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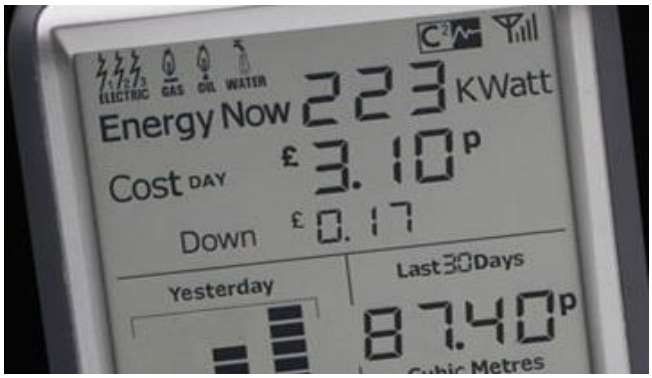
Smart Metering of Energy and Water



Smart meters record energy and water usage and improve how this information is relayed to both consumer and suppliers. The Government plans to roll-out smart meters of electricity and gas to all households in Great Britain by the end of 2020. This POSTnote examines the potential benefits and risks associated with smart metering of both water and energy, and the challenges for the energy smart metering roll-out.

Overview

- The Government plans a nationwide roll-out of smart meters for electricity and gas, which can enable energy savings, accurate billing and reduce the cost of operating the electricity and gas networks.
- The case for conventional or smart water metering varies regionally. There are no plans for a national roll-out of water meters.
- The behaviour change required to make significant energy and water savings from smart metering depends on widespread and sustained consumer engagement.
- There are concerns about the distribution of roll-out benefits for different sectors and social groups, and that costs could rise.
- The increased volume of data from smart metering could present privacy and cyber security challenges.

Background

Using energy and water more efficiently is a simple and cost-effective way of cutting carbon emissions, reducing demand on resources and lowering consumer bills. Evidence suggests there are a number of barriers preventing consumers from making energy and water savings (POSTnote 417), including a lack of access to detailed information on their energy and water usage.[1] Information on usage is provided to consumers through their bills, based on infrequent readings from conventional gas, electricity and water meters. Conventional meters are typically located out of sight of the user and are not designed for user engagement.

Smart meters measure the usage of gas, electricity or water, allow information to be sent wirelessly to and from the supplier, and send the real-time usage data to a device to be viewed by the consumer. Energy consumers will be able to view their usage (in energy or monetary units) and pricing information via an in-home display (IHD). IHDs can also display the amount of electricity exported to the grid from consumer-owned micro-generation, such as solar panels. For water smart metering, using IHDs may not always be feasible and usage may need to be viewed through online alternatives.

Smart Metering Policy

Smart energy metering

The Government plans a nationwide roll-out of electricity and gas smart metering. Following the 2008 and 2011 Energy Acts the Department of Energy and Climate Change (DECC) established a regulatory framework for the roll-out (Box 1) overseen by the UK gas and electricity market regulator Ofgem. The framework places a regulatory obligation on suppliers to take all reasonable steps to install smart meters and IHDs in all domestic and small non-domestic properties in GB between 2015 and the end of 2020. Consumers will not be mandated to accept smart meters but all will take on the costs and some of the benefits of the roll-out through their bills. The roll-out aims to achieve close to 100% coverage for both electricity and gas meters and DECC estimates that 53 million smart meters will be installed. The roll-out will ensure that the UK complies with the 2012 EU Energy Efficiency Directive, which requires countries to supply at least 80% of consumers with smart electricity meters by 2020 and to perform a cost-benefit analysis for smart gas meters.

Smart metering will create large volumes of energy usage data. Access and use of these data are protected under the 1998 Data Protection Act (DPA). The Smart Energy Code

(SEC) (Box 1) ensures compliance with the DPA, giving consumers control over who can access their usage data, except for billing or regulated purposes such as detection of crime. Suppliers and network operators are only able to collect smart meter readings at daily or half-hourly intervals with the consumer's permission.

Water metering policy

There is no policy to encourage a nationwide programme for smart or conventional metering of water. Most UK households are not currently fitted with smart or conventional water meters and are charged a fixed annual rate. Switching more water users from fixed to metered charging by installing water meters is considered an effective step to reducing demand for water resources (POSTnote 419). However, the Defra 2011 Water for Life White Paper concluded that there is currently no economic case for a blanket policy for smart or conventional water metering because the benefits of metering vary across the UK.[2] At a regional-scale, water companies may implement a compulsory metering programme if an area is designated as 'water stressed' based on Environment Agency assessment and the company demonstrates that this is the most cost-effective way to reduce water usage. In all regions, customers can request a water meter and all new properties are required to have conventional water meters.

As the demand on water resources changes, the need for regional smart water metering programmes may increase. It is envisaged that a smart water metering roll-out could be assisted by using the communications infrastructure used for the energy roll-out. However, in 2012, the Smart Meter Advisory Group concluded that while this is feasible, there are major technological and logistical obstacles. For example, most water meters are located underground outside of properties, so it may be difficult to transmit information from the meter into the house.

Benefits of Smart Metering

Energy, water and financial savings

Access to usage information through an IHD or other display may encourage consumers to change their usage behaviour (Box 2 and POSTnote 417) and make energy and water savings. Trials have indicated that reductions in electricity consumption of 3-19% and in gas consumption of 3-5% are possible.[3,4] The lower ends of these ranges are likely to be more realistic for larger-scale roll-outs that include disinterested customers (some of the trails did not). Indeed, DECC has estimated that IHD interaction will result in reductions of 2.8% in electricity use and 0.5% to 2% in gas use. This is expected to save the average dual-fuel household £43 on its annual energy bill (currently approximately £1,400 on average) by 2030.[5] The National Audit Office (NAO) has reported widespread agreement across industry that these estimates are realistic, however it is uncertain how all GB consumers will engage with smart metering in the long-term (see smart metering challenges).[6]

Box 1. The roll-out framework

As part of the roll-out, the Data Communications Company (DCC) has been established, which is regulated by Ofgem. The DCC will provide the wireless network that will allow information from household smart meters to be transmitted to suppliers, network operators and other external parties such as energy advice companies. Organisations using the DCC will be bound by a number of rules.

- **Smart Metering Equipment Technical Specifications** – the standards for all smart metering equipment installed as part of the roll-out. This includes the type of information displayed and stored by the IHD, the communications technology used and security measures to prevent unauthorised access.
- **Smart Energy Code (SEC)** – a contract between the DCC and its users establishing how smart metering data will be used and handled by suppliers and networks operators. For example, the SEC dictates how meter readings will be used to calculate bills. It also ensures customer access and control of their data.
- **Smart Metering Installation Code of Practice** – the rules dictating the standard of service that should be provided by installers. For example, the code requires clear guidance to be given on how to use the smart meter and IHD to save energy and sets out specific obligations in respect of vulnerable consumers.

Box 2. Effect of IHDs on energy use behaviour

Research has indicated possible ways consumers may reduce their energy consumption in response to interaction with an IHD.[7]

- IHDs can help consumers to identify and reduce wasteful energy uses. Trials have shown that this can be effective over two or more years and that savings can increase over time if consumers continue to interact with their IHDs.[3]
- IHDs can also prompt consumers to purchase more efficient appliances, which will make further savings in the longer term.

The level of savings achieved varies with the type, amount and frequency of information provided to consumers. Research also emphasises that simply making usage more visible may not result in significant savings.[8] Additional advice, prompts and incentives may be required to encourage users to make long-term reductions.

Anglian Water has trialled smart water meters with IHDs in the homes of over 11,000 customers. Results suggest that customers reduced their water usage by 3-4% over 18 months. Water savings also have associated energy savings because of the energy used in water distribution, heating and treatment.

Improves billing and payment

Customers with conventional meters receive bills based on manual meter readings taken at intervals of between one month and two years, which may be missed. Across GB, 37% of energy bills are based on estimates that may be inaccurate. Smart metering should eliminate estimated billing and the need for home visits to read meters because suppliers will have access to regular remote readings. Remote readings are expected to be available most of the time, but the SEC (Box 1) allows suppliers to base bills on estimates if remote readings are unavailable (for example, if the smart meter signal was too weak to transmit readings). Citizens Advice has recommended that a guaranteed standard is set for billing accuracy. Ofgem is examining the consumer protections needed in the smart meter market.

Enables a smart energy grid

The energy sector is seeking to upgrade the electricity system to a 'smart grid', which has two key features. First, consumers, suppliers and network operators will have access to more detailed information about the nature and timing of energy supply and demand. Second, they will all be able to act on this information to enable quicker, more cost-effective balancing of supply and demand. These actions will become increasingly automated. Smart meters contribute towards a smart grid in the following ways:

- They collect detailed usage data from consumers over long periods. These data can be used by suppliers and network operators (Box 3).
- They also allow incentives to be offered to consumers in return for changing when they use their electricity (Box 4 and POSTnote 452). This can help companies or National Grid to match energy demand to supply from renewable sources such as wind and solar, which vary over time (POSTnote 464), and inflexible supply from nuclear.

Reduces network failures

The provision of real-time usage data from smart meters can help suppliers monitor and avert potential problems. For example, fraudulent activity such as energy theft can be detected more easily; water leakage from customer pipes can be identified automatically; and power outages can be identified faster and pinpointed to particular addresses.

Smart Metering Challenges

The smart energy metering roll-out has raised a number of challenges that may also apply to future smart water metering. Stakeholders have suggested that the main challenges involve consumer engagement, the distribution of benefits and controlling costs. To a lesser extent, concerns have been expressed regarding health effects, data access and cyber security.

Consumer engagement and behaviour change

There is some uncertainty about whether the whole UK population will engage sufficiently with smart metering to agree to smart meter installation, interact with their IHD in the long term (as opposed to the 1-2 year timescale of trials) and make changes to their normal routines to reduce usage. To mitigate uncertainty, DECC has a Consumer Engagement Strategy, which sets out a requirement for energy suppliers to set up a non-profit, independent Central Delivery Body to help build awareness, confidence and willingness towards smart metering. This is likely to involve:

- providing customers with advice on how to use IHDs
- undertaking promotional campaigns
- communicating through trusted third parties, such as charities, housing associations and community groups.
- making specific provisions for vulnerable customers.

International experience suggests that, in order to achieve sufficient consumer engagement, consumers should be offered a range of ways to access their usage information to suit individual preferences. Energy suppliers are developing a range of options for providing customers with usage information (Box 5) and suggest these may provide cost-effective alternatives to IHDs. These alternative and complementary options will not be mandated but DECC envisages that companies will offer these products and services to consumers.

Box 3. Uses of metering data by suppliers and network operators

If energy and water suppliers or networks operators have access to half-hourly or daily smart metering data over sufficient time frames it could allow them to:

- improve their forecasts of customer demand, which would reduce the cost of keeping supply and demand in balance
- plan more cost-effective network infrastructure developments
- provide personal feedback and advice to customers
- monitor the success of different pricing tariffs
- assess the effect of other energy efficiency incentives
- understand better how much energy is being generated by micro-generation (e.g. solar panels) from consumers' premises and also provide more accurate payment if it is exported to the grid.

Box 4. Time of Use (TOU) tariffs

Smart meters and IHDs can enable suppliers to offer consumers incentives, typically TOU tariffs that charge consumers different electricity prices at different times of the day. These aim to encourage consumers to shift their usage to different times. For example, the 'Economy 7' tariff puts a fixed price on electricity in the day and a cheaper fixed price on electricity at night, encouraging more night time use. Future TOU tariffs may involve more frequent and greater variation in the price level of TOU tariffs. Smart metering could allow price information to be updated remotely by suppliers and be displayed on the IHD. Based on this pricing consumers could either react manually or set 'smart' appliances, such as washing machines, to switch on when the electricity price falls below a certain level. This type of automation of smart appliances has been shown to enhance energy shifting.[14] Overall, pilot studies conducted in the UK suggest TOU tariffs can encourage customers to use around 10% less electricity during the more expensive peak (4pm-8pm) period.[4] However, certain household practices, such as cooking, may be more difficult to reduce or adapt than others, such as clothes washing.[9]

Distribution of benefits

There are a number of costs and benefits associated to the roll-out. The roll-out is projected to cost suppliers £11 billion. It is expected to result in direct energy savings for consumers worth £6 billion, direct benefits for suppliers of £9 billion, direct benefits to network operators of £1 billion and indirect benefits to society through carbon reductions of £1.3 billion.[6] The supplier and network operator benefits and costs should be passed on to consumers. However, there are concerns about how the benefits will be split between consumers and companies and also between different social groups.

- Consumer groups are concerned that suppliers will not pass on all the savings while passing on the costs. In June 2014, Ofgem referred the energy industry to the Competition and Markets Authority, which will report on competition in the industry by the end of 2015.
- Consumer groups warn that the benefits of smart metering may be less accessible for vulnerable and low-income groups. This could be due to a lack of ability to

Box 5. Alternative ways to communicate usage to consumers

The following alternative or complementary options have been used to communicate usage to users.

- The Energy Saving Trust has developed a website that supplies tailored usage information and advice on ways to save energy.
- Energy companies are offering feedback that uses email, text message or social media to inform consumers about how their energy use compares with households in the local area.
- It is expected that mobile phone applications will be developed to allow access to consumption data and energy saving advice.

There is a lack of evidence indicating the level of energy savings achieved using these options.

change their patterns of energy use because of housing, work or health constraints. Citizens Advice suggests that these vulnerable customers may require extra assistance to achieve the benefits of smart metering. An Ofgem-funded project will trial a scheme to provide additional assistance for these customers from 2014 to 2017. DECC considers that there is insufficient evidence to quantify the effect of smart metering on different households.

Roll out costs

Citizens Advice has criticised the lack of cap on roll-out costs. The escalation in capital expenditure for Government projects involving the manufacture of equipment or IT development has historically ranged from 10-200%.[10] DECC has accounted for up to 20% escalation, based on information from industry and international roll-out experience.[6] Some reasons for cost escalation have been suggested.

- The roll-out may take longer than intended. Suppliers are yet to establish how they will handle potential challenges such as reluctant customers, equipment failures and properties presenting technical or logistical problems, such as blocks of flats. Furthermore, some suppliers may not be prepared for the roll-out; others have installed around one million smart meters in total already.[11]
- Alternatively, the lack of flexibility in the 2020 roll-out completion date may force fast and expensive decisions to be taken to resolve some of the challenges above.

Public concerns about health effects

Some campaign groups have raised concerns that being exposed to the electromagnetic fields (EMFs), which are produced by smart meters, could lead to health effects ranging from nausea to cancer. However, Public Health England's (PHE's) Advisory Group on Non-Ionising Radiation has concluded that there is no convincing evidence that EMF exposure below guideline levels (published by the International Commission on Non-Ionizing Radiation Protection) causes health effects.[12] Based on international experience, the exposure related to smart meter use is expected to be far lower than guideline levels and also many times lower than exposure from, for example, mobile phones. As the roll-out proceeds, PHE is measuring exposure under a range of scenarios to reassure the public. The safety of smart metering equipment is also required under the EU Directive on Radio and Telecommunications Terminal Equipment.

Concerns relating to authorised data access

There are concerns about the planned use of consumption data. It is suggested that police access to data such as consumption information for the prevention or detection of crime may overly infringe on privacy (POSTnote 470). Also, the more detailed usage information provided to consumers could potentially lead to domestic disputes. For example, members of shared properties may use consumption data to monitor each other's behaviour.[13]

Conversely, there are concerns that suppliers may not have sufficient data access. Energy companies are concerned that too few consumers will give them permission to access more detailed (half-hourly) data and that this will limit the benefits of smart metering to suppliers (see Box 3). Consumers may not opt-in if they consider the potential use of data for commercial practices such as customer profiling and targeted advertising as overly intrusive. However, energy companies which are already installing smart meters have reported that 90% of early adopters have opted-in to half-hourly data access.

Unauthorised access and cyber-attacks

Smart meters and their data could be used illegally.

- Smart metering equipment could be subject to cyber-attacks, such as hacking, potentially leading to energy disconnections (POSTnote 389).
- Energy usage data could potentially be used to ascertain a person's presence or behaviour within a dwelling. This could indicate when a property is vulnerable to burglary.
- Customers could tamper with their own smart meters to disrupt meter readings and obtain reduced bills.

DECC has taken measures to mitigate these potential problems. The Smart Metering Equipment Technical Specifications (Box 1) set out security measures to prevent external access to smart metering equipment.[14] These measures include the authentication of users, verification of messages, encryption of data and the tamper resistance of smart metering equipment. However, security threats can evolve rapidly and the Institution of Engineering and Technology warns that testing on its own can never provide adequate evidence that a system is secure.

Endnotes

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POST is an office of both Houses of Parliament, charged with providing independent and balanced analysis of policy issues that have a basis in science and technology. POST is grateful to Ian Keyte for researching this briefing, to the Royal Society of Chemistry for funding his parliamentary fellowship, and to all contributors and reviewers. POSTnote 471 updates POSTnote 301. For further information on this subject, please contact the co-author, Dr Aaron Goater.