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Science and Technology Committee

Evidence Check: Smart metering of electricity and gas

Sixth Report of Session 2016–17

Report, together with formal minutes relating to the report

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Science and Technology Committee

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Summary

This report addresses the smart metering programme—the first inquiry from our 'Evidence Check' initiative. Evidence check is a novel way of working for select committees. We asked the Government for statements on the evidence behind a range of different policies and developing areas. We were disappointed to find that the Government was unable to provide statements in some areas, and that there were delays in receiving some responses to our requests. The variation in the quality of statements suggests that some departments are unfamiliar with communicating the evidence base behind their policies, and the Government will need to reflect on its ability to respond to such an exercise in future.

Our inquiry on the smart metering of electricity and gas used the Government's evidence check statement as its starting point. The statement was weak in some respects, which led us to explore a range of smart metering issues. We found that the Government's ongoing impact assessments for the rollout were making good use of evidence to inform its work in this area, and that attention was being paid to the significance of behavioural science evidence. We are concerned, however, that the level of work invested in the impact assessments was not apparent in the Government's initial statement, and that this might mean that the impact assessments are not as embedded in the policy development process as they should be.

We also found that there is a lack of clarity about the primary purpose of smart metering. The rollout could have a diverse range of benefits, but we fear that with a disparate set of 11 objectives the success of the project may be difficult to ascertain. In particular, there is a risk that the project will become viewed solely as an inefficient way of helping consumers to make small savings on their energy bills. The national benefits of smart metering—in terms of optimising electricity generation and storage, and paving the way for a smart energy system—are important, and the Government will need to communicate this alongside emphasising savings for individual customers.

The rollout of smart meters includes an 'in-home display' as a means of providing consumers with feedback on their energy usage. This element is expected to lead to consumer savings, but the technology alone will not have an impact unless accompanied by a programme of user engagement before, during and after installation. It is important that the Government and suppliers do not compromise on this purely in order to make up for the ongoing delay of the mass rollout.

We sought to avoid duplicating the work of other committees, as we have focused on the quality and completeness of the evidence base for the policy. We have nevertheless highlighted concerns about a number of aspects of smart metering. Our interaction with GCHQ gives us confidence that security—one of these concerns—is being taken seriously. It is important that consumers have confidence in this system, and the way that the Government communicates on this point requires further reflection. The interoperability of foundation stage smart meters when the customer changes supplier—another highlighted concern—remains unresolved, despite having been raised by other committees in the past.

We intend to continue to monitor the implementation of the smart metering programme, and to test its adherence to Evidence Check best practice.

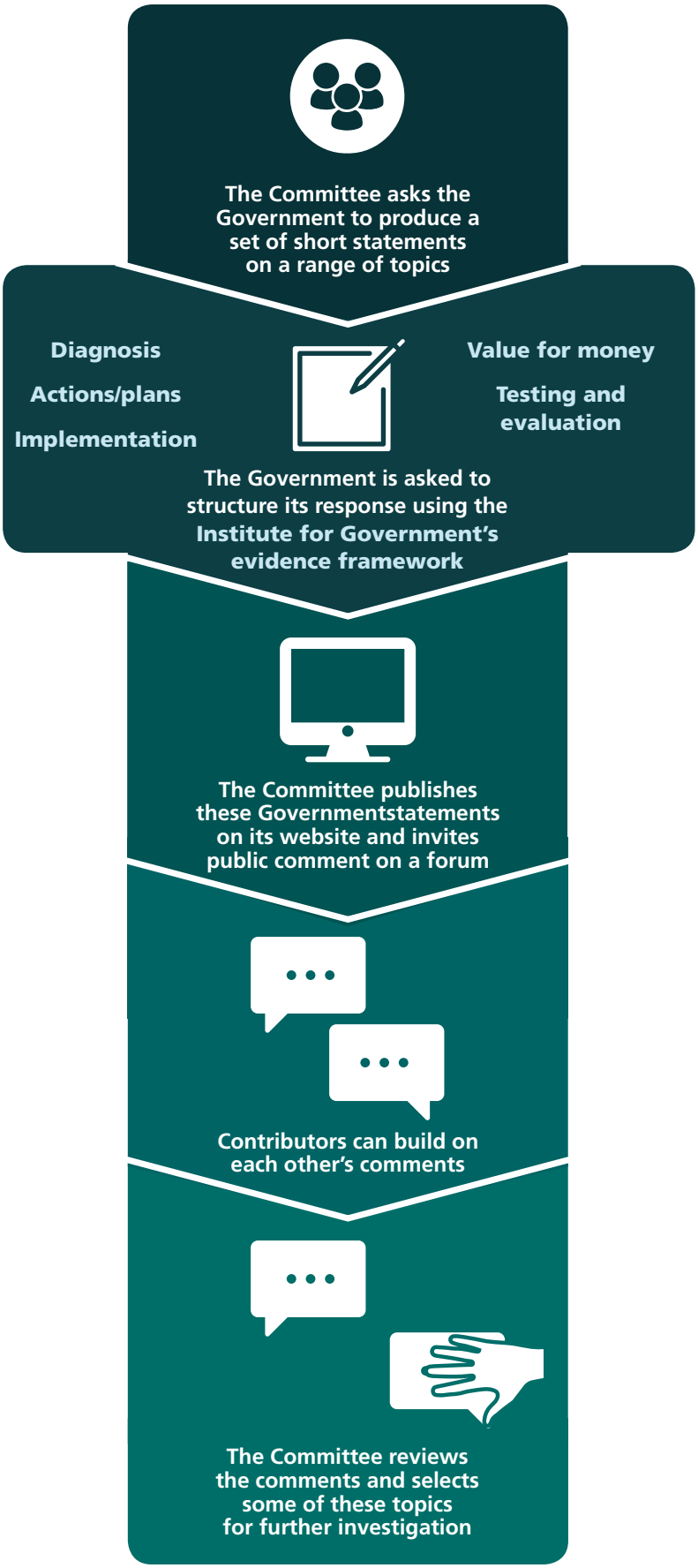
1 The Evidence Check process

1. This report addresses the smart metering programme—the first inquiry from our 'Evidence Check' initiative. Evidence check is a novel way of working for select committees. It has three distinguishing features:

- The exercise has an explicit focus on the evidence behind Government policies;
- The process begins with a short statement from the Government on its evidence base for a particular policy, which can be used as a focus for scrutiny and is provided from the start rather than alongside other written evidence;
- A public forum is hosted on our website which allows comments to be posted in response to the Government's statement on the topic, and for contributors to build on each other's comments.

More broadly, it provides a mechanism for us to scope future inquiries; several topics can be explored simultaneously on separate forum threads, and further action can be considered according to the issues raised. The process is set out in Figure 1.

Figure 1: The evidence check process



2. In September 2015 we asked the Government to prepare short statements on the evidence behind its policies on nine topics of interest to us:

- Digital Government;
- Flexible working and facilitating working away from the office;
- Innovation in, and accelerated access to, healthcare;
- Smart meters;
- Smart cities;
- Driverless cars;
- Genetic modification and gene editing;
- Science and technology challenges for an ageing population; and
- Artificial intelligence.

Statements relating to the first four topics above were received in time to be published on our website in January 2016, and we invited comments on them via public forums online. We received a second batch of statements on three further topics, and subjected them to the same process in March.

3. The Government told us that it was not able to supply statements on the final two topics above—science and technology challenges for an ageing population, and artificial intelligence—as a suitable lead department to prepare the response could not be identified at that time.[1]

4. **The delays in receiving some of the Government statements in response to our evidence check request were regrettable. It is concerning that the Government was not able to identify a lead department in two cases.**

The Institute for Government's Evidence Transparency Framework

5. Our approach built on the work of the Education Committee in 2015,[2] and our predecessors in 2009.[3] In addition we asked the Government to structure its statements to reflect the Institute for Government's 'Evidence Transparency Framework' described in its *Show Your Workings* report.[4] The framework was developed by the IfG following the Education Committee's evidence check work, and provides a means of assessing

1 As a result, we launched a separate inquiry into Artificial Intelligence and Robotics. Details of this inquiry are available from the "Current inquiries" page of our website. Correspondence with the Cabinet Office regarding delays is also available on our website.

2 Education Committee, "'Evidence Check' web forum", accessed 1 September 2016

3 Science and Technology Committee, Second Report of Session 2009–10, *Evidence Check 1: Early Literacy Interventions*, HC 44

4 Institute for Government, *Show your workings: Assessing how government uses evidence to make policy* (October 2015)

the *transparency* of the evidence base and the logic behind the policymaking process, rather than the *quality* of the evidence provided. The framework is based on five "chain of reasoning" steps:[5]

- Diagnosis: Does the Government show that it knows about the issue, its causes, effects, and scale?
- Actions and plans: Has the Government shown that any policy intervention is evidence-based, that it has assessed the strengths/weaknesses of the evidence base, and identified other policy options?
- Implementation: Has the Government shown that the implementation method for the policy has been based on evidence on what works?
- Value for money: Are the costs and benefits understood and evidence-based?
- Testing and evaluation: Are plans for testing and evaluation adequate?

6. When we asked the Government for its evidence check statements we requested that it address the five steps above. The level of engagement with this framework varied considerably across the Government statements, as did their overall quality. Some were comprehensive and well structured, while others made very little reference to any evidence base.

7. **The Government's difficulty in engaging with the evidence check framework suggests that in some departments there is a lack of experience of articulating the evidence base for its policies. More worryingly it may also indicate that some areas lack the necessary evidence base.**

The smart metering evidence check and our subsequent inquiry

8. Smart metering was by far the most popular forum thread in the initial batch of four evidence check topics, with over 580 comments posted.[6] We decided to pursue some of the smart metering issues raised in the forum through a call for written evidence and an oral evidence session. Several other committees have examined the specifics of the smart meter roll-out in recent years, including the Energy and Climate Change Committee in 2013[7] and 2015,[8] and the Public Accounts Committee in 2014.[9] We sought to avoid duplicating their work by concentrating on the evidence behind smart metering policy, rather than exploring progress with the rollout from a value-for-money or project management perspective as other committees already have done.

5 Institute for Government, *Show your workings: Assessing how government uses evidence to make policy* (October 2015) p11

6 A large proportion of the comments appeared to result from a campaign submit multiple times the same concerns about the health effects of wireless technologies, using near-identical text. These fears had been explored previously by the Energy and Climate Change Committee and we did not pursue them further. The level of concern does highlight a potential engagement challenge for the rollout, however.

7 Energy and Climate Change Committee, Fourth Report of Session 2013–14, *Smart meter roll-out*, HC 161

8 Energy and Climate Change Committee, Ninth Report of Session 2014–15, *Smart meters: progress or delay?*, HC 665

9 Committee of Public Accounts, Twelfth Report of Session 2014–15, *Update on preparations for smart metering*, HC 103

9. Informed by inputs to our evidence check, we called for written evidence on the following issues:

- Evidence—from existing smart meters and behavioural science—on how smart meters can be expected to affect consumer behaviour, including in terms of reducing energy consumption and buying more energy efficient products, and how levels of engagement with In-Home Displays change over time;
- Evidence on the extent to which Time of Use Tariffs (which smart meters enable) can be expected to alter patterns of energy usage during the day;
- Evidence on the expected net savings for the consumer over time, including in the context of the longevity and technical capability of the smart meter technology being rolled out, and whether similar savings could be achieved by other means;
- Evidence of how data from smart meters can be used to optimise national energy generation and storage; and
- Evidence on the security of smart meters, and the ability of suppliers to maintain security levels in the future.

Forty written submissions were received. We took oral evidence from witnesses including British Gas, researchers, Smart Energy GB, and Lord Bourne, then then Parliamentary Under-Secretary of State for Climate Change. We are grateful to everyone who contributed to our inquiry, and to those who commented on our evidence check forum.

What is smart metering?

10. Smart electricity and gas meters use wireless technologies to enable two-way communication with utility suppliers.[10] Smart meters transmit readings of the amount of gas or electricity that has been used in each property and receive information from suppliers such as current tariff rates. An-in-home display (IHD) connects with the smart meter and provides consumers with details of their energy consumption and costs, in near-real time.

11. Smart meters also exist for other utilities such as water. However, the Department for the Environment, Food and Rural Affairs' 2011 *Water for Life* White Paper concluded that there was currently no economic case for a blanket policy for smart water metering, because the benefits of metering vary across the UK.[11] While suppliers in some 'water stressed' areas are implementing their own smart water metering systems,[12] our inquiry focused specifically on the national roll-out of smart metering of electricity and gas in Great Britain.[13]

12. The Department for Energy and Climate Change (DECC) expected that smart meters (and the accompanying IHDs) would help consumers reduce their energy consumption, encourage them to shift demand away from peak times (through time-of-use tariffs), and make it easier to switch between suppliers.[14] DECC's impact assessment also explains

10 Gov.uk, "Smart meters: a guide", accessed 1 September 2016
11 HM Government, *Water for Life* (December 2011) p51
12 See, for instance, Thames Water, "Smart metering", accessed 26 August 2016.
13 Energy policy is devolved to Northern Ireland.
14 Department of Energy and Climate Change (SME 31) para 3

that smart meters facilitate more efficient collection of billing data and identification of meter faults, and act as enabling technology for "more decentralised electricity systems and a smart grid".[15] The assessment also states that "the smart meter policy supports the broader Government programme for a more ambitious EU carbon emission reduction target by 2020, through encouraging investment in renewable energy, feed in tariffs and home energy efficiency via the Green Deal".[16]

The smart meter rollout

13. EU Directive 2009/72 states that "where roll-out of smart [electricity] meters is assessed positively, at least 80% of consumers shall be equipped with intelligent metering systems by 2020".[17] Member states have each made their own assessment of the economic merits of smart metering in their jurisdiction, drawing a range of conclusions. The UK Government's current assessment for smart metering in Great Britain calculates a significant net positive benefit, while other countries such as Germany have concluded that smart metering is not worthwhile.[18]

14. The Government's Smart Metering Implementation Programme requires energy suppliers to offer 53 million meters to homes and small businesses in Great Britain by 2020.[19] The costs of providing smart meters, some £10.9 billion, is being borne by consumers through their energy bills (an average of £215 per home, including installation costs).[20]

15. Smart meters are being rolled out in two phases, both led by energy suppliers. The foundation phase began in 2013 using "SMETS 1" (Smart Metering Equipment Technical Specification) meters, which acted as a trial phase to "put commercial and regulatory frameworks in place to support smart metering, trial and test systems and learn lessons from early installations to enhance the consumer experience".[21] The mass roll-out phase begins in earnest later this year using SMETS 2 meters, which have technical enhancements which allow them to make use of a new infrastructure provided by the Data Communications Company (DCC). There are now over 3.6 million smart meters operating across homes and businesses in Great Britain.[22]

15 DECC, Smart meter roll-out for the domestic and small and medium non-domestic sectors (GB): Impact assessment (January 2014) p12

16 DECC, Smart meter roll-out for the domestic and small and medium non-domestic sectors (GB): Impact assessment (January 2014) p10

17 EU Directive 2009/72/EC, Annex I, para 2 specifies the target for smart electricity meters; a slightly different wording applies for gas meters in Directive 2009/73/EC, without a target. See also EU Directive 2012/27, article 27, which brings these together.

18 Institute of Directors, *Not too clever, will Smart Meters be the next Government IT disaster?* (March 2015) p11

19 Department of Energy and Climate Change (SME 31) para 2. Suppliers are required to offer smart meters to all customers, but customer compliance is not compulsory.

20 DECC, *Smart meter roll-out for the domestic and small and medium non-domestic sectors (GB): Impact assessment* (January 2014) p35

21 Department of Energy and Climate Change, *Smart meters quarterly report to end March 2016 Great Britain* (30 June 2016) p4

22 Department of Energy and Climate Change, *Smart meters quarterly report to end March 2016 Great Britain* (30 June 2016) p3

The Government's Evidence Check statement

16. The Government's evidence check statement on smart metering (reproduced at Appendix 1) was supplemented during our subsequent inquiry by written evidence from the then Department of Energy and Climate Change addressing the specific terms of reference we issued. We explore these in Chapters 2–5.

17. We have used the Institute for Government's (IfG) evidence transparency framework[23] to assess DECC's initial evidence check statement. The framework is described in further detail in Appendix 2. Our analysis is set out in Table 1 below. Some of the weaknesses of the initial statement were subsequently addressed by the Government's written submissions.

18. **The Government's evidence check statement on smart metering was disappointing in some respects. There was a lack of a clear description in the statement of the 'problem' that smart metering aims to address, and as a result the measures by which the project will be evaluated were opaque. The transparency of the statement was strengthened, however, by including references to DECC's impact assessment. Overall, we were unable to rate the statement highly against the Institute for Government's evidence transparency framework.**

19. While aspects of the smart metering statement were disappointing, we note that this was neither the weakest nor the strongest of the evidence check statements we received. For instance, the Government's statement on 'innovation in, and accelerated access to, healthcare'[24] engaged fully with the framework and provided many sources of evidence and information in a transparent way. In contrast, the statement on 'driverless cars'[25] was cursory in its engagement with the IfG's framework and provided little information beyond a description of the Government's plans in this area.

20. ***In its response to this report, the Government should reflect on its experience of collecting evidence check statements from a range of departments using the IfG's Evidence Transparency Framework and consider how its processes could be improved, including by building the IfG structure into its guidance and policy-development methodologies. We hope that the Government will be more consistent in its engagement with the Institute for Government's Evidence Transparency Framework when preparing future evidence check statements for us and other committees.***

23 See Appendix 2
24 Evidence check statement: Innovation in, and accelerated access to, healthcare
25 Evidence check statement: Driverless cars

Table 1: Analysis of the Government's smart metering statement using the Institute for Government's Evidence Transparency Framework

Factor	Analysis
Diagnosis *This concerns why something is proposed, i.e. what the issue is that will be addressed. The document should explain:* • *what policy makers know about the issue, its causes, effects, and scale* • *how policy makers have assessed the strengths and weaknesses of that evidence.*	The 'diagnosis'—the description of the problem to be solved through the policy—is not explicit, but can be inferred to some extent from the stated benefits of the smart metering programme. As a result, the statement does not include a description of causes, effects and scale of the issue that smart metering seeks to address.
Proposal *What is the Government's chosen intervention? The document should explain:* • *why the Government has chosen this intervention* • *what evidence, if any, that choice is based on* • *how policy makers have assessed the strengths and weaknesses of the evidence base, including what has been tried before and whether that worked or not* • *whether there are other options and why they have not been chosen* • *what the Government plans to do about any part of the intervention that has not yet been decided upon.*	Without a clear description of the issue that the Government wishes to tackle through smart metering, it is difficult to identify the evidence for its choice of intervention as a whole. Other options are not referred to at this scale. However, evidence from a pilot phase is offered to support the requirement for suppliers to offer in-home displays as part of the smart meter rollout. Some uncertainties in this are acknowledged by the Government, and provision for alternatives is being explored.

Factor	Analysis
Implementation *How will the chosen intervention be rolled out? The document should explain:* • *why this method for delivering the intervention has been chosen* • *what evidence, if any, that decision is based on* • *whether there are other methods and if so the reasons for not choosing them* • *if the way to deliver the intervention is still being decided, what the method is for deciding*	The statement focuses on the decision to make energy suppliers responsible for the roll-out of smart meters. The case for this is based on a description of the commercial and financial incentives for energy suppliers to deliver the programme effectively and efficiently (see Appendix 1, paragraph 6). However, the statement does not include a discussion of whether other options were considered and why they were not chosen, or an explicit evidence base for the choice beyond describing the incentives. The statement explains that consumer engagement is "a prerequisite for the success of the Programme" and describes plans for ensuring engagement.
Value for Money *This considers the costs and benefits of the policy to show why the Government thinks it is worth doing. The document should explain:* • *what the costs and benefits are estimated to be* • *the assumptions behind those calculations* • *what evidence is being used to make those assumptions* • *the uncertainties about the costs and benefits and how likely the figures are to change.*	The statement refers to a series of impact assessments and includes hyperlinks to them. Figures for the overall costs and benefits of the programme are provided, but without any discussion of how these might change. The assumptions behind the impact assessment are described as having been "widely consulted on", and "benchmarked against international evidence as well as scrutinised by experts".
Testing and Evaluation *How will we know if the policy has worked? The document should explain:* • *plans to measure the impact of the policy and the outcomes that will be measured* • *plans to test the policy first, or reasons why not* • *plans to evaluate the effects of the policy, including a timetable.*	Several evaluation reports are referred to, including evaluation of pilot stages of the programme and how lessons learned have informed further work. A Monitoring and Evaluation Strategy is referenced, but the statement is not explicit on how the impact of the project will be measured or its success criteria.

2 Consumer behaviour: what mileage in meters?

The use of behavioural science

21. Several written submissions highlighted the need to understand and alter consumer behaviour in order to deliver some of the intended benefits of smart metering. Dr Sarah Darby of the Environmental Change Institute explained that:

> An effective 'smart' system is one that brings together everyday human intelligence and action with technical ingenuity: it does not attempt to vest all the smartness in the technology and edit humans out of the picture.

Sacha Deshmukh, Chief Executive of Smart Energy GB (the body established as the national "voice" of the smart meter rollout),[26] described the project as "the biggest behavioural change programme that this country has seen—in some ways, you could argue, that the world has seen—on a very important subject".[27] Smart Energy GB explained that:

> Success for the smart meter rollout is not limited to engaging every household in accepting and enabling the installation of a new meter […] What matters equally is the extent to which consumers use their smart meters to change their behaviour in relation to energy.[28]

22. Such behaviour change could involve reducing consumption or altering the time of day when energy is consumed in order to promote efficiencies in national electricity generation (paragraph 59) and therefore reduce reliance on high-carbon sources. During our inquiry, Smart Energy GB published an extensive report documenting its use of behavioural science to support the rollout of smart meters, including a review of theoretical frameworks and behaviour change models, and a description of possible engagement ideas to be piloted.[29] The report claimed that "we have already, and will continue to, reflect behavioural science best practice in all elements of our campaign".[30]

23. However, Dr Kevin Burchell of the University of Westminster cautioned that thinking purely in terms of 'behavioural change' may underestimate the scale of the challenge:

> Energy consumption reduction should be understood as a challenge of changing householders' everyday lives, not of changing behaviour or even behaviours. […] Energy consumption is the outcome of many or even most actions around the home, and these actions are both interlinked and endlessly repeated in the daily patterns of people's lives.[31]

26 Smart Energy GB, "Who is Smart Energy GB?", accessed 12 August 2016
27 Q80
28 Smart Energy GB, *A smart route to change: The application of behavioural science in supporting Great Britain's smart meter rollout and changing the way we use energy for the better* (July 2016), p3
29 Smart Energy GB, *A smart route to change: the application of behavioural science in supporting Great Britain's smart meter rollout and changing the way we use energy for the better* (July 2016)
30 Ibid p33
31 Dr Kevin Burchell (SME 14) para 6(i)

He was concerned that Smart Energy GB was "wedded to behavioural science alone" and argued that there was a need for Smart Energy GB to "facilitate interdisciplinary understanding and collaborative effort across sociology, social psychology and behavioural science".[32] Smart Energy GB acknowledges that "any approach [to engagement in the smart meter rollout] will need to address the intricacies of energy-related decision-making in everyday life—recognising the fact that households use energy in many very different ways".[33]

24. ***Smart Energy GB is making good use of behavioural science to consider how best to support the smart meter rollout. This could usefully be bolstered by evidence from sociologists and social psychologists, given that energy usage is an integral part of modern life.***

Feedback as the mechanism for behavioural change

25. Dr Darby explained that smart meters—through the In-Home Display (IHD)—provide near-real time feedback on consumption, and that it is this feedback mechanism that can drive behavioural change:

> The basic idea is that feedback on electricity or gas use alerts people to their consumption by making it more visible, gives them a tool for assessing it in relation to their activities, and allows them to see the consequences of actions and decisions such as altering the heating controls, turning appliances on and off, insulating, or replacing an appliance with a new model. Feedback thus allows people to teach themselves, at their own pace.

Other forms of feedback beyond that provided by the IHD itself include informative billing, home energy reports, or alerts through other systems when consumption is unusually high. Nevertheless, many of our witnesses focused on the IHDs being supplied as part of the smart meter rollout.

26. Suppliers are required to offer IHDs, the cost of which (£15 each) comprises 7% of the cost of the equipment and installation in each premise.[34] Few other countries have included IHDs in their smart meter trials or rollouts, which limits our ability to compare their findings.[35]

27. Sacha Deshmukh explained that "in an analogue system, with a lack of information, it is very difficult to support anyone in changing their behaviour. That has been a vicious cycle that has trapped many of the attempts to do so in energy to date. It can be broken with smart metering, good information systems and good engagement around those".[36] He also provided a sobering picture of the problem of "fear of the bill" and how a lack of information on energy consumption led to a problem of 'self-disconnection', or "people turning off their heat or not cooking when it is cold":

32 Dr Kevin Burchell (SME 14) para 14
33 Smart Energy GB, *A smart route to change: the application of behavioural science in supporting Great Britain's smart meter rollout and changing the way we use energy for the better* (July 2016) p11
34 DECC, Smart meter roll-out for the domestic and small and medium non-domestic sectors (GB): Impact assessment (January 2014) p35
35 Sarah Darby (SME 22) para 7
36 Q86

> I spoke to a woman who told me she was not cooking her family fish fingers in the evening at the end of the month because she was worried about what the bill would be […] Smart [meters] will finally give us a chance to break through with that.[37]

28. However, some researchers have queried the level of faith placed in the capabilities of feedback provided by existing IHDs. Dr Kathryn Buchanan and colleagues at the University of Essex note that IHDs "do not have the capability to reduce energy consumption by themselves but rather their success is entirely dependent on user engagement;[38] other constraints on the impact of IHDs highlighted by Dr Buchanan and others include:

- The problem of a substantial time delay between taking steps to reduce energy consumption and being rewarded through a lower bill;[39]
- Fluctuations in the price of energy obscuring financial savings from reduced consumption;[40]
- A difficulty for users to identify which appliances or actions are using energy, without conducting "mini-investigations" involving turning appliances on and off while watching the IHD;[41] and
- The risk of legitimising existing consumption rather than prompting behavioural change.[42]

Researchers argue that these points and others underline the need to consider carefully the design of IHDs in order to maximise the feedback effect.

29. The Institute for Government's Evidence Transparency Framework raises the issue of whether alternative ways of achieving a policy outcome have been considered. Dr Darby explained that it was possible to provide feedback to consumers without smart meters,[43] and several other witnesses noted that relatively low-cost 'clip on' electricity monitors are already available to consumers (although not for gas consumption).[44] The Energy and Climate Change Committee has previously explored whether feedback could be provided instead through a smartphone app rather than through an IHD.[45] In order to trial other engagement tools, the Government now allows suppliers to apply for a derogation from the requirement to offer an IHD.[46]

37 Q112
38 Buchanan, K, et al, "The question of energy reduction: the problem(s) with feedback", *Energy Policy* 77(2015) pp 89–96
39 Buchanan, K, et al, "The question of energy reduction: the problem(s) with feedback", *Energy Policy* 77(2015) pp 89–96. Smart Energy GB's review of behavioural models (see footnote 28) also notes that "there is a strong body of evidence that states that where the impact of people's actions is distanced in either time or space, the prospect of an informed choice becomes unrealistic, and an often unconscious habit takes precedence".
40 Buchanan, K, et al, "The question of energy reduction: the problem(s) with feedback", *Energy Policy* 77(2015) pp 89–96
41 Dr Kevin Burchell (SME 14) para 6(ii)
42 Dr Kevin Burchell (SME 14) para 7
43 Q52
44 Institute of Directors (SME 28)
45 Energy and Climate Change Committee, Ninth report of Session 2014–15, *Smart meters: progress or delay?*, HC 665, paras 17–19
46 Annex 1, para 18

30. **The inclusion of an in-home display in the smart meter rollout provides a necessary feedback mechanism on energy consumption, although other forms of feedback are possible and are being trialled. The Government's evidence check statement did not include material on whether alternative energy use feedback mechanisms (such as clip-on energy monitors) had been considered.**

Changes in engagement with IHDs over time

31. Pam Conway, Head of Smart Strategy at British Gas, told us that 60–70% of British Gas customers with smart meters reported having made behavioural changes "such as using only the amount of water that they need in the kettle, switching off and unplugging when they are not using any of their devices, or using energy-saving light bulbs".[47] She reported that 45% use or refer to their IHD at least once a day, and 65% once a week or more.[48] However, some witnesses were concerned that the level of engagement with an IHD diminishes over time, with a corresponding impact on the benefits of smart meters. Nick Hunn, Chief Technology Officer of WiFore Consulting Ltd and a frequent critic of the smart meter rollout, told us that "we know from evidence of IHD usage that most end up in drawers within a few months. We also know that although there can be an immediate change in behaviour, it slips back within about six months. That's because for most consumers, energy is used when it's needed and saving a few pounds each week does not change behaviour for long".[49]

32. In contrast, Dr Sarah Darby told us that many users were still using their IHDs many months after installation:

> IHDs are sometimes dismissed as ineffective on the grounds that 'people just leave them in a drawer after the first three weeks'. While this does happen, it is far from being the whole story. The detailed in-home survey of ~2000 smart-metered customers carried out for the Smart Meter Early Learning Project found that 96% of consumers with an IHD had plugged it in at some point since the installation visit, and 60% still had it in use when they were interviewed between 6 and 24+ months later. Those who had received them more recently were no more likely than those who had received them two years earlier still to have their IHD plugged in.[50]

33. She emphasised that "While levels of engagement with IHDs do typically change over time, reports of falling effectiveness often seem to be exaggerated when compared with findings from the UK and elsewhere".[51] BEAMA, an electrotechnical industry trade association, was also strong on this point:

> Levels of engagement with IHDs are expected to change over time, though not in the way assumed by uninformed or self-interested critics of the Programme. Many critics claim that the impact of consumption feedback on consumer behaviour is short-lived, that IHDs are thrown away in a few weeks or months, or that engagement is not sustained after the novelty of the new 'gadget' wears off. This is not true. In fact the quantitative analysis

47 Q1
48 Q22
49 Nick Hunn (SME 2)
50 Dr Sarah Darby (SME 22) para 9
51 Dr Sarah Darby (SME 22) para 9

> reveals that programmes lasting two years had a greater impact than those lasting just a few months or a year, and the longer pilot durations tended to correspond with higher consumption reduction.[52]

34. Smart Energy GB told us that "Energy saving and purchasing activities appear to become more prominent the longer a consumer has had their smart meter […] Of those who had a smart meter for seven months or more, 36% said they had looked at more energy efficient appliances (versus 19% for those with their smart meter for less than six months)".[53] Dr Darby offered a rationale for engagement improving over time rather than the novelty wearing off:

> If you see the use of better information and feedback to customers as a learning process, you would expect the effect to increase a bit over time. That is what seems to be happening. The figures for savings by people who have smart meters compared with the figures for those who do not have gone up now in the British Gas experience. Other long term trials also tend to show that you get an increase over time.[54]

Figures provided by British Gas suggested that there may indeed be an increase in engagement over time, at least for some people: "After a lengthy period of time, 54% say that they are using their in-home display more often than they were at the beginning, when they first got it".[55]

Maximising engagement

35. Dr Darby told us that the rollout of smart meters needed to be supported by high-quality engagement with consumers:

> What customers learn before and during smart meter installation is an important factor in helping them to make the most of the information they can gain from a smart meter, and this is documented fully in the qualitative research carried out for the GB Smart Metering Early Learning Project. It shows the value of the SMICoP [Installation Code of Practice] requirement for trained installers who will explain to customers how they can benefit from their smart meter, and indicates the value of post-installation customer support, especially for more vulnerable customers.[56]

Similarly, Professor Christine Liddell told us that:

> Because energy usage is deeply embedded in routine and key domestic activities, people rarely make drastic behavioural changes in their energy use; they are more likely to adjust gradually. Consequently consumer engagement can be maximally beneficial when support programmes are sustained, introduce new elements over time, and set modest but progressive goals tailored to people's individual circumstances and constraints.[57]

52 BEAMA (SME 18) para 3.6
53 Smart Energy GB (SME 19) para 4.2.3
54 Q7
55 Q22
56 Dr Sarah Darby (SME 22)
57 Professor Christine Liddell (SME 11) para 16

These observations are reflected in Smart Energy GB's recent report on the use of behavioural science to support the smart meter rollout.

36. ***In order to reflect the available evidence the Government should ensure that in its bid to complete the smart meter rollout by 2020 it does not compromise on consumer engagement before, during and after installation, including for small businesses. The impact of smart meters will be limited without this support from installers and Smart Energy GB.***

Reducing energy consumption: sources of evidence

37. Witnesses highlighted a range of recent reports which have addressed the effects of smart meters and IHDs on energy consumption in Great Britain, summarised in Table 2. These indicate that a reduction of around 2–3% might be expected. Studies in other countries produce higher results: a review of 100 pilots by the European Smart Metering Industry Group suggests savings of around 5-6% from interventions without an IHD, and an average of 8.7% with an IHD.[58] However, witnesses warned that energy consumption practices differ in other countries due to the need for summer cooling as well as winter heating,[59] and DECC acknowledges that "it is difficult to transfer evidence on levels and persistence of savings directly to the GB context".[60] DECC's impact assessment takes "a conservative approach" by assuming a 2.8% reduction in domestic electricity consumption, and a 2% reduction for gas credit meters (0.5% for gas pre-payment metering).[61]

38. The Institute of Directors queried the meaningfulness of such projections, given an existing trend towards more energy efficient consumer products. They described a 2% reduction in consumption as "a very poor yield".[62] Dr Darby acknowledged that it was difficult to disentangle smart meter savings from general increases in energy efficient appliances,[63] but it should be noted that the reductions take account of the effect of increasing energy efficiency because they are typically measured relative to a control group rather than simply the individual customer's previous consumption. In practice smart meter owners could expect to see a greater reduction in their own personal usage from one year to the next. British Gas provided the figures in Table 3 below as an illustration of the calculation process, including an averaging over two years to smooth seasonal fluctuations:[64]

58 European Smart Metering Industry Group, *The potential of smart meter enabled programs to increase energy and systems efficiency* (October 2011) figure 4

59 Professor Christine Liddell (SME 11) para 1

60 DECC, *Smart meter roll-out for the domestic and small and medium non-domestic sectors (GB): Impact assessment* (January 2014) p46

61 DECC, *Smart meter roll-out for the domestic and small and medium non-domestic sectors (GB): Impact assessment* (January 2014) p47

62 Institute of Directors (SME 28)

63 Q7

64 British Gas explains that "We take the data from the original 1 year test and identify the customers where both the Smart (sample) & Standard (control) customer have remained with British Gas for at least 2 years after the smart meter installation. We then calculate a simple mean annual consumption using the total consumption for the 2 years following the smart install (i.e. the sum of Post install Year 1 consumption & Post install Year 2 consumption divided by 2). We calculate the figure like this to smooth out the impact of weather fluctuations over the 2 year period., We then divide the mean annual consumption by the annual consumption in the 1 year prior to the smart install period".

Table 2: Results from a selection of smart meter studies relevant to Great Britain, as highlighted in written evidence

Study	Scale	Demand reduction	Notes
Energy Demand Research Project (2007–10)[A]	18,370 households with smart meters, four suppliers	Around 3%, but with some higher or lower savings, depending on fuel, customer group and period	Commissioned from AECOM by Ofgem on behalf of DECC
Netherlands trials[B]	670 households (with a control group of 50,000 households)	0.9% (gas), reductions for electricity not statistically significant	Smart metering did not include an in-home display
Early Learning Project[C]	Analysis of consumption data for 10,000 households	2.3% (electricity, 1.5% (gas), although "it is realistic to expect durable energy savings of 3% based on evidence from the research literature and trials worldwide, the ELP findings and the potential improvements identified".	Research conducted for DECC by the Environmental Change Institute, University of Oxford, the University of Ulster, and the Tavistock Institute
CER Smart meter trials in Ireland (2009–10)[D]	5,028	2.5% (electricity)	Used a combination of Time of Use tariffs and demand side reduction measures

[A] Ofgem, *Energy Demand Research Project: Final Analysis* (June 2011)

[B] Rijskdienst voor Ondernemend Nederland, *Dutch Energy Savings Monitor for the Smart Meter* (March 2014)

[C] Department of Energy and Climate Change, *Smart Metering Early Learning Project: Synthesis report* (March 2015)

[D] Commission for Energy Regulation, *Electricity Smart Metering Customer Behaviour Trials (CBT) Findings Report* CER 11080a (May 2011)

Table 3: Illustration of how British Gas calculates energy consumption reductions for smart meters against a control group, averaged over two years

Customer	Pre-installation consumption (kWh)	Post-installation consumption Y1 (kWh)	Post-installation consumption Y2 (kWh)	Total consumption (kWh)	Mean annual consumption (kWh)
Smart	10,346	9,000	10,000	19,000	9,500
Standard	10,346	9,346	10,300	19,646	9,823

	After 1 year	After 2 years
Difference (kWh)	346 (i.e. 9,346–9,000)	323
Difference (%)	3.3% (i.e. 346 / 10,346)	3.1%

Source: British Gas (SME 45)

39. British Gas provided us with some information based on 40,000 gas smart meters and 60,000 electricity smart meters installed since 2014, compared with a control sample of 100,000 customers with standard meters. This sample found that smart meter users reduce their energy consumption by around 3% per year, echoing the results of other studies.[65] Nick Hunn complained that British Gas had not released information from the much larger number of meters it had installed, over a longer period. We asked Pam Conway whether it was possible to analyse data from the 2.7 million meters that had now been deployed by British Gas. She explained that "we needed to look for customers we could match. We looked at the size of a household, their average annual consumption and the region in which they were based, and matched a smart-metered customer to a customer without a smart meter" and "to ensure the numbers were robust […] we needed to select customers who had been with British Gas for 24 to 27 months". This "puts constraints on finding like for like across that base [of 2.7 million]".[66] She told us that British Gas was nevertheless considering whether to open up its datasets,[67] which might allow anonymised data to be explored by others.

40. **'Implementation' is one of the IfG's 'chain of reasoning' steps—implementing a policy based on evidence of 'what works'. The Government's evidence check statement highlighted available evidence on whether smart meters could lead to a reduction in energy consumption through engagement with in-home displays. That evidence does suggest such an outcome, although the scale and durability of such savings is contested and it would appear that the rollout could alter consumption levels by 2–3%.**

41. ***The Government should update its research on the impact of smart meters as the rollout progresses, adjusting the Impact Assessment as necessary. It should take the opportunity now available to examine five years of data for some customers in the Early Learning Programme. It should explore with British Gas the opportunity to make its large datasets, from 2.7 million fitted smart meters, available to researchers.***

65 British Gas (SME 32)
66 Q9
67 Q11

3 Changing when energy is used

42. DECC told us that smart meters will enable 'time of use' (ToU) tariffs to be introduced, with different prices at different times of day. There are two ways in which a ToU tariff could operate: either as a static tariff, with different pricing periods remaining fixed, or a dynamic tariff, where prices could be set according to the prevailing generating costs and communicated to consumers via their In Home Display, or utilised through automated appliances. By altering the price during the day, such tariffs can incentivise consumers to avoid times of peak demand, and therefore reduce the need for excess capacity in the system overall to cope with peaks and troughs. DECC's 2014 impact analysis assumed that, including existing Economy 7 customers, there would be a 20% take up of static ToU tariffs, starting from 2016.[68] ToU tariffs are only relevant to electricity usage, as gas is not generated on demand in the same way.

43. Lord Bourne, the then Parliamentary Under Secretary of State for Climate Change, explained in June that ToU tariffs would be "beneficial to the nation at large, because it will smooth demand, which will mean that demand is less at peak times, and enable us to manage the whole system better".[69] Daron Walker, the then Senior Responsible Owner for the smart metering implementation plans at DECC, told us that it was "really early days" for ToU tariffs.[70] He explained that DECC's smart metering impact assessment had "assumed very low levels of penetration of time of use" and that ToU was "not embedded in [DECC's] business case".[71] Nevertheless, Dr Sarah Darby noted that smart meters and ToU tariffs laid the ground for further energy-saving innovations in the future:

> In the longer term, ToU tariffs could form part of programmes to manage the charging of electric vehicles and storage heaters, the timing of heat pumps and the provision of distributed storage (in hot water tanks, batteries and other media). This type of arrangement is already being piloted, partly by Government-funded research, and it could make a substantial difference to the flexibility of the electricity system. Householders' familiarity with the technologies and rationale behind such programmes will be a vital issue here.

The impact of ToU: sources of evidence

44. While ToU tariffs may be "some way down the line",[72] the extent to which consumers are able to vary when they use electricity has been explored in research. The results of some of the major trials highlighted in written evidence are summarised in Table 4; the general consensus appears to be that ToU tariffs can shift 8–10% of peak demand.

68 DECC, *Smart meter roll-out for the domestic and small and medium non-domestic sectors (GB): Impact assessment* (January 2014) p59
69 Q84
70 Q88
71 Q88 [Daron Walker]
72 Q90 [Lord Bourne]

Table 4: Results from a selection of (UK) smart meter studies that include Time of Use tariffs

Study	Scale	Peak demand shifted	Notes
Energy Demand Research Project (2007–10)[A]	194 (EDF); 1,352 (SSE)	"Up to 10%" of peak load can be shifted	Two ToU trials; one run by EDF, the other by SSE
Consumer Network Revolution Project[B]	628 participants	8% reduction in average peak power demand; 6% reduction in average annual consumption during peak periods; no statistically significant reduction in average annual consumption compared to smart metering without ToU tariff.	
Low Carbon London trials (2012–14)[C]	1,119	9%	Included dynamic ToU. This trial tried to simulate "not just a regular peak—winter evenings—but the impact on the system of having a lot of wind or little wind, looking ahead to a time when there are lots of renewables in the mix. It was sending signals to customers a day ahead, as you might do on the basis of a weather forecast, to tell them what the price was going to be. A lot of customers quite got into that, and found it an appealing and engaging thing to do".[D]
British Gas free Saturdays or Sundays[E]	4,000 British Gas customers	11%	
CER Smart meter trials in Ireland (2009–10)[F]	5,028	8.8% reduction in peak consumption	Study used a combination of ToU and demand side reduction

A Ofgem, *Energy Demand Research Project: Final Analysis* (June 2011) para 1.5

B Durham University (SME 26) para 3.2

C UK Power Networks, *Residential Demand Side Response for outage management and as an alternative to network reinforcement* Report A1 (September 2014)

D Q37 [Dr Darby]

E Qq30–31

F Commission for Energy Regulation, *Electricity Smart Metering Customer Behaviour Trials (CBT) Findings Report* CER 11080a (May 2011)

45. Professor Liddell provided data on the scope for peak load transfer in other countries (as described in their own impact assessments), emphasising that the scope for transfer in Great Britain is more limited than in other parts of Europe.[73] Nick Hunn explained that other countries have additional demands from air conditioning, and that "we have one of the smallest variations between peak and standard demand of almost any country in the world […] We have such a different demand curve from most of the rest of the world that we are going to have to make it up as we go along".[74]

Smoothing energy demand

46. Clearly if consumers are to change their behaviour they must have the opportunity to act differently as well as the ability and motivation. The Institute of Directors (IoD) argued that "the only real 'activities' that can be shifted (and not without their own inconveniences) relate to washing machines and dishwashers". The IoD told us that it was "a fundamental conceit at the heart of the smart meters programme" that householders have large flexibility over how much energy they use and when.[75]

47. DECC's impact analysis estimates that the "discretionary load"—the portion of consumption that can potentially be shifted to off-peak times—is 20% of the total consumption at peak, comprising 17% from 'wet' appliances (i.e. washing machines and dishwashers) and 3% from other sources.[76] The analysis also assesses what part of this discretionary load will actually be shifted by consumers:

> In the short run, we assume that those customers on STOU [static Time of Use tariffs] will only shift one third of the discretionary load at peak that they actually could. As time goes by, we expect the number of times that load is actually shifted to increase to 50% of the available discretionary load, driven by the consolidation of the behavioural change and customer familiarisation with the technology, and the role of other factors such as higher price differentials and the introduction of some home automation and smart appliances, which would reduce the need for active action by the householder.[77]

48. Professor Harriet Bulkeley and colleagues at Durham University noted that "ToU tariffs can work very well for households with high levels of flexibility capital. The ability of customers to be flexible is not only related to the design of the tariff and the incentive it provides but linked to existing patterns and structures of social life".[78] The Federation of Small Businesses also raised this as an issue for SMEs:

> It is clear that some businesses will be more able to take advantage of Time of Use charges than others, depending on the nature of their operation. FSB also raises caution that many businesses operate on different cycles to the average domestic customer. So a one size fits all approach to Time of Use

73 Professor Christine Liddell (SME 11) figure 3
74 Q37 [Nick Hunn]
75 Institute of Directors (SME 28)
76 DECC, *Smart meter roll-out for the domestic and small and medium non-domestic sectors (GB): Impact assessment* (January 2014) p59
77 DECC, *Smart meter roll-out for the domestic and small and medium non-domestic sectors (GB): Impact assessment* (January 2014) p60
78 Durham University (SME 26) para 1.1

> charges will not work. In order to drive behaviour change, the market will need to provide not only a price disincentive against using energy at certain times, but also a clear pathway for achieving this. For instance, it may be prudent to consider a recommendation for all users above a certain energy threshold to implement storage and management systems that allow them to run 'off line' at certain times of the day.[79]

49. Nick Hunn believed that in order to significantly influence consumer behaviour through ToU tariffs "you need either to set a low value for the cheap one, which the customers jump on and then the energy supplier loses money, or to ramp up the peaks so much that the regulator steps in".[80] Dr Darby told us that "where the ratio between the peak and the off-peak cost is very slight, you tend to get a pretty slight response. We have seen that in Italy and Ontario, for example".[81] Other examples noted by witnesses were

- The Powershift tariff in Northern Ireland, where peak price was about three times the non-peak price, and "the customers were doing so well out of it that the company had to discontinue the tariff".[82]
- The CLNR project trialled a ToU tariff with off-peak prices set at 70% of the standard day rate and peak times charged at 200%. Northern Powergrid explained that this static tariff "was insufficient on its own to shift materially the network peak on the winter day with the maximum peak load for which we size our network". Instead it suggested that "more sophisticated tariffs, such as dynamic Time of Use or critical peak pricing may be beneficial".

50. We asked the Minister whether he would be comfortable with ToU peak prices being many times higher than at non-peak times in order to prompt a large enough response to materially smooth demand. He told us that competition between suppliers would limit the severity of such a tariff: "We have many more energy suppliers now than we had even five years ago, so I just do not see it happening".[83] Sacha Deshmukh told us that high peak time prices were not the only mechanism that could deliver behaviour change, pointing to increased take up of recycling and smoking cessation campaigns as examples of where behavioural change can arise through "a combination of understanding that it is good for them in a marketplace and good for their household, and that it has a national benefit".[84]

51. The extent to which consumers themselves save money through ToU tariffs depends on the details of the tariff and the extent to which consumers are able and willing to alter when they use energy. Smart Energy GB told us that the CLNR study referred to above had found that "the majority" saved money on their energy bills through a time of use tariff, although Professor Harriet Bulkeley highlighted how many would have seen an increase in their bill:

> Analysis of shadow billing data provided by British Gas indicates that 243 of the 628 [CLNR] participants (39%) would have paid more money for

79 Federation of Small Businesses (SME 36) para 3.3
80 Q37 [Nick Hunn]
81 Q37 [Dr Darby]
82 Q37 [Dr Darby]
83 Q85
84 Qq86–87

their electricity by being on the tariff had they not been compensated by the project for the increased bills incurred in-trial. Of these the median increase would have been £18.40.

52. ***There is an extensive range of studies providing evidence on the likelihood and scale of consumers changing their usage patterns in response to Time of Use tariffs. Some evidence suggests that driving genuinely significant change could require a level of differential pricing which might be commercially, and potentially politically, difficult.***

4 The balance between consumer and national benefits

53. Smart Energy GB told us that smart meters were bringing about a "revolution in Great Britain's national energy system", that would bring "huge benefits for consumers and our national infrastructure".[85] Similarly, DECC believes that the rollout will "bring major benefits to consumers and the nation".[86] This chapter explores the balance between the benefits of smart metering to the individual and to the network and the country.[87]

54. The most recent of DECC's Smart metering Impact Assessments (IA), published in January 2014 and running to some 140 pages, estimates an overall positive net present benefit of £6.2 billion over the period to 2030 (comprising benefits of around £17 billion and costs of around £10.9 billion).[88] The Department intends to publish an updated impact assessment later in 2016.[89]

Benefits to the individual and the supplier

55. The 2014 IA for the rollout refers to a 2.8% saving in electricity consumption and a 2% reduction amongst gas (credit) customers. The IA predicts that by 2020 an average household could make an annual saving on their dual fuel energy bill of £26, rising to £43 in 2030. The average dual-fuel *non-domestic* premise could be expected to save £200 per year in 2020.

56. Nick Hunn was sceptical of the extent to which consumers will change their behaviour for a relatively modest financial reward, arguing that "£26 a year or 7p a day is not a big incentive", and that "there are far cheaper ways of achieving savings".[90] Pam Conway argued that "the savings come almost as a result of the data insight, rather than necessarily from people thinking of it as 50p a week".[91]

57. Other benefits to the consumer referred to in DECC's Impact Assessment include:

- Easier switching between suppliers;
- More accurate billing, the avoidance of billing problems, and the need for meter readings; and
- Avoidance of debt accumulation through access to accurate near real time information.

85 Smart Energy GB (SME 19) para 1
86 DECC (SME 31) para 3
87 Others have explored the costs of the smart meter rollout, such as the Public Accounts Committee, and the National Audit Office published reports in 2011 and 2014 on this topic.
88 DECC, *Smart meter roll-out for the domestic and small and medium non-domestic sectors (GB): Impact assessment* (January 2014)
89 Department of Energy and Climate Change (SME 42) para 16
90 Q6
91 Q5

58. Although not a benefit to the consumer, other than through savings being passed on to customers, the Impact Assessment also describes benefits to suppliers:

- Removing the need for site visits to complete meter reads;
- Reducing call centre traffic, with fewer queries about estimated bills;
- Improved theft detection and debt management; and
- Remote disconnection.

Benefits of optimising electricity generation and network management

59. DECC's December 2015 publication *Towards a smart energy system* explains that smart meters are a "critical building block" in delivering a smart energy *system*, alongside the development of better energy storage solutions.[92] The document explains that a smart energy system as a whole could:

- Defer or avoid investment in network reinforcement;
- Reduce the need for a significant increase in reserve generation capacity;
- Meet binding climate change targets with less low carbon generation;
- Make the best use of low carbon generation;
- Optimise balancing of the energy system on a minute-by-minute basis.[93]

60. DECC's current Impact Assessment refers to network benefits including:

- Benefits from electricity load-shifting, including generation capacity investment savings, leading to carbon savings arising from changes in generation mix;
- Outage detection (including savings in reducing calls to fault and emergency lines, improved response times);
- Reduction in operational costs to fix faults;
- Better informed investment decisions for electricity network enforcement (since "having more detailed historical information will allow bottlenecks in the network to be identified more easily"); and
- Avoided costs of investigation of customer complaints about voltage quality of supply (since voltage can be monitored remotely through smart meters).

61. Other national benefits referred to include reduction in carbon emissions,[94] air quality benefits, and of course the enablement of a future smart grid.

92 Department of Energy and Climate Change, *Towards a smart energy system* (17 December 2015) para 5

93 Department of Energy and Climate Change, *Towards a smart energy system* (17 December 2015) para 15

94 One witness (Hugh Smeaton (SME 43)) was concerned that the design of the smart meter rollout would not tackle avoidable network losses—the power lost through heating transmission wires—as another route to achieving carbon reductions.

Future benefits: smart grids, electric vehicles and smart charging

62. DECC's report suggests that the significance of the demand side response can be expected to grow with electrification of heating and transport, and predicts that in the future "consumers could choose to set up smart appliances (e.g. heat pumps, dishwashers and washing machines) to respond automatically to price signals from smart meters and use energy when it is cheapest".[95] It also suggests that electric vehicles could automatically charge in this way when demand is low, and function as a means of storing electricity for managing times of peak demand.

63. BEAMA told us that the electrification of transport will "create challenges for network management", given that "future EV [Electric Vehicle] fleets could add c.28GW peak demand in 2050 if no charging management solutions are in place".[96] BEAMA points to smart meters as a way of meeting the challenges of increased pressures on grid infrastructure, explaining that they would enable a "smart charging system":

> In a smart charging system, the charging cycle can be altered by external events and the EV effectively integrates with the whole power system in a grid. This means that, when permitted by the consumer, the charging of an EV can be paused or the rate of charge increased or decreased in response to commands received from energy network operators […] the system will provide an optimal charging profile to deliver lowest cost while ensuring the vehicle is ready when needed.[97]

Consequences of the electrification of transport for the grid were also considered in a recent report by the Energy and Climate Change Committee.[98]

95 Department of Energy and Climate Change, *Towards a smart energy system* (17 December 2015) para 23
96 BEAMA (SME 18) para 6.2
97 BEAMA (SME 18) paras 6.4–6.5
98 Energy and Climate Change Committee, *2020 renewable heat and transport targets*, Second report of Session 2016–17, HC 173, Chapter 4

The balance of benefits

64. In DECC's impact assessment, the benefits are divided between those for consumers (from energy saving), suppliers (such as avoided site visits), and everyone (such as improved air quality).[99] Table 5 summarises DECC's figures.

Table 5: Overall (domestic and non-domestic) benefits of smart metering

	Domestic (£m)	Non-domestic (£m)	Total (£m)
Consumer benefits (from energy saving and microgeneration)	4,295	1,437	5,732
Supplier benefits (including avoided site visits, reduced inquiries etc)	7,970	295	8,265
Network benefits (reduced losses, reduced outage notification calls, fault fixing, avoided investment from ToU (distribution/transmission) etc)	877	112	947
Generation benefits (avoided investment in generation from peak shifting through ToU)	803	49	852
UK-wide benefits (including CO2 reduction, air quality)	867	440	1,307

Source: DECC, Smart meter roll-out for the domestic and small and medium non-domestic sectors (GB): Impact assessment (January 2014) (summarised), "central case" scenario, pp 75 & 116

65. DECC's analysis gives a significant gross benefit to consumers, which is much larger than the benefits to the network. However, this is less substantial at an individual or household level: if the gross consumer benefits are divided equally between the 30 million households and small businesses the benefit appears much smaller, at £191 each up to 2030.

66. Professor Christine Liddell of the University of Ulster noted that "a comparison of DECC's [Impact Assessments] in 2011 and 2014 indicates that the benefits accruing to consumers have been downsized. At the same time, benefits accruing to networks and generators have increased".[100] This arises from a range of updates to the cost-benefit analysis. Nick Hunn argued that customer savings were being promoted as a key benefit of the rollout when the emphasis should instead be on supporting a smart grid:

> We have made up the concept that this is all being led by customer savings, when there are probably better ways of getting customers to save money […] Yes, it is good to save energy, but the main reason for smart metering should be getting the data to control the grid and that seems to have been lost as the primary reason.[101]

Similarly, Dr Sarah Darby told us that:

99 DECC, *Smart meter roll-out for the domestic and small and medium non-domestic sectors (GB): Impact assessment* (Janu ar y 2014)

100 Professor Christine Liddell (SME 11) para 5

101 Q2

> smart metering was introduced as a means of improving system efficiency in the electricity network as a whole […] The smart metering programme is fundamentally about that. Having said that, I believe that it can be used in such a way as to help customers save money. We now have quite a body of evidence to show that that happens and is being sustained.[102]

67. **It is unclear whether the Government's primary aim of the smart meter rollout is the establishment of a smart energy system (and the realisation of the corresponding benefits of this for efficient energy generation, both now and in the future), or to save individuals money on their energy bills.** ***The Government needs to do more to communicate the national benefits of smart metering alongside the potential cost savings and efficiencies for individual consumers. This was a weakness of the Government's evidence check statement, and relates to a lack of clarity over the 'problem' that smart meters aim to address. In its response to this report, the Government should provide further information on how it expects smart metering to affect the required energy generation capacity of the network and the mix of energy generation sources.***

102 Q3

5 Technical, security, and privacy issues

Interoperability

68. Interoperability of smart meters between different suppliers was explored previously by the Energy and Climate Change Committee in 2013 and 2015.[103] Witnesses to our inquiry remained concerned that SMETS 1 meters—those deployed in the foundation stage—may not necessarily be able to work in "smart mode" if the customer switched supplier. Those deployed in the mass rollout phase are not expected to suffer from this limitation because they operate in a different way, by connecting with the national communications infrastructure known as the Data Communications Company (DCC) that will link smart meters in homes and businesses to energy suppliers. It is expected that the DCC will be operational later this year, after several significant delays.[104]

69. DECC told us that "in some cases" foundation stage meters could still be operated as smart meters after a consumer switches, but acknowledged that this was "subject to agreement between energy suppliers".[105] It was the Government's "aim" that foundation stage smart meters would become interoperable in the future, through these meters being "adopted and operated by the DCC". In the meantime, DECC told us, Energy UK (the trade association for the UK energy industry) was "working with energy suppliers on interim commercial and technical solutions for increasing the likelihood of consumers keeping a smart service when they switch".[106] The DCC has been commissioned to undertake a feasibility project to assess options for achieving this, with the "ambition" that the meters will be adopted ahead of the completion of the rollout in 2020.[107]

70. We note that the Energy and Climate Change Committee recommended some 18 months ago that the DCC must "urgently" find ways of incorporating foundation stage meters into the communication infrastructure[108] and that it appears that the issue will remain for a number of customers for several years. Clearly this will affect the benefits of smart meters to some consumers in terms of the ability to switch suppliers with greater ease. ***The problem of interoperability of some early smart meters has still not been resolved, despite having been raised previously. This undermines efforts to encourage consumers to switch suppliers to get the best tariff deals and requires timely action.***

103 Energy and Climate Change Committee, Ninth Report of Session 2014–15, *Smart meters: progress or delay?*, HC 665

104 "Smart meter IT system delayed until autumn", BBC News website, 17 August 2016

105 Department of Energy and Climate Change (SME 42) paras 7–8

106 Department of Energy and Climate Change (SME 42) para 9

107 Department of Energy and Climate Change (SME 42) para 9

108 Energy and Climate Change Committee, Ninth Report of Session 2014–15, *Smart meters: progress or delay?*, HC 665, para 24

Data granularity

71. Nick Hunn provided an explanation of how a smart meter records and transmits data:

> Basically it measures the usage every 15 minutes in the course of the day in each home. At the end of the day, it sends that amount of usage back through DCC and then to the energy supplier. The energy supplier uses that for its billing.[109]

He argued that this transmission schedule would not be of any significant advantage to the network, since receiving data 24 hours in arrears was "not a vast improvement on what the grid operators already know",[110] and that as a result the Government was "missing an opportunity to put out a system that can provide data in real time […] It feels as if an old, out-of-date system is being put in, just at the point when we need something to cope with distributed generation".[111]

72. Pam Conway of British Gas argued that from a supplier point of view the smart meter data was "of a standard that we have not had previously and that we certainly do not get from standard meters", and believed that "if we can get more frequent data it can be aggregated to help to inform product design and grid efficiencies and innovations".[112] Northern Powergrid, the Distribution Network Operator for the North East of England, told us that "the availability of smart meter data to suppliers in half hourly increments at the end of each day, albeit not real-time, is a significant upgrade on the situation today when there is no such granularity and it may take more than a year for an estimate of the customer's consumption to be processed".[113] Northern Powergrid noted that the availability of smart meter data on a daily (as opposed to real-time) basis would "still require suppliers to use forecasts and assumptions to manage their share of the circa 30m GB electricity customers", but that "these new abilities will enable the development of demand side response".[114]

Reliance on the 2G mobile network

73. There is some uncertainty about whether and when 2G mobile phone networks might be turned off, and what the consequences might be for early smart meters using that technology. Nick Hunn was concerned that the smart meter technology being deployed will need to be replaced, because "the UK's GPRS networks are scheduled to be turned off by 2026 at the latest", and two out of the three Carriage Service Provider contracts specify GPRS technology.[115] He told us that "if smart meters are to remain operational after 2026, then all of the comms hubs in these areas will need to be replaced". The Royal Academy of Engineering, on the other hand, told us that GPRS was "being replaced by 3G/4G from 2023". There has been some speculation that operators might stop supporting 2G as soon as 2020.[116]

109 Q40
110 Nick Hunn (SME 2)
111 Q40 [Nick Hunn]
112 Q44
113 Northern Powergrid (SME 44)
114 Northern Powergrid (SME 44)
115 Nick Hunn (SME 2)
116 USwitch.com, "2G and 3G to be phased out by 2020", accessed 1 September 2016

74. Pam Conway told us that suppliers' interests in this were protected by "clear and robust commercial contracts to ensure the longevity and robustness of that technology, and that it works and is sufficient for communications".[117] Daron Walker added that suppliers' contracts were such that "from the last point at which they install a SMETS1 meter, they will have at least 10 years of communications coverage", and that "our understanding from working with Ofcom is that there is no evidence that [2G] will close down in the early 2020s".[118]

Smart meter security

75. British Gas told us that "Smart meters are extremely secure and they meet robust security standards specified by Government", and that the company had "not seen any security issues so far". British Gas describes the security features as follows:

- Cryptography scrambles messages to make them unreadable to anyone other than the sender and the intended recipient
- Data sent by smart meters use an Advanced Encryption Standard which is more complex than that used for internet banking
- Smart meters store data with methods widely used across industries such as banking and telecoms
- British Gas smart meters are designed to withstand and alert the company to any physical tampering.

76. The Royal Academy of Engineering told us that "the smart meter network is being installed before its requirements as an Internet-connected energy system have been fully determined". Smart Energy GB clarified that smart meters "do not use the internet, they use their own dedicated secure communication system".[119] The Academy told us that "the threat of cyber attacks—either to gain information, 'steal' electricity or disrupt supply—is real and pressing. […] Disruption to energy and gas supplies at a massive scale is possible, either from cyber attack or errors in software".[120]

77. Nick Hunn raised specific concerns about the ability of smart meters to disconnect consumers, and about the need to maintain smart meter firmware, arguing that "the level of firmware engineering in many metering companies is best described as hobbyist". He argued that the inclusion of an isolation switch in every smart meter was "an unnecessary risk", and that "if somebody could hack into that or turn off very large numbers of meters by mistake, the sudden shock of taking them off the grid—even worse if they were all turned back on at the same time—would cause significant damage".[121] He was also concerned about this risk of a "rogue programmer" in a metering company, claiming that "if I were working for one of those companies, I could insert code that would make every meter turn off on a particular date in a year's time".[122]

117 Q49
118 Q93
119 Smart Energy GB (SME 19) para 8.2
120 Royal Academy of Engineering (SME 37) para 23
121 Q57
122 Qq57–59

78. On 18 March 2016, the Financial Times reported that GCHQ had "intervened" in smart metering security, claiming that the agency had "discovered glaring loopholes in meter designs".[123] Given these concerns we held a private informal meeting with a representative of GCHQ to explore the issue of smart meter security, and asked DECC for further information. After our meeting we were provided with assurances on the issues raised above. On the involvement of GCHQ and the design of the system, DECC told us that:

> DECC has worked with GCHQ since the very early design stage of the rollout, when the programme was initiated […] The media reports relating to "loopholes" in the Smart Meter system are based on misunderstanding. Security lies at the heart of the smart metering system and has been a key consideration at every stage of system development to ensure there are no 'loopholes'. The system operates on a national scale and has been designed as a secure end-to-end system, not just a collection of meters, energy suppliers and other components that have evolved individually.[124]

On the risk of mass-disconnection, we learned that:

> The smart metering security architecture has been designed to ensure that any unintended impact on energy supply would require the compromise of multiple layers of security by multiple parties. The layers of security controls that have been designed into the end-to-end smart metering system ensure that messages sent to the meter that could affect supply must be digitally signed by the sender and checked for any unintended consequences. The message must then be digitally countersigned by the Data and Communications Company (DCC) and subjected to a further check to detect any potential for anomalous consequences.[125]

On the scope for a "rogue programmer" disrupting the system, we heard that:

> Personnel security arrangements must be implemented by the DCC, energy suppliers and any other users of the system. These arrangements will include segregation of duties and security vetting for privileged users that have access to sensitive system components. […] The end-to-end security architecture further mitigates the potential impact that a rogue employee could have on the overall system, and the capability for any vulnerability to be exploited at scale.[126]

79. The Government's statement on smart meter security is at Appendix 3, and a detailed description of the design of the smart metering system can be found on GCHQ's website.[127]

80. **The public is already familiar with IT-based systems having been hacked. It would be unfortunate if unwarranted concerns in media reports about smart meter security diminished public trust in the programme. GCHQ's recent blog post describing the security features of the system is a good example of communication with a technically-**

123 "GCHQ intervenes to secure smart meters against hackers", Financial Times, 18 March 2016
124 Appendix 3, para 1
125 Appendix 3, para 6
126 Appendix 3, paras 16–18
127 Consumer Electronics Security Group, "The smart security behind the GB Smart Metering System" (25 April 2016), accessed 1 September 2016

literate specialist security audience, but further efforts may be necessary to convince the wider public that smart meters are secure. ***We recommend that the Government consider further how to communicate the level of thought that has gone into designing a secure system for smart metering.***

Big data and privacy

81. In our 2016 report *The Big Data Dilemma* we explored the potential for large datasets to open up opportunities for innovation and unlock new lines of research, tempered by the need to ensure privacy is respected.[128] We asked our witnesses how the data provided by smart meters could be used, and how privacy concerns were being met. Daron Walker, the then Senior Responsible Officer for the smart meter rollout at DECC, told us that access to different levels of data granularity required different permissions:

> The existing framework is that energy suppliers will have access to monthly data automatically, to allow them to do billing. The more disaggregated you get, the more explicit the consumer consent has to be. For daily data, individual consumers have to opt out. When you get down to the really granulated half-hourly data, consumers have to opt in actively and explicitly. The whole framework is about making sure that consumers take the decisions about how other parties make use of their data.[129]

82. Smart Energy GB confirmed that "consumer energy data belongs to the consumer",[130] and DECC clarified that "No central repository of smart metering energy consumption data is held by the DCC, Government or any other organisation".[131] Indeed, our discussions on security and privacy with GCHQ led the Government to provide the following written statement:

> There is currently a large volume of academic work on the potential for reidentification in anonymised datasets, an example of which is a paper by Paul Ohm[132] which raises a potential problem in managing privacy and the laws that surround it. The paper highlights that our faith in the privacy protecting power of anonymising "personal data" in large data sets has been undermined and that the possibility to "reidentify" or "deanonymise" individuals hidden in anonymised data has been demonstrated sometimes with astonishing ease. The paper also contains the observation that the usefulness and privacy of data are intrinsically linked in such a way that regulation cannot increase data privacy without decreasing the usefulness of the data. Once again, appropriate balances need to be struck.[133]

83. Sacha Desmukh speculated on some of the future uses of the data on an individual-access basis, rather than as an anonymised large dataset:

128 Science and Technology Committee, Fourth report of Session 2015–16, *The big data dilemma*, HC 468
129 Q77
130 Smart Energy GB (SME 19) para 8.3
131 Appendix 3, para 19
132 "Broken Promises of Privacy: responding to the surprising failure of anonymization", *UCLA Law Review*, vol 57 (2010) pp1701–1777
133 See Appendix 3

> Organisations such as Citizens Advice, some of the age charities and some of the more vulnerable charities—even some of the energy suppliers themselves—are looking to see how they could develop a relatively simple algorithm that would allow you, if you wanted, or, let us say, a parent if you were caring for them, to have data matched against temperature. If the data indicated they were not heating at the time when the temperature was dropping to show that they should, you can either speak to them directly if you are the care service or speak to their designated carer […] it could finally mean that we can get information support and advice for people to say, "Don't turn your heating off, or if you have run out of money, we'll solve the money problem but in the meantime we don't want you to freeze to death or end up in an NHS hospital," which costs us all a lot more [compared with] targeting some of that support".[134]

Vulnerable consumers are currently able to sign up to energy companies' Priority Services Registers[135] which require the suppliers to meet particular safeguards. The Government's evidence check statement also emphasises that licence conditions for smart meters will address the needs of "vulnerable, low income and pre-payment consumers" (see Appendix 1, paragraph 12).

84. **As with many examples of big data, there are opportunities to explore as well as risks to manage. We look forward to seeing how the data that smart meters produce can be put to use beyond the obvious applications for energy network management, including how data can be used to support vulnerable customers. We were assured that consumers will own their data and be able to decide who can access it. Wider questions about processes for anonymisation and the ethics of data usage and consent will need to be considered carefully by the Data Services Ethics Council being set up by the Government following our Big data dilemma report.**

134 Q112

135 Citizens Advice, "Priority Services Register for older and disabled people", accessed 14 September 2016

6 Conclusions

85. The smart metering policy has been supported by various trials, alongside an extensive 'foundation stage' before the mass rollout begins later this year. It is clear that the Government has invested considerable work in developing an evidence base for the project.

86. The Government's smart meter implementation plan is underpinned by a series of substantial impact assessments, the current version of which runs to some 140 pages and is in the process of being updated. The Treasury 'Green Book' guidance requires Impact Assessments to be undertaken to support policy business cases. As the Guidance states, an impact assessment summarises the rationale for Government intervention, the options considered (including non-regulatory options), and the expected costs and benefits.[136] It stipulates that impact assessments are produced and updated at each of the relevant stages of the programme's 'policy cycle': development, options, consultation, final proposal, enactment, validation and review. Impact assessment, the guidance states, should be "a continuous process […] used to help develop policy" by assessing and presenting the likely costs and benefits and the associated risks of a proposal.[137]

87. The Impact Assessment for the smart meter rollout included some analysis of alternative delivery models, including a fully competitive model, a fully centralised model and deployment by network operators. But this analysis was not referred to in the Government's original evidence check statement (Appendix 1). This apparent disconnect could bring into question whether the impact assessment is fully embedded in the development and communication of the smart meter policy.

88. **The Government's evidence check statement on smart metering did not fully reflect the amount of work undertaken as part of the impact assessment for the project. The gap between the quality of the statement and the impact assessment is concerning, as it suggests there could be a disconnect between those responsible for the policy and those tasked with completing the impact assessment.**

89. **The Government has invested in trialling smart meters and in studies of their impact. Smart Energy GB is also making use of evidence in understanding consumer behaviour. Despite the growing evidence base underpinning the project, there are a number of areas where the Government clearly believes there are misconceptions and misunderstandings about the utility, impact, and security of smart metering. *The Government should reflect on these in the context of the mass rollout and consider how best to communicate with consumers on some of these topics.***

90. Some criticisms of the project arise from a lack of clarity over the primary aim of the smart meter rollout and the 'problem' that it seeks to address. DECC's 2014 Impact Assessment lists 11 different policy objectives, the second of which is "to promote cost-effective smoother electricity demand, so as to facilitate anticipated changes in the electricity supply sector and reduce the costs of delivering (generating and distributing) energy", and the sixth of which refers to supporting the development of smart grids.[138].

136 BIS, *Better Regulation Framework Manual: Practical guidance for UK Government officials* (March 2015)

137 BIS, *Better Regulation Framework Manual: Practical guidance for UK Government officials* (March 2015) para 2.1.4

138 DECC, *Smart meter roll-out for the domestic and small and medium non-domestic sectors (GB): Impact assessment* **(January 2014) para 1.3**

91. The Government has sought to support consumers in reducing their energy consumption by including IHDs as part of the smart meter rollout, providing a mechanism for feedback on energy usage—unlike in other countries introducing smart meters. There is a risk that this could be perceived to be the primary purpose of smart metering, given that it will be the most visible manifestation of the project for consumers. The fact that savings for consumers are likely to be modest is well-documented by research and trials, and it would be unfortunate if the wider future benefits of a smart grid are forgotten amongst this. The national benefits of smart metering—in terms of optimising electricity generation and storage, and paving the way for a smart energy system—are important, and the Government will need to communicate this alongside emphasising savings for individual customers.

92. ***The smart meter rollout has too many objectives, and this may hinder implementation and evaluation. The Government should be clearer about the primary purpose of smart metering and use this to drive evaluation of the project. Taking this approach will help make future evidence check statements clearer. Smart meters need to be clearly understood by the consumer and provide information in a format that the customer finds helpful. In order for consumers to benefit directly from smart metering there will need to be appropriate investment in customer engagement, given that this is being introduced in an era of low public trust in utility providers.***

Conclusions and recommendations

The Evidence Check process

1. The delays in receiving some of the Government statements in response to our evidence check request were regrettable. It is concerning that the Government was not able to identify a lead department in two cases. (Paragraph 4)

2. The Government's difficulty in engaging with the evidence check framework suggests that in some departments there is a lack of experience of articulating the evidence base for its policies. More worryingly it may also indicate that some areas lack the necessary evidence base. (Paragraph 7)

3. The Government's evidence check statement on smart metering was disappointing in some respects. There was a lack of a clear description in the statement of the 'problem' that smart metering aims to address, and as a result the measures by which the project will be evaluated were opaque. The transparency of the statement was strengthened, however, by including references to DECC's impact assessment. Overall, we were unable to rate the statement highly against the Institute for Government's evidence transparency framework. (Paragraph 18)

4. *In its response to this report, the Government should reflect on its experience of collecting evidence check statements from a range of departments using the IfG's Evidence Transparency Framework and consider how its processes could be improved, including by building the IfG structure into its guidance and policy-development methodologies. We hope that the Government will be more consistent in its engagement with the Institute for Government's Evidence Transparency Framework when preparing future evidence check statements for us and other committees.* (Paragraph 20)

Consumer behavioural science

5. *Smart Energy GB is making good use of behavioural science to consider how best to support the smart meter rollout. This could usefully be bolstered by evidence from sociologists and social psychologists, given that energy usage is an integral part of modern life.* (Paragraph 24)

6. The inclusion of an in-home display in the smart meter rollout provides a necessary feedback mechanism on energy consumption, although other forms of feedback are possible and are being trialled. The Government's evidence check statement did not include material on whether alternative energy use feedback mechanisms (such as clip-on energy monitors) had been considered. (Paragraph 30)

7. *In order to reflect the available evidence the Government should ensure that in its bid to complete the smart meter rollout by 2020 it does not compromise on consumer engagement before, during and after installation, including for small businesses. The impact of smart meters will be limited without this support from installers and Smart Energy GB.* (Paragraph 36)

8. 'Implementation' is one of the IfG's 'chain of reasoning' steps—implementing a policy based on evidence of 'what works'. The Government's evidence check

statement highlighted available evidence on whether smart meters could lead to a reduction in energy consumption through engagement with in-home displays. That evidence does suggest such an outcome, although the scale and durability of such savings is contested and it would appear that the rollout could alter consumption levels by 2–3%. (Paragraph 40)

9. *The Government should update its research on the impact of smart meters as the rollout progresses, adjusting the Impact Assessment as necessary. It should take the opportunity now available to examine five years of data for some customers in the Early Learning Programme. It should explore with British Gas the opportunity to make its large datasets, from 2.7 million fitted smart meters, available to researchers.* (Paragraph 41)

Changing when energy is used

10. *There is an extensive range of studies providing evidence on the likelihood and scale of consumers changing their usage patterns in response to Time of Use tariffs. Some evidence suggests that driving genuinely significant change could require a level of differential pricing which might be commercially, and potentially politically, difficult.* (Paragraph 52)

The balance between consumer and national benefits

11. It is unclear whether the Government's primary aim of the smart meter rollout is the establishment of a smart energy system (and the realisation of the corresponding benefits of this for efficient energy generation, both now and in the future), or to save individuals money on their energy bills. *The Government needs to do more to communicate the national benefits of smart metering alongside the potential cost savings and efficiencies for individual consumers. This was a weakness of the Government's evidence check statement, and relates to a lack of clarity over the 'problem' that smart meters aim to address. In its response to this report, the Government should provide further information on how it expects smart metering to affect the required energy generation capacity of the network and the mix of energy generation sources.* (Paragraph 67)

Technical, security and privacy issues

12. *The problem of interoperability of some early smart meters has still not been resolved, despite having been raised previously. This undermines efforts to encourage consumers to switch suppliers to get the best tariff deals and requires timely action.* (Paragraph 70)

13. The public is already familiar with IT-based systems having been hacked. It would be unfortunate if unwarranted concerns in media reports about smart meter security diminished public trust in the programme. GCHQ's recent blog post describing the security features of the system is a good example of communication with a technically-literate specialist security audience, but further efforts may be necessary

to convince the wider public that smart meters are secure. *We recommend that the Government consider further how to communicate the level of thought that has gone into designing a secure system for smart metering. (Paragraph 80)*

14. As with many examples of big data, there are opportunities to explore as well as risks to manage. We look forward to seeing how the data that smart meters produce can be put to use beyond the obvious applications for energy network management, including how data can be used to support vulnerable customers. We were assured that consumers will own their data and be able to decide who can access it. Wider questions about processes for anonymisation and the ethics of data usage and consent will need to be considered carefully by the Data Services Ethics Council being set up by the Government following our Big data dilemma report. (Paragraph 84)

Conclusion

15. The Government's evidence check statement on smart metering did not fully reflect the amount of work undertaken as part of the impact assessment for the project. The gap between the quality of the statement and the impact assessment is concerning, as it suggests there could be a disconnect between those responsible for the policy and those tasked with completing the impact assessment. (Paragraph 88)

16. The Government has invested in trialling smart meters and in studies of their impact. Smart Energy GB is also making use of evidence in understanding consumer behaviour. Despite the growing evidence base underpinning the project, there are a number of areas where the Government clearly believes there are misconceptions and misunderstandings about the utility, impact, and security of smart metering. *The Government should reflect on these in the context of the mass rollout and consider how best to communicate with consumers on some of these topics.* (Paragraph 89)

17. *The smart meter rollout has too many objectives, and this may hinder implementation and evaluation. The Government should be clearer about the primary purpose of smart metering and use this to drive evaluation of the project. Taking this approach will help make future evidence check statements clearer. Smart meters need to be clearly understood by the consumer and provide information in a format that the customer finds helpful. In order for consumers to benefit directly from smart metering there will need to be appropriate investment in customer engagement, given that this is being introduced in an era of low public trust in utility providers.* (Paragraph 92)

Appendix 1: The Government's smart metering evidence check statement

This text was received in December 2015 in response to our request for an evidence check statement, and was published online for comment in January 2016.

Diagnosis and plans

1) The Government has a manifesto commitment to 'ensure that every home and business in the country is offered a smart meter by 2020, delivered as cost effectively as possible'. Smart metering is an investment programme to modernise our metering system and bring it into the digital age—some consumers still have meters based on technology that is over 100 years old. The Programme will replace 53 million meters with smart electricity and gas meters in all domestic properties, and smart or advanced meters in smaller non-domestic properties, by the end of 2020.

2) The Competition and Market Authority's provisional findings from its energy market investigation recognise the key contribution smart metering will make to strengthening retail competition and consumer engagement in the energy market.

3) Smart meters will deliver a range of benefits to consumers, energy companies and networks:

- domestic consumers will be offered an In Home Display (IHD) enabling them to see what energy they are using and how much it is costing;
- smart meters will bring an end to estimated billing, consumers will only be billed for the energy they actually use, helping them to better manage their budget. Suppliers will have access to accurate data for billing, removing the need to manually read meters;
- the rollout will: increase consumers' confidence in, and engagement with, the energy market; enable them to provide their data to third parties, such as switching sites; and, is an enabler for 24 hour switching. Taken together this will lead to a more competitive retail energy market;
- energy networks will have better information upon which to manage their activities and investments.
- smart meters are a platform for smart grids and will provide the foundation for demand-side response in conjunction with half-hourly settlement. As part of this, time of use tariffs and load control will help to manage peak electricity demand as part of a more flexible and responsive future energy system.
- smart meters can also be paired with 'consumer access devices' that will allow consumers access to the tariff and energy usage data in the smart meter. DECC expect that this will enable third-party SME developers to offer innovative services to consumers such as automated energy saving advice, interfaces to home energy management systems and analysis or display of information on a smartphone.

4) The Government has engaged widely with industry and other stakeholders in developing common technical standards for the smart metering equipment to ensure that it is interoperable and has the functions necessary to enable benefits realisation.

Implementation: a Competitive Rollout

5) Energy suppliers are responsible for planning and delivering the roll-out of smart meters, working within the legal framework established by the Government. The case for an energy supplier-led approach in GB is strong, as suppliers have the main relationship with consumers. This was consulted upon at an early stage of the Programme.[139]

6) Moreover, unlike many other countries where metering is the responsibility of the network companies, in Great Britain metering is already the responsibility of energy suppliers. Energy suppliers also have strong commercial and financial incentives to engage consumers and deliver good quality service at lowest cost. Those energy suppliers that do not deliver the roll-out efficiently or do not provide for a good consumer experience risk losing customers to their competitors.

Value for Money

7) DECC's Impact Assessment has been developed and updated over the last six years. Costs and benefits have been quantified by collecting information from key stakeholders including industry, consumer groups and academia. The assumptions have been widely consulted on and have been benchmarked against international evidence as well as scrutinised by experts.

8) The latest Impact Assessment (IA)[140] for the Programme, published in January 2014, estimates a positive net present benefit of £6.2 billion over the period to 2030, by delivering total benefits of around £17.1 billion and costs of around £10.9 billion. The Government will be publishing an updated Impact Assessment in the first half of 2016.

9) The Government reviews progress on the Smart Meter Programme on a continuing basis including tracking progress against the business case.

Consumer Engagement

10) All consumers stand to benefit from the control, convenience and energy system efficiencies that smart meters will bring outlined above. The Government considers consumer engagement to be a prerequisite for the success of the Programme. The Smart Metering Programme's Consumer Engagement Strategy[141] (published in 2012) was developed in close consultation with stakeholders, informed by a range of UK and international evidence, and led to an approach whereby:

139 A consultation on smart metering for electricity and gas, May 2009: http://webarchive.nationalarchives.gov.uk/20090703093717/http:/www.decc.gov.uk/en/content/cms/consultations/smart_metering/smart_metering.aspx

140 Smart Meter roll-out for the domestic and small and medium non-domestic sectors: impact assessment https://www.gov.uk/government/publications/smart-meter-roll-out-for-the-domestic-and-small-and-medium-non-domestic-sectors-gb-impact-assessment

141 Government Response to the consultation on the Consumer Engagement Strategy, December 2012: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/43042/7224-gov-resp-sm-consumer-engagement.pdf

- energy suppliers will have the primary consumer engagement role as the main interface with their customers before, during and after installation;
- supplier engagement will be supported by a programme of centralised engagement undertaken by Smart Energy Great Britain (Smart Energy GB); and
- the Government will continue to communicate with consumers, in addition to the activity undertaken by the industry and consumer organisations, where this will provide additional benefit.

11) Smart Energy GB has published a Consumer Engagement Plan[142], which was last updated in December 2014. Its plans include: national campaigns to raise general awareness and interest in smart meters; partnerships with local organisations to support engagement, particularly with vulnerable consumers; a website (in English and Welsh) with detailed information for consumers on smart meters; and a series of online and educational films.

12) The Government is committed to ensuring that all consumers benefit from smart meters, including low income and vulnerable customers, and has:

- introduced Licence Conditions on large energy suppliers that oblige Smart Energy GB to assist vulnerable, low income and pre-payment consumers;
- put in place the Smart Metering Installation Code of Practice (SMICoP), which requires energy suppliers to meet the needs of vulnerable consumers; and
- placed a requirement on energy suppliers to ensure that the In Home Display (IHD) is accessible for a broad range of users, including those with impairments.

13) Developing a framework of rules to protect consumers was an essential first step in establishing the smart metering system. In relation to privacy, the Data Access and Privacy Framework[143] governs access to smart meter consumption data by energy suppliers, network operators and third parties. It establishes the purposes for which this information can be used and the choices available to consumers.

14) As technologies evolve and consumers gain confidence with the opportunities offered by smart metering, data access rules may need to evolve. The Government remains committed to monitoring the current Data Access and Privacy Framework and in March 2015 we consulted on the timing of a formal review of these regulations. We will report on this shortly.

Requirement to offer In-Home Displays

15) The Government is requiring energy suppliers to offer all their domestic consumers an In Home Display (IHD) where they install a smart metering system. The IHD is central to putting consumers in control of their energy use. For many consumers, the IHD will be

142 Smart Energy GB Consumer Engagement Plan, December 2014: http://www.smartenergygb.org/sites/default/files/engagement-plan-1213.pdf

143 SMIP Data Access and Privacy Government response to consultation: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/43046/7225-gov-resp-sm-data-access-privacy.pdf

the first opportunity to visualise their energy consumption—how much they use, when they use it, and how much it costs them. The IHD ensures that low income households can benefit from access to smart meter data, even in the absence of access to the Internet.

16) GB trials and international experience demonstrate that IHDs are instrumental to energy savings. The findings of the Early Learning Project (ELP),[144] published in March 2013, provide substantial new evidence confirming that the IHD is an important tool for engaging consumers with energy-use information. The research showed that more than nine in ten of all smart meter customers surveyed who received an IHD had plugged it in at some point since the installation visit. Around six in ten reported that they generally still had their IHD plugged in.

17) There is evidence that other forms of complementary feedback may provide additional benefits. Innovative forms of feedback might, for example, integrate smart meter data into other devices, including tablets, smart phones or even televisions. However there is very little UK or international research in this area. Unknowns include whether such alternatives are likely to be effective and enduring methods of engaging consumers and whether they would add to the energy saving benefits of IHDs. Whereas IHDs have been shown to be accessible and used by most consumer types, the characteristics of consumers who would use alternatives to IHDs are not understood.

18) The Government therefore consulted this summer on allowing energy suppliers to apply for a derogation from existing requirements to offer consumers an IHD so that they could trial alternative innovative energy use engagement tools. This will provide then Government with the evidence it needs to ensure that approaches to providing consumers with feedback on their energy use remain optimised for consumers in a technologically fast moving and innovative environment.

Testing and Evaluation

19) The Government published its Monitoring and Evaluation Strategy[145] in 2012. The Foundation Stage of the Programme, which began in April 2011, is also enabling suppliers to gain valuable learning and experience to inform preparations for the main installation stage of the Programme beginning in 2016, as well as enabling consumers to learn about smart meters, and to access early benefits. Those energy suppliers that have undertaken significant numbers of installations are reporting higher levels of satisfaction among their customers with smart meters.

20) The findings from the ELP show that a positive picture has emerged around consumer response to smart metering in the early roll out. Early smart metering customers are saving both electricity and gas as a result. Findings from the ELP also outlined the transformative benefits smart meters can bring to prepayment customers (who can often be low income or otherwise vulnerable customers). Being able to see an account balance on an easily-accessed IHD—rather than often awkwardly placed meters—reduces the risk of pre-payment customers accidently self-disconnecting from energy supply when they run out of credit.

144 Smart Meter Early Learning Project and Small-Scale Behaviour Trials: https://www.gov.uk/government/publications/smart-metering-early-learning-project-and-small-scale-behaviour-trials

145 SMIP: Government Response to consultation on information requirements for monitoring and evaluation: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/43136/7206-gov-resp-cons-sm-monitor-evaluation.pdf

21) The ELP identified categories of energy user who would particularly benefit from tailored, follow-up support to ensure they are able to fully realise the benefits of smart meters: householders with specific difficulties, due to low levels of literacy, long-term illness, age or disability; Tenants; Low-income consumers; and, prepayment consumers.

22) To support suppliers and Smart Energy GB with these categories of consumers, the Government is leading on further work in 2015 to:

- assess the planned provision of follow-up support for vulnerable consumers and whether further steps are required to support provision of benefits to key groups of consumers;
- to develop good practice energy efficiency advice and guidance materials to be used at the point of installation, for use by installers and those providing follow-up support.

23) The Government's monitoring and evaluation plans will continue to be reviewed and refined as the Programme moves towards the main installation stage of the Programme.

24) Note—The Fourth Annual Report on the Rollout of Smart Meters in Great Britain was published on 18 November and provides and overall update on progress of the Programme.[146]

146 Fourth Annual Report on the Roll-out of Smart Meters: https://www.gov.uk/government/publications/fourth-annual-report-on-the-roll-out-of-smart-meters

Appendix 2: The Institute for Government's evidence transparency framework

Policy proposal	Level 0	Level 1	Level 2	Level 3	Worked example
Diagnosis	Not clearly enough for level 1.	Evidence is mentioned, with some explanation of how it has been used.	As in level 1 but the supporting evidence is linked to the relevant parts of the policy, properly cited and you could find the source.	As in level 2 but the evidence base is also assessed and uncertainties and contradictory information are acknowledged.	The Government has assessed the extent of problem drinking in the UK: the economic and human cost.
Proposal	Not clearly enough for level 1.	Evidence is mentioned, with some explanation of how it has been used.	As in level 1 but the supporting evidence is linked to the relevant parts of the policy, properly cited and you could find the source.	As in level 2 but the evidence base is also assessed and uncertainties and contradictory information are acknowledged.	The Government has chosen to implement minimum unit pricing for alcohol, instead of, for example, increasing alcohol taxes or starting a new educational campaign.

Policy proposal	Level 0	Level 1	Level 2	Level 3	Worked example
IImplementation	Not clearly enough for level 1.	Evidence is mentioned, with some explanation of how it has been used.	As in level 1 but the supporting evidence is linked to the relevant parts of the policy, properly cited and you could find the source.	As in level 2 but the evidence base is also assessed and uncertainties and contradictory information are acknowledged.	The Government has chosen to implement minimum unit pricing through a voluntary agreement with major retailers rather than through legislation.
Value for money	Not clearly enough for level 1.		As in level 1 but the supporting evidence is also properly cited and you could find the source.	As in level 2 but it is also clear how the uncertainties in these assumptions have been considered.	The assessment shows the potential of the proposal to reduce problem drinking, but also the impacts on business (e.g. supermarkets, pubs), the public sector (e.g. police, NHS), and the public of raising prices.

Source: Institute for Government, *Evidence transparency framework* (October 2015)

Appendix 3: Written evidence submitted by the Government on smart meter security

During the inquiry we held a private informal meeting with a representative of GCHQ to discuss smart meter security issues. The Government subsequently submitted the following memorandum on the points we raised during the session:

GCHQ involvement

1) The Department of Energy and Climate Change (DECC) has worked with GCHQ since the very early design stage of the rollout, when the programme was initiated. The engagement with GCHQ has been one of partnership, issue discussion and resolution. DECC has worked with GCHQ to provide the following information about the security of smart meters.

Media reports

2) The media reports relating to "loopholes" in the Smart Meter system are based on misunderstanding. Security lies at the heart of the smart metering system and has been a key consideration at every stage of system development to ensure there are no 'loopholes'. The system operates on a national scale and has been designed as a secure end-to-end system, not just a collection of meters, energy suppliers and other components that have evolved individually. This is particularly evident from the GCHQ description of smart metering security on their website.[147]

The system's security is proportionate

3) DECC, working with GCHQ and industry experts, designed the Smart Metering System with layers of security controls that can practicably be implemented by industry participants. Detailed threat modelling of hypothetical attacks, errors and failures has been undertaken to ensure these controls are proportionate to the current threat landscape and, together with trust modelling, cryptography and other controls that have been applied, are designed to ensure that the system is as secure as it needs to be in relation to this threat landscape.

4) Trust modelling has been used to identify and segment the transactions between energy suppliers and network operators with meters to ensure that each transaction is adequately protected. Symmetric and asymmetric cryptography is used to ensure the authenticity of transactions (i.e. that it originates from an authorised party) and the integrity of the transaction (i.e. that the transaction cannot be altered in transit) and also to ensure non-repudiation (i.e. that the originator cannot deny that they initiated the transaction).

5) Each component part of the system is subject to a very detailed and comprehensive set of security obligations and regular ongoing independent security assessment. The nature

147 https://www.cesg.gov.uk/articles/smart-security-behind-gb-smart-metering-system

of the threat landscape means that individual components of the system will be subject to new compromise methods over time. The end-to-end security architecture minimises the risk that a single compromise to any one component could have a significant impact and allows for new threats to be addressed.

Mass disconnection

6) The smart metering security architecture has been designed to ensure that any unintended impact on energy supply would require the compromise of multiple layers of security by multiple parties. The layers of security controls that have been designed into the end to end smart metering system ensure that messages sent to the meter that could affect supply must be digitally signed by the sender and checked for any unintended consequences. The message must then be digitally countersigned by the Data and Communications Company (DCC) and subjected to a further check to detect any potential for anomalous consequences.

7) Each message received by a meter is authenticated via a secure cryptographic algorithm, where the authentication code is unique to each message and each meter. The meter will not respond to any message that does not have the correct cryptographic signatures of both the sender (the 'owner' of the meter who has the private key that will be recognised by the meter) and the additional message authentication code appended by the DCC.

8) It is clear therefore that that any message that has the potential to affect supply is very tightly controlled and is protected by multiple layers of security controls in different organisations and different locations that would all need to be compromised to achieve an unintended disconnection.

Ongoing relationship:

9) The Smart Energy Code (SEC) is a multi-party agreement which defines the rights and obligations of industry parties involved in the end-to-end management of smart metering in Great Britain.

10) GCHQ will continue to be available to attend the SEC Panel Security Sub-Committee if it is necessary to provide expert security advice. However, GCHQ does not consider it appropriate to have a seat on the SEC Panel Security Sub-Committee, as industry are responsible for ensuring the security of the enduring system and we expect them to proactively manage the risk. A representative from DECC is invited to attend SEC Panel Security Sub-Committee meetings enabling GCHQ to be called upon when needed, as well as continuing to proactively monitor the threats to key national infrastructure.

Assuring manufacturers

11) CESG (GCHQ's security arm) has been working with DECC and the Commercial Product Assurance (CPA) test labs to define the security standards that the end point equipment manufacturers (Electric & Gas meters and communication hubs) need to meet. The manufacturers are working with the test labs to gain assurance and CPA certification of these components.

SMETS1 meters

12) During the foundation phase of the programme energy suppliers are responsible for developing systems capable of communicating with their SMETS1 meters. Energy supplier licence conditions require them to take the right steps to securing these systems. Each metering system in SMETS1 therefore has its own security model. Arrangements are in place to ensure the security of these systems are independently assessed annually, with energy suppliers obligated to take steps to address any issues that are identified.

13) There is ongoing work relating to the enrolment and adoption of these meters into the DCC infrastructure. The requirement is to ensure that such adoption does not materially reduce the security of the overall system.

Threat Model

14) Throughout the system design information regarding changes to the threat landscape has been incorporated into the ongoing risk assessment process. These assessments have been informed by the UK intelligence community and augmented by industry knowledge and real-world incident reporting.

Resilience within the DCC

15) The DCC services are segmented into a number of core components. These include the systems which provide data transformation services, communications and the public key infrastructure. The DCC is required to employ proportionate technical controls to separate these systems to improve the resilience of the overall infrastructure. Business continuity and disaster recovery arrangements must be established and annually tested.

Rogue employees

16) Personnel security arrangements must be implemented by the DCC, energy suppliers and any other users of the system. These arrangements will include segregation of duties and security vetting for privileged users that have access to sensitive system components.

17) Under the CPA Scheme meter manufacturers will need to build their devices against a set of relevant security characteristics. Build standards are in place aimed at ensuring meter manufacturers adhere to security good practice standards within their organisation, including personnel security arrangements. The CPA scheme will also cover secure coding practices and assess whether an appropriate fault remediation process is in place.

18) The end-to-end security architecture further mitigates the potential impact that a rogue employee could have on the overall system, and the capability for any vulnerability to be exploited at scale.

Big data

19) There is no central repository of energy consumption data held by Government, the DCC or any other organisation. Where data is held, for example by energy suppliers, the provisions of the Data Access and Privacy Framework apply. This Framework imposes

requirements on those parties accessing data, including obligations regarding the provision of information to consumers about how often data is being collected, for what purposes and what choices are available to the consumer.

20) Where network operators wish to access detailed consumption data for regulated purposes, such as planning network reinforcement, they are required (under the Electricity Distribution Standard Licence Condition 10A.9) to treat the data so that it is no longer possible to identify a particular household. Network operators' plans for treating the data must be approved by Ofgem. There are a number of different approaches to making data anonymous, but we recognise that removing the ability to relate data to individuals is not always straightforward.

21) There is currently a large volume of academic work on the potential for reidentification in anonymised datasets, an example of which is a paper by Paul Ohm[148] which raises a potential problem in managing privacy and the laws that surround it. The paper highlights that our faith in the privacy protecting power of anonymising "personal data" in large data sets has been undermined and that the possibility to "reidentify" or "deanonymise" individuals hidden in anonymised data has been demonstrated sometimes with astonishing ease. The paper also contains the observation that the usefulness and privacy of data are intrinsically linked in such a way that regulation cannot increase data privacy without decreasing the usefulness of the data. Once again, appropriate balances need to be struck.

22) We are aware that GCHQ has started some research work to quantify and understand the risks in this area, resulting in the production of a set of authoritative advice for government and other parties about anonymisation and the risks of unintended disclosure.

Smart Meter firmware

23) The energy supplier is the 'owner' and operator of the smart meter and any command to update firmware must be initiated by them. Meter manufacturers, the DCC, and the SEC Panel will also play a role in this process to protect the integrity of the firmware image and ensure that the meter has all necessary certifications prior to a new version of firmware being updated.

24) The SEC places obligations on suppliers to ensure that any firmware updates they receive are digitally signed by the manufacturer (to ensure authenticity of the origin) with a SHA 256 hash across the face of the image (to ensure integrity i.e. no tampering after it has left the manufacturer). As a further security control, before acting on any request by the supplier to update the firmware on a device, the DCC will check the digital signatures of the supplier and independently validate the SHA 256 hash against that held on the SEC Panel Certified Product List. Only after these checks have been validated will it add the DCC's message authentication code. The meter will not activate the firmware without verifying the digital signature, the message authentication code and the firmware hash from the manufacturer.

25) An assurance maintenance plan must be agreed between each meter manufacturer and their CPA lab. This will describe the changes to the device that will trigger re-

148 "Broken Promises of Privacy: responding to the surprising failure of anonymization", *UCLA Law Review*, vol 57 (2010) pp1701–1777

evaluation by the CPA lab, in particular any which could impact the security of the device. This re-evaluation must be completed prior to any firmware update being authorised and listed on the CPL.

Formal Minutes

Wednesday 14 September 2016

Members present:

Victoria Borwick	Carol Monaghan
Chris Green	Graham Stringer
Dr Tania Mathias	Matt Warman

Dr Tania Mathias took the Chair, in accordance with the Resolution of the Committee of 19 July 2016.

Draft Report (*Evidence check: smart metering of electricity and gas*), proposed by the Chair, brought up and read.

Ordered, That the draft Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 92 read and agreed to.

Summary and Appendices agreed to.

Resolved, That the Report be the Sixth Report of the Committee to the House.

Ordered, That the Chair make the Report to the House.

Ordered, That embargoed copies of the Report be made available, in accordance with the provisions of Standing Order No. 134.

[Adjourned till Wednesday 12 October at 3.45 pm

Witnesses

The following witnesses gave evidence. Transcripts can be viewed on the inquiry publications page of the Committee's website.

Tuesday 3 May 2016	*Question number*
Nick Hunn, Chief Technology Officer, WiFore Consulting Ltd, **Pam Conway**, Head of Smart Strategy, British Gas, and **Dr Sarah J Darby**, Environmental Change Institute, University of Oxford	Q1–74
Lord Bourne of Aberystwyth, Parliamentary Under-Secretary of State for Climate Change, Department of Energy and Climate Change, **Daron Walker**, Senior Responsible Owner, Smart Metering Implementation Plan, Department of Energy and Climate Change, and **Sacha Deshmukh**, Chief Executive, Smart Energy GB	Q75 –118

Published written evidence

The following written evidence was received and can be viewed on the inquiry publications page of the Committee's website.

SME numbers are generated by the evidence processing system and so may not be complete.

1 AECB the association for environment conscious building (SME0015)

2 Alex Henney (SME0003) and (SME0006)

3 All-Party Parliamentary Carbon Monoxide Group (SME0021)

4 BEAMA (SME0018)

5 BGL Group Limited (SME0034)

6 British Energy Efficiency Federation (SME0010)

7 British Gas (SME0032), (SME0040) and (SME0045)

8 Centre for Sustainable Energy (SME0007)

9 Citizens Advice (SME0023)

10 Department for Energy and Climate Change (SME0031) and (SME0042)

11 Dr Isaac Jamieson and Dr Erica Mallery-Blythe (SME0004)

12 Dr Kevin Burchell (SME0001) and (SME0014)

13 Dr Sarah Darby (SME0022)

14 Durham University (SME0026)

15 Federation of Small Businesses (FSB) (SME0036)

16 Foundation for Information Policy Research (SME0012)

17 Glasgow Caledonian University (SME0017)

18 Hugh Smeaton (SME0035), (SME0041) and (SME0043)

19 Institute of Directors (SME0028)

20 Maple Tree Energy Management Ltd (SME0016)

21 Mr Andrew Shaw (SME0008)

22 National Energy Action (NEA) (SME0020)

23 Nick Hunn (SME0002)

24 Northern Powergrid (SME0030) and (SME0044)

25 Ofgem (SME0038)

26 Pilot Systems (SME0027)

27 Royal Academy of Engineering (SME0037)

28 Secure Meters Group (SME0033)

29 Smart DCC Limited (SME0029)

30 Smart Energy GB (SME0019) and (SME0039)

31 Stephen Browning (SME0013)

32 Ulster University (SME0011)

33 Utilita Energy Ltd (SME0025)

List of Reports from the Committee during the current Parliament

All publications from the Committee are available on the publications page of the Committee's website.

The reference number of the Government's response to each Report is printed in brackets after the HC printing number.

Session 2016–17

First Report	EU regulation of the life sciences	HC 158
Second Report	Digital skills crisis	HC 270
Third Report	Satellites and space	HC 160
Fourth Report	Forensic Science Strategy	HC 501

Session 2015–2016

First Report	The science budget	HC 340 (HC 729)
Second Report	Science in emergencies: UK lessons from Ebola	HC 469 (Cm 9236)
Third Report	Investigatory Powers Bill: technology issues	HC 573 (Cm 9219)
Fourth Report	The big data dilemma	HC 468 (HC 992)
First Special Report	Royal Botanic Gardens, Kew: Government Response to the Committee's Seventh Report of Session 2014–15	HC 454
Second Special Report	Current and future uses of biometric data and technologies: Government Response to the Committee's Sixth Report of Session 2014–15	HC 455
Third Special Report	Advanced genetic techniques for crop improvement: regulation, risk and precaution: Government Response to the Committee's Fifth Report of Session 2014–15	HC 519
Fourth Special Report	The science budget: Government Response to the Committee's First Report of Session 2015–16	HC 729
Fifth Special Report	The big data dilemma: Government Response to the Committee's Fourth Report of Session 2015–16	HC 992