regulate the functions of a smart grid, but not the technological solutions needed to achieve that function.

As smart grids include a wealth of ICT technologies and large quantities of data flows, the role of an energy regulator will necessarily change and expand to encompass these new communication technologies. Of particular interest is the data collected from customers’ smart meters. In the UK, for example, this data is collected by the suppliers and sent to a new central communications entity. However, this data is of use to DNOs, who will be able to use it to balance the network. The questions of data ownership, privacy and sharing will be very important to regulators in the future, especially as this data will contain details of customers’ usage patterns and behaviour. How open the access to data will be, and how trust will be built and maintained between the regulator, supply companies and customers will be big issues in the future.

One interesting outcome of smart grid technologies will be a greater understanding of the electricity flows and usages through the network, and therefore far more accurate calculations can be made on the cost of supplying energy to different customers. Currently the UK socialises most network costs, as there is no easy way to determine how much it costs to supply electricity to different smaller customers. It will be possible, however, to charge customers the exact amount for the costs of the infrastructure to deliver their energy using smarter grid technologies. Future regulators will have to decide whether to continue socialising much of these costs or to more accurately charge people for the required infrastructure.

**BREAKOUT 5: The smart grid requires numerous actors to deliver it. Who are they, are they engaged, and are they all talking to each other?**

**Host: François Moisan, ADEME**

The smart grid has a very large number of stakeholders (including technology developers, telecommunication, electronics part providers, Distribution Network Operators (DNOs), Distribution System Operators (DSOs), local authorities, regulators, policy-makers, NGOs, universities, public research, alliances and consumers) involved at different stage of the development from demonstration to implementation. There are a growing number of new “unconventional” actors such as communication and IT businesses. The myriad of actors are not all necessarily at the same stage of smart grid development and are not necessarily speaking a common smart grid language. It was also questioned whether all the stakeholders are cooperating or in competition. In some cases there are areas of tension – one example was the area of smart meters where there is competition between energy providers and telecom/services providers. One participant questioned whether there is/should be a global collaboration on smart grids – if so how should it operate?

It was suggested that it has not been fully elucidated what the risks, costs and benefits of the smart grid are and how they will be shared between the various stakeholders. Stakeholders are currently trying to find their position and numerous new communities are being created, but in the absence of a controlling mind. One participant suggested that we are not developing smart grids in a constructive manner and that the Government should lead the way. However, it was also suggested that Governments do not necessarily understand what a smart grid is and therefore perhaps a programme of education was required.

Analogies between the smart grid and the internet were drawn by several participants. It was questioned whether a smart grid could develop in a free market in an analogous manner. It was noted that internet blackouts have “never killed anyone”.

There was a question whether there was sufficient collaboration ongoing between academia and industry. One specific example is whether students are being trained by schools/university to have the skills required by industry to deliver the smart grid.

## List of participants and affiliations

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