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The Knowledge Network

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Dear Mr Nash

SMART METERING FOR ELECTRICITY AND GAS

This response is submitted by the Institution of Engineering and Technology with input from and endorsement by the Royal Academy of Engineering and the UK Computing Research Committee.

It draws on the expertise of professional engineers in the energy, ICT and communications communities, being prepared by the IET's Energy Sector Panel in consultation with the IET's IT and Communications Sector Panels. It takes into account comments from experts in the wider IET membership as well as inputs from the Royal Academy of Engineering and the UK Computing Research Committee.

We support the deployment of smart meters as enablers of change in the UK energy sector. Smart meters are an important part of the IET's vision for more flexible and efficient energy supply infrastructures, particularly for electricity. As such the deployment programme for smart meters must be designed and implemented as part of a wider plan for smart energy grids.

The consultation addresses many aspects of this subject but omits a number of important areas. The smart meter itself is the tip of the iceberg. It will need a major supporting infrastructure to allow data to be collected, aggregated, distributed and used, and to enable decisions made on this data to be implemented. Delivering such infrastructure will be a major business change project that will require significant investment, and attention to the detail of project definition and management.

A further aspect requiring substantial attention is that of data security. The data will be used by multiple users: customers, energy suppliers, network operators and others, and both data security and integrity will be at risk unless appropriately robust and resilient systems are provided.

Smart metering hardware and software will continue to develop at a fast pace through innovations in Europe, the USA and elsewhere. It is essential therefore that systems developed for the UK are not only compatible with global developments and but also that they are flexible to future changes. Equipment installed towards the end of the planned rollout is likely to have substantially enhanced functionality compared to what it available today.

None of this complexity is an argument for delay. The climate change challenge is too urgent for that. Instead we need to move forward rapidly with pilot schemes and trials, and learn from these experiences whilst continuing to develop robust systems for major rollout. At the same time, a strong public engagement programme will be vital to involve users in getting the best from this substantial investment.

Please let us know if we can be of any further assistance.

Yours sincerely,

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IET and RAEng Submission to DECC on Smart Metering - August 2009

PART 1 – OVERVIEW

Energy Policy benefits

The IET is strongly supportive of a deployment of smart meters as enablers of change in the UK energy sector. Smart meters are an important part of the IET's vision for more flexible and efficient energy supply infrastructures, particularly for electricity. As such, the deployment programme for smart meters must be designed and implemented as part of a wider plan for smart energy grids.

We agree that this initiative has the potential to achieve a number of objectives with the overall aim of facilitating a low carbon infrastructure:

- Consumer education about energy consumption, usage and cost of use
- Management of peak demand and/or short term supply and demand imbalances, particularly in electricity
- More efficient and secure operation of the energy systems, especially electricity where it will improve security of supply by facilitating the provision of frequency response, reserve and reactive power to the energy system
- Enabling and encouraging small scale electricity production
- Assisting network management, particular as networks become smarter
- Informing future developments and current R&D so as to allow customers to derive maximum benefits from technology.

Therefore smart meter deployment should not be seen as an end in itself. It should lead seamlessly into the development and deployment of smart networks, changing the technical and business model, especially for electricity, to enable customers to become engaged in energy supply and demand. It is the starting point to engage end users in an energy revolution and, as emphasised above, should be seen as part of a bigger picture involving customer education, carbon pricing, energy efficiency in buildings, electrification of transport and many other aspects of our daily lives.

A Major Business Change Project

The fundamental concept should be that smart meters are a small part of a large and complex system. Their deployment is more about wider business change, using information and communication (ICT) technology as an enabler, and hosted on, or utilised by, infrastructure that has not yet been fully defined or built. As such it cannot be overstated how important it will be to capture requirements, design, test, and plan as a system, and implement, taking a holistic and top level systems view.

We envisage the system will comprise as a minimum:

- Hardware installed in the customer's premises capable of being remotely accessible via one or more wireless or network interfaces
- Output interfaces capable of driving a local display or instructing designated appliances
- Secure, resilient and reliable communication infrastructure to transport data to and from the energy supplier, and to and from the network/system operator
- Agreed communication protocols and software tools and modules

- Data collection and management functions utilising secure technologies that will ensure data integrity and reliability
- Data repository – required for billing, maintenance and configuration management
- Means to give access to stored data by authorised industry players
- Customer call centre facilities for handling queries, along with change requests from both service providers and customers
- A maintenance, installation workforce trained for both gas and electricity installations along with appropriate ITC training

The approach needs to take account of what is technologically feasible, both now and in the future, and what is desirable by all parties. Stakeholders will include customers and manufacturers of white goods through to the owners and maintainers of the infrastructure and of the associated data. If the challenge is not approached in this manner, the project runs serious risks of at best underperformance, at worst failure, as experienced by other large (IT) projects.

Over time this business change may also challenge current fragmentation of ownership and models of regulation in the industry. The UK's energy industry is among the world's most competitive but also among the world's most fragmented. Delivery of the required outcomes may require some revisiting of industry relationships, particularly in the responsibilities of network companies versus supply companies, and of responsibilities for metering.

Security

Smart Meters are computer-based systems utilising as yet undefined means of remote access. As such these systems are potentially vulnerable to attacks including the propagation of viruses and mal-ware and the possibility of user generated attacks into the metering infrastructure. It is surprising to note that nowhere in the consultation are there references to safety, security, resilience or data integrity. This is a significant omission.

The proposed network of smart meters will form a critical element of the national infrastructure and as such should be designed from the start to mitigate the risks and threats of sabotage, vandalism /hacking, denial of service attacks, unauthorised access etc. It also needs to be designed to fail in a safe manner in the event of a fault at any stage in the process.

For these reasons it should be a prerequisite that all proposed systems and architectures be the subject of a formal and rigorous review by independent experts.

Communications infrastructure

Communication and access technologies likely to be utilised, and the architecture used to transport data for both service providers and customers, are not considered in the consultation; again a significant omission. As it is a major UK investment programme that will impact all homes, it is surprising that there is no mention or apparent connection with the plans and proposals set out in the Digital Britain[1] report.

[1] "Digital Britain" published by BIS and DCMS, June 2009
http://www.culture.gov.uk/images/publications/digitalbritain-finalreport-jun09.pdf

In terms of data communication, security and resilience it may be necessary to implement two means of access. One layer of infrastructure owned and maintained by the energy supplier which cannot be bridged, intercepted, disconnected or tampered with, so as to guarantee reliable communications between the service provider and the customer's metering equipment. A second interface, probably read-only, that would enable the customer to access usage and cost data. This would need to be sufficiently flexible to provide data for computer based systems as well as other embedded systems that may help those suffering disability or who are in fuel poverty.

Customer Premises Metering Equipment

Although referred to as a 'Smart Meter' what is needed is a device at the customer's premises that can monitor usage and provide data such as cost per unit of energy and trends of usage. In addition it needs to be able to measure separately the import and export of energy, and provide an interface that can be exploited by proprietary energy saving products. This approach would provide customer choice in the adoption of standard computer based solutions, or off the shelf plug and play high street products.

Flexibility for the Future

Since smart metering is essentially ICT, it is likely to develop at the same pace as other consumer networks and electronics such as mobile telephony and the internet. Both its potential and capability will be vastly greater in five to ten years than currently. We expect this pace of change to continue. Some elements of the metering system installed in the early years will be out of date well before rollout has been completed and the overall system will need to accommodate this. This is not an argument for delay, rather a caution against over prescription.

This may also require an assessment of the global trends in smart meters and related systems as many countries have similar plans for deployment. It is vital that we do not create a UK smart meter system that has indigenous characteristics that increase its costs and/or reduce its ability to evolve into the future. It is essential to learn from and work within the international community to avoid such an outcome. We believe that if the fundamental architecture of the smart grid communications system and the smart meter device is well conceived and able to be updated dynamically the ability to meet future challenges will be greatly enhanced.

Stakeholder Buy-In

We commented above that smart metering is part of a much bigger development in our energy infrastructures. For this reason, it is vital that all parties that have a stake in this future vision have their views taken fully into account in the smart meter debate. We strongly recommend that the views of customer representatives, network companies, domestic appliance manufacturers, potential energy services providers, the transport sector and the IT and communications sector are taken into account before committing to a course of action. Whereas the use of smart meters might initially be led by energy suppliers, in the medium term this could just be part of an intelligent grid/customer interface.

End User Benefits

Care needs to be taken to convince customers of the benefits of smart meters. Displays of energy consumption need to be appealing, and different display types

allowed to evolve to suit different customer needs. The longer term benefits of reduced costs through response to more sophisticated tariffs will only be realised after sustained effort, and consumers' interest will meanwhile need to be maintained.

Cost data availability opens the way for more intelligent and cognitive building designs and equipment that could provide benefit to customers in an automated manner. The availability of such energy related data would be a major enabler for the next generation of buildings and appliances that can make direct autonomous use of the data thus freeing the customer from having to make detailed calculations.

The take up of access to the internet has been rapid with the majority of household's now viewing broadband access as a basic utility service. As a consequence network connectivity is no longer considered unusual. What may not have been fully appreciated is that having made the step to network attached appliances whole new industries and services will be spawned. Intelligent fridges have received some publicity but there would be prospects for other applications such as remote medical diagnostics and service monitoring.

The DECC activity in smart metering could benefit from closer linkage to Digital Britain from an implementation perspective. Homes are unlikely to wish to have separate hubs for energy, security, entertainment, education and healthcare. The smart metering consultation seems to have ignored an integrated home as a domain approach, or the benefits that smart metering could also bring to Digital Britain

Human Factors

Evidence is emerging of some public mistrust and reaction against control of their household energy by an external organisation such as an electricity supplier, whose motives may not be trusted. Winning hearts and minds will be a major part of the change process.

What seems entirely logical to engineers as a means for smoothing peak demand and combating climate change may sound like an infringement of personal liberty to home owners. A particular sensitivity will be to the potential ability to interrupt electricity service.
Appropriate safeguards, together with clear factual public information from trusted sources will be needed. Above all, customers need to be able to rely on the system being safe, secure and affordable and that their personal data will not be compromised or misused.

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PART 2 - RESPONSES TO CONSULTATION QUESTIONS

Q1. Do you have any comments on the Government's preference for the Central Communications model?

We support the Central Communications model in preference to the "competitive" or "fully centralised" model. This is the model for metering in virtually every other European country. It would benefit from common standards and protocols to enable metering to be standardised.

Many of the solutions present in a smart grid will be competitively offered by commercial entities outside the regulated industry. Therefore, whatever communications model is chosen, it should facilitate, rather than being a barrier to, new and innovative products and services which enhance a smart grid and make it smarter.

Security is of paramount importance and implementation will require a careful balance between open access to data for current and new market participants and the need for critical infrastructure to be sufficiently protected from unauthorised access.

Given the magnitude of the proposed roll-out, consideration should be given to provision for metering facilities where there is distributed (micro) generation which may also become a significant feature by 2020. The matter is discussed in the report to the Electricity Networks Strategy Group (ENSG) by PB Power and Lower Watts Consulting, entitled "Future Network Architectures", 2007.
http://www.ensg.gov.uk/assets/dgcg00102rep.pdf

The provision of metering facilities for distributed generation could be provided by the Central Communications Model but the related network control function would indicate that the smart metering should be provided by the network operator and not the supplier. A further reason for this view is that a network operator already has an appreciable technical capability and considerably more than that of the supplier. (Paragraphs 2.20 to 2.21 of the DECC Consultation Document refer.)

The IET is concerned that the allocated budget for the communication infrastructure is low. For the preferred Central Communications model, the allocated figure for the communications costs over the 21 year period from 2009 to 2030 is £1,544 million (NPV)[2]. This amounts to £73.5 million per year. This budget spread over 25 to 26 million households[3] means a per meter communications cost of £2.94 per year. This includes the initial rollout costs of the nationwide communications infrastructure. Most companies which own and run nationwide communications infrastructures would consider this to be an impractical figure.

[2] Smart Meter Roll Out: Market Model Definition & Evaluation Project, V1.0, section 4.3, Baringa Partners LLP, 8 April 2009
[3] Mostly Mobile, Ofcom's mobile sector assessment Second consultation, 8 July 2009

Q3. Do you agree the Central Communications model effectively facilitates 'end to end' management of the electricity networks system needed for smart grids?

In general the proposed model is acceptable but would need to ensure that data access was open to new market players (with appropriate security and integrity) providing integration services to both the consumer and the utility.

The SmartGrid is a concept which requires "total system" design and implementation to be considered. The roll-out of the SmartGrid will take decades to achieve. It is therefore imperative the Central Communication model allows for a decentralised functionality to evolve as the distribution power networks evolve into more dynamic active networks.

Therefore although Automated Meter Reading functionality is an important starting point with possible two-way communication to a centralised control centre being considered visionary, the ability to allow for localised peer-to-peer communication to seamlessly evolve will be of the utmost importance. Further, the need to allow for connectivity to the smart meter via a high speed data bus for external controllers/gateways will dictate how "smart" our networks will be allowed to become in the life time of the smart meters rolled-out today.

The major advantage of this model is the development of a UK wide standard interface and the ability to provide incremental improvements to the "back-bone" as required by new functionality from new third-party stakeholders.

An important issue will be who bears the cost for any functional improvement through time and how this will affect the interfaces provided.

Q7. Do you agree with the functionality proposed for smart meters? Please explain your reasons and if possible give evidence for your comments.

As indicated in the previous answer, the external connectivity into the intelligent home of the future and the ability to allow data transfer through the smart meter will dictate the level of Active Network Management that will be achievable/practical with the current proposals. To be effective it must enable the customer to choose technologies for the use of energy that are "automatic" so that there is no need for suppliers to intervene directly when deciding which appliances are run and when.

The challenge will be to move from purely user action required by interface from a display device, to one of unseen yet programmable action by the user to automatically select appropriate tariffs, buy/sell ancillary services, export/import supply, manage future carbon market opportunities, etc.

The potential widespread use of electric vehicles has interesting implications for electricity metering. The ability to handle different tariffs for different uses as well as different time periods may be required.

It is vital that network companies and supply chain stakeholders such as white goods manufacturers, electric vehicles manufacturers and others are fully engaged in the development of the overall meter specification.

In terms of the functionality identified in table 3.3 of the consultation document, we make the following observations:

A Remote provision of accurate reads/information for defined time periods

This is a very high level description of functionality. The definition of a "market organisation" is undefined and therefore open to interpretation.
In order for smart metering to be effective it must enable the customer to connect the many commercially available products and the many products in late stage R&D in order to leverage the benefits offered by these technologies.

B Two way communications to the meter system

No mention is made of scanning rates and hence associated requirements of telecommunication systems. For remote meter reading (say for quarterly billing) or where time-of-use tariffs are fixed, such requirements may not be onerous. However if the domestic customer were to be offered dynamic prices according to spot market prices then a high capacity telecommunications system would be required. This would be particularly the case if there was a high level of penetration of distributed generation among domestic and SME customers. In this case, the Great Britain System Operator (National Grid) would need to know the cumulative level and energy source of distributed generation in (near) real time – say by settlement period (i.e. each half hour) for system frequency control purposes. Further, if the future HEV/EV load/storage implications are considered, the ability to have specific interruptible load or fast response buy/sell storage options will depend on data control response times. Similarly, Distribution Network Operators (DNOs) will need data that allows loadings on distribution feeders to be measured and managed, something that will become increasingly important as new forms of load such as electric vehicle charging and heat pumps start to multiply.

Some work needs to be done to fully understand the level of aggregation of data that is appropriate for the system operator at national or perhaps local level to carry out its function. Detailed, real time data about the performance and intentions of every distributed generator and intelligent/smart load would not be required and some information (possibly enough) could be gleaned from sensing power flows and learning from their fluctuations in response to changing price signals.

C Home area network based on open standards and protocols
- provide "real time" information to an in-home display, other devices to link to the meter system

As pointed out already, the "other devices to link to the meter" requires careful consideration of connectivity standards, protocols supported and "pass-through" capability of the meter to support true Active Network Management integrated with the intelligent appliances of the future and the electric transport options that could be supported into the future.

D Support for a range of time of use tariffs
- multiple registers within the meter for billing purposes

A minimum requirement would be the ability for external devices (possibly from both sides of the meter connection) to gain access to tariff data and ability to automatically select correct tariffs.

E Load management capability to deliver demand side management
- ability to remotely control electricity load for more sophisticated control of devices in the home

This is a very limited view. Demand side participation requires a much wider view than just controlling loads, e.g. the ability to

- use stored energy for export or
- demand ancillary services such as reactive load support
- interact in real time with Active Network Management devices in the distribution network, etc

All of the above should be encompassed in the phrase "more sophisticated control of devices". For example:

- extent of load management capability (number of devices)
- means of communicating with loads (what sort of wireless/wired networks)
- extent of communication (can meter interrogate a device to find out whether it is suitable to be disconnected and for what period?)
- sophistication of linkages of these decisions to tariff
- extent to which customer can control/override this, linkages to home PC or its successor

F Remote disablement and enablement of supply
- that will support remote switching between credit and pre-payment

While remote switching between credit and pre-payment is acceptable and labour-saving, it should be ensured that the system is designed to be fail safe. Note here that "system" includes all aspects of the billing process including the human interfaces. Customers need to be assured that it is NOT proposed to enable a supply to be cut off from a house remotely.

It is the possibility of unintended remote disablement of supply – perhaps on a regional level - which we believe brings Smart Metering into the extended Critical National Infrastructure with all the additional safeguards that this implies. It is an additional vulnerability which previously did not arise.

G Exported electricity measurement
- Measure net export

We disagree that measuring net export is sufficient. The need to measure import separately to export for electricity will allow for connection of controllers to the smart meter to interrogate and act on this information, based on end user defined preferences, to enable enhanced tariffs to encourage distributed renewable generation.

H Capacity to communicate with a measurement device within a microgenerator
- receive, store, communicate total generation for billing

Two very different technology environments will be brought together via the smart meter:

- Active Network Management, primarily of benefit to the network company, and

- intelligent energy management, primarily of benefit to users and supply companies

Network management functions necessary as smart grids develop will include voltage control, load management on distribution feeders, and measurement and management of power quality issues such as harmonics and voltage flicker at local level. The smart metering system should be capable either of providing this information to the DNO from day one, or of straightforward subsequent enhancement to have this capability.

Q8. Are there any additional requirements that will be needed to facilitate smarter network management, efficient energy management and the development of "smart Grids"? Please provide analysis particularly on costs and benefits, where possible.

It is important to realise that the proposals to date are little more than enhanced Automatic Meter Reading capabilities that will need to be continually upgraded via software enhancements. An analogy is that of Sky box facilities which have grown with the same hardware but incremental updates to software via downloads have been (sometimes) invisible to the end user.

Problems arise if the hardware interfaces are unable to support the improved functionality. Again going back to the Sky box analogy this would be the requirement to go from Sky+ to SkyHD functionality.

It is therefore imperative that sufficient future proofing of hardware interface to the "outside world" is allowed for while ensuring that sufficient capacity for future software enhancements is considered. Many of these technologies are in the early demonstration phases of deployment. Examples are EPSRC projects such as Aura-NMS or European FP7 projects such as FENIX or ADDRESS. The proposed functionality/requirements should take note of these projects to ensure early future proofing is included in the deployment of the proposed smart meters.

Q12. Do you agree with the Government's position that a standalone display should be provided with a smart meter?

The impact of user displays is not yet fully understood. The expectation now is for user preferences to be taken account of in an automated and intelligent manner. e.g. (for electricity) by programmable interfaces: selection of tariff ranges, low carbon preference (I wish to use as much of my own generation as possible and reduce imported generation), etc. If displays are to be used they should not be relied on as the only form of mass behavioural change mechanism. Many studies both nationally (e.g. (SPRU) Powering the House) and internationally have focused on these key areas, heed should be taken of this body of opinion.

As automated, intelligent devices will not be available in most houses at the time that a smart meter is installed, the provision of a standalone display will be important for two reasons. Firstly, it will physically demonstrate a change from the current metering technology and secondly, it will give householders the opportunity at least to start to learn about the way they use energy. For these reasons, they should be provided and a significant research effort should be devoted now to determine the most useful types of display in terms of both usability and data displayed.

Q13. Do you have any comments on what sort of data should be provided to consumers as a minimum to help them best act to save energy (e.g. information on energy use. Money, CO2 etc)?

This is a very specialist area as it depends not just on what information is provided but how users, who are not a uniform group, react to the information. The IET would not claim to have specialist knowledge in this area. A minimum might include energy use, money, CO2 and a means of showing historical trending but the format would need to be good. Note that this would still be a relatively "dumb" display, without the programmable interactivity that is envisaged for the future.

We understand that Government is funding an Energy Demand Research Project that is exploring a range of methods of providing information to consumers to understand which techniques are most effective. The results from studies of this type, and other work being carried out internationally, should be taken fully into account.

Q18. Do you have any comments on the implications of the Government's proposed approach in [the SME] sector for the development of smart grids?

An SME, as far as a SmartGrid is concerned has greater potential for control/import/export than a residential user. The difference will normally be the level of connection, e.g. a three phase connection at 415V or connectivity to a higher voltage. The distinct differences on the user side of the "intelligence" will be to be able to select different zones or apparatus as non-interruptible or high availability, etc. So price signals or load reduction signals may need to interpreted differently but should be uniform from the utility side of the meter. Much can be learned from Sweden in this respect.

Q21. Do you agree with the Government's approach to promoting inter-operability in the non-domestic market? Do you have particular views about the interaction between the Government's proposals for the non-domestic sector and the domestic smart meter roll out?

A dilemma exists with timing in this respect, if we wait for interoperability to be solved across many different aspects (the utility side communications/protocols versus the residential side communications/protocols) the chance of using this as a demand side response tool for the 2020 energy efficiency targets is unlikely.

A balance will be required to ensure very well known interfaces are utilized between meter and the residential side, such as Ethernet or USB, to ensure fast exchange of information to intelligent controllers and the more recognisable standards on the utility side of the meter, such as IEC 61850, are utilised as a fast first step.

Openness to future change at frequent intervals is important, and every effort should be made to standardise with approaches being taken elsewhere, especially in Europe, to avoid a solution involving hardware unique to the UK.

Q22. Has the Government identified the right issues for the immediate next steps?

We believe that Government should address the integrated power network and ICT integration issues simultaneously. In particular:

- The need to address this as a major business change project enabled by ICT. There is much good advice available on how to go about this.

- The need to address head on the security and reliability issues raised by smart metering and the additional vulnerabilities that two-way interconnectivity will bring. The proposed network of smart meters will form a critical element of the national infrastructure and as such should be designed from the start to mitigate the risks and threats of sabotage, vandalism /hacking, denial of service attacks, unauthorised access etc as well as failing in a safe manner in the event of a fault. **For these reasons it should be a prerequisite that all proposed systems and architectures shall be the subject of a formal and rigorous review by independent experts**. The absence from the consultation of communications and IT aspects and their security and reliability is startling. This work needs to be integral to the project and in hand now.

- A missing "next step" is to ensure there is joined up activity to ensure Active Network Management on a distributed as well as centralised communication model enables local control and automation actions within the Distribution (HV/LV) Networks.

- More work is needed on the ability of the programme to accommodate change. The policy concept seems to be around a one off rollout over many years. The reality is that technology will overtake this programme. What is installed in 2020 should be totally different to what is installed in 2010.

- There is a need to ensure that the training of installers of combined smart meters (electricity and gas) equips them to inform the customer on both the use and capability of the device.

Although more work is needed as outlined above, the urgency of the climate change problem demands action now, and the current linear approach is likely to be slow. Pilot schemes should be undertaken quickly so lessons can be learned and applied to more extensive roll-outs.

IET and RAEng
3 August 2009