Department for
Business, Energy
& Industrial Strategy

SMART METER ROLL-OUT COST-BENEFIT ANALYSIS

Part II – Technical annex

August 2016

Note on structure

This is the second part of a two part publication. Part I provides a summary of the changes to evidence and methodology since the 2014 Impact Assessment (IA), and the effect these changes have on the costs and benefits of the smart meter roll-out. Part II provides more detail in a technical annex of the evidence base on which the assessment is now based for both the domestic and non-domestic sector. It also includes information on monitoring and evaluation, and specific impact tests.

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Glossary of Terms

ACEEE - American Council for an Energy-Efficient Economy
BEIS - Department for Business, Energy & Industrial Strategy
CAPEX - Capital Expenditure
CBA - Cost-Benefit Analysis
CERT - Carbon Emission Reduction Target
CML - Customer Minutes Lost
CRC Energy Efficiency
CRM - Customer Relationship Management
DCC - Data and Communications Company
DNOs - Distribution Network Operators
DPCR5 - Distribution Price Control Review 5
EDRP - Energy Demand Research Project
ENA - Energy Networks Association
ENSG - Electricity Networks Strategy Group
ESCO - Energy Service Company
ESCOs - Energy Services Companies
ESMIG - European Smart Metering Industry Group
EV - Electric Vehicle
GBCS - Great Britain Companion Specification
GHG - Greenhouse Gas
GPRS - General Packetised Radio Service
GSM - Global System for Mobile Communication
HAN - Home Area Network
IA - Impact Assessment
IDTS - Industry Draft Technical Specification
IHD - In-Home Display
IT - Information Technology
LAN - Local Area Network
NPV - Net Present Value
O & M - Operation & Maintenance
Ofgem - Office of Gas and Electricity Markets
OPEX - Operational Expenditure
PPM - Pre-payment Meter
PV - Present Value
RFI - Request for Information
RIIO - Revenue = Incentives + Innovation + Outputs
RTD - Real Time Display
SEC - Smart Energy Code
SMETS - Smart Meter Technical Equipment Specification
SMIP - Smart Metering Implementation Programme
SMKI - Smart Metering Key Infrastructure
SPC - Shadow Price of Carbon
TOU - Time of Use (tariff)
UEP - Updated Energy Projections
WAN - Wide Area Network

Section A: Smart meter roll-out for the domestic sector

Summary: Analysis & Evidence **Policy Option 1**

Description: This assessment reflects a supplier led roll-out of smart meters with a centralised Data and Communications Company (DCC) in the domestic sector.

FULL ECONOMIC ASSESSMENT

Price Base Year 2011	PV Base Year 2016	Time Period Years 18	Net Benefit (Present Value (PV)) (£m)		
			Low: 19	High: 7,932	**Best Estimate: 3,794**

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant	Total Cost (Present
Low	NA		NA	**NA**
High	NA		NA	**NA**
Best Estimate	716		693	**10,555**

Description and scale of key monetised costs by 'main affected groups'

Meters, their installation and operation, and the In-Home-Display (IHD) amount to £5.12bn. DCC related costs, including asset costs for the provision of communications hubs, amount to £3.05bn. Energy suppliers and other industry IT systems costs amount to £1.00bn. Industry governance, organisational and administration costs, energy, pavement reading inefficiency and other costs amount to £1.38bn.

Other key non-monetised costs by 'main affected groups'

NA

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant	Total Benefit (Present
Low	0		778	**10,551**
High	0		1,368	**18,509**
Best Estimate	0		1,060	**14,349**

Description and scale of key monetised benefits by 'main affected groups'

Total consumer benefits amount to £3.86bn and include savings from reduced energy consumption (£3.81bn), and avoided costs of microgeneration metering (£49m). Total supplier benefits amount to £7.95bn and include amongst others avoided site visits (£2.86bn), and reduced inquiries and customer overheads (£1.16bn). Total network-related benefits amount to £748m and generation benefits to £899m. Carbon related benefits amount to £823m. Air quality improvements amount to £69m.

Other key non-monetised benefits by 'main affected groups'

These include benefits from further development of the energy services market and the potential benefits from the development of a smart grid. Smart metering is expected to result in stronger competition between energy suppliers due to increased ease of consumer switching and improved information on consumption and tariffs. An end to estimated billing and more convenient switching between credit and pre-payment arrangements will improve the customer experience.

Key assumptions/sensitivities/risks **Discount** 3.5%

Cost assumptions are adjusted where appropriate for risk optimism bias and benefits are presented for the central scenario unless stated otherwise. Sensitivity analysis has been applied to the benefits as energy savings depend on consumers' behavioural response to information and changes to them affect the benefits substantially. The numbers presented are based on the modelling assumption that the scope of the DCC will include data aggregation in the long term.

Annual profile of monetised costs and benefits for the domestic sector (undiscounted)*

£m	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Total annual costs	106	96	255	433	576	848
Total annual benefits	8	25	52	113	274	611

£m	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Total annual costs	1,071	1,102	977	945	944	913
Total annual benefits	995	1,228	1,323	1,446	1,467	1,532

£m	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Total annual costs	914	915	908	743	709	730
Total annual benefits	1,596	1,645	1,659	1,663	1,700	1,742

* For non-monetised benefits please see summary pages and main evidence base section

Emission savings by carbon budget period for the domestic sector ($MtCO_2e$)

Sector		**Emission Changes* ($MtCO_2e$) - By Budget Period**		
		CB II; 2013-2017	CB III; 2018-2022	CB IV; 2023-2027
Power sector	Traded	0	0	0
	Non-traded	0	0	0
Transport	Traded	0	0	0
	Non-traded	0	0	0
Workplaces & Industry	Traded	0	0	0
	Non-traded	0	0	0
Homes	Traded	0.29	3.04	3.13
	Non-traded	0.41	3.74	4.65
Waste	Traded	0	0	0
	Non-traded	0	0	0
Agriculture	Traded	0	0	0
	Non-traded	0	0	0
Public	Traded	0	0	0
	Non-traded	0	0	0
Total	Traded	0.29	3.04	3.13
	Non-traded	0.41	3.74	4.65
Cost effectiveness	% of lifetime emissions below traded cost comparator	100%		
	% of lifetime emissions below non-traded cost comparator	100%		

1 Domestic Evidence Base

1.1 Overview

In this section we describe the main assumptions underpinning the analysis in relation to the domestic sector and the reasons for them, with references to the evidence where appropriate.

The main assumptions used to calculate the overall impact of the roll-out described in this section are in the following categories:

1. Counterfactual/benchmarking
2. Costs
3. Benefits

These assumptions are then combined and modelled to provide cost-benefit outputs (see section 2 of this document)

It should be noted that within the economic model all up-front costs are annuitised over the lifetime of the equipment or over the roll-out period, apart from the costs of IHDs (see section 2.12 of Part I of this assessment document). The cost of financing differs across the capital cost categories:

- For meter assets and installation costs, the cost of capital is assumed to be 6% (real). These costs are generally financed through Meter Asset Providers (MAPs) who charge suppliers a rental fee to cover the costs of the asset and installation. MAPs' business models are perceived as lower risk than energy suppliers and they can therefore access cheaper finance. The assumed cost of capital is based on evidence provided by commercial experts.

- For communication hub costs, the cost of capital is assumed to be the level set in contracts with the DCC. This is unchanged from the assumption in the 2014 IA.

- For all other costs, such as IT costs, the cost of capital is assumed to be 10% (real). This reflects a conservative estimate of the cost of capital of an energy supplier who would be expected to finance these costs directly and is unchanged from the 2014 IA.

The benefits are not annuitised but annualised, that is they are counted as they occur. The realisation of most benefits will begin to occur as smart meters are installed and operated in consumers' premises, so they are modelled on a per meter basis and are linked to the roll-out profile.

1.2 Counterfactual

A counterfactual case has been constructed. This assumes no Government intervention on domestic smart metering but includes the implementation of the policies on billing (primarily provision of historic comparative data) and displays set out in the August 2007 consultation on billing and metering[1]. It includes:

- The costs of the continued installation of traditional meters;
- Benefits from better billing; and
- 5% of the predicted consumer electricity savings from smart metering are assumed to occur in the counterfactual world as a result of the Carbon Emissions Reduction Target (CERT) and other delivery of clip-on displays. The assumption that real-time displays installed under CERT will deliver the same savings as those arising from the roll-out of smart meters is likely to overestimate the savings from CERT clip-on displays and therefore underestimate the savings attributable to the smart meters roll-out. IHDs provided as part of the smart meter roll-out will have access to precise price information, a feature not provided by clip-on displays into which a unit price of energy has to be inputted by the consumer. Clip-on displays typically also cannot help monitor gas consumption, a feature that will be provided by smart meter IHDs. The smart meter roll-out will include the installation of the display (this has to be done by the consumer with clip-on displays, including input of the relevant tariff information) and in addition be supported by a consumer engagement strategy to ensure that energy consumption behaviour changes are facilitated.

The cost of the continued traditional meter installation is deducted from the costs for the smart meter deployment. A certain number of meters have to be replaced in every year due to either breakdown or because they have reached the end of their operational life.

The benefits from better billing and displays policies discussed above are subtracted from the overall benefits for smart meters as they are assumed to occur in the counterfactual case.

It is difficult to judge whether any significant numbers of smart meters would have been rolled out in the absence of Government facilitation. In deregulated and competitive supply markets such as Great Britain, suppliers or other meter asset owners are reluctant to install their own smart meters without a commercial and technical inter-operability agreement. Without such an agreement meter owners would face a large risk of losing a major part of the value of any smart meter installed. This is because there is a high probability that consumers would switch to a different energy supplier at least once over the lifetime of the metering assets; that supplier might not want or be able to use the technology installed earlier and might, therefore, not be willing to pay to cover the full costs – making the smart meter redundant.

Some small suppliers have deployed smart meters in the absence of Government intervention as a way to differentiate their services from the offerings of other energy suppliers. However this activity had been very limited in overall terms by the time Government decided to put a regulatory requirement in place (information received from small suppliers indicated less than 50,000 smart electricity and less than 25,000 smart gas meters had been installed as of early 2012, equating to less than 0.15% of the total meter population). Despite recent growth in the number and size of small suppliers, activity by some small suppliers would not have the potential to result in any significant penetration of

[1] A *'do nothing'* option is not analysed because policy implementation as described is ongoing and will continue.

smart meters within the overall population given the dominance of large suppliers in both the domestic electricity and gas markets[2].

It is therefore reasonable to assume for modelling purposes a counterfactual world in which there is no smart meters roll-out: this is the assumption used in the headline estimates presented in this analysis. This is supported by the fact that even though the technology had been available for a number of years, no significant numbers of smart meters had been rolled out to domestic customers prior to the announcement of a Government mandate. Following that announcement, some of the larger energy suppliers also started rolling out limited numbers of smart meters. This reflects individual energy suppliers' commercial strategies towards the mandated roll-out and it can be assumed that even this number of installations might not have occurred without the Government mandate[3].

1.3 Costs of smart metering

We classify the costs associated with the smart meters roll-out in the following categories: meter and IHD capital costs; communications equipment in the home; installation costs; operating and maintenance costs; supplier and industry IT costs; DCC's and its service partners' capital and operational expenditure; energy costs from smart metering equipment in the home; meter reading costs; disposal costs; legal and organisational costs and cost associated with consumer engagement activity.

In line with the technical and security architecture and Licence obligations, delivery of real time information is assumed to be through a standalone display, the IHD, which is connected to the metering system via a Home Area Network (HAN)[4]. It is assumed that a Wide Area Network (WAN)[5] is also required to provide the communications link to suppliers and other authorised DCC users, via the DCC.

1.3.1 IHD, meter, communications equipment and installation costs[6]

Table 1-1 below show the capital costs of meter and communications assets used for the analysis. These assumptions include changes introduced to the analysis as discussed in section 2 of Part I of this assessment.

Table 1-1: Costs of equipment / installation in the home (per device)

Component	Cost
IHD	£15
Electricity meter	£44
Gas meter	£57
Communications equipment	£29

[2] DECC's UK Energy Sector Indicators publication (2012) shows that in 2010 93.9% of electricity supplied in the industrial, commercial and domestic sector were provided by the top 9 suppliers. For gas, 82.0% were supplied by the top 9 suppliers: http://www.decc.gov.uk/assets/decc/11/stats/publications/indicators/6801-uk-energy-sector-indicators-2012.pdf . Note further that not all of the small suppliers provide smart meters as part of their offering.
[3] We estimate that in total approximately 3.2m smart and smart-type meters have been installed to date, approximately 6% of the domestic metering population.
[4] The HAN is the network contained within a premise that connects a person's smart meter to other devices such as for example and in-home display or smart-appliances.
[5] The WAN is the communications network that in this case spans from the smart meter to the DCC.
[6] Costs are expressed in 2011 real prices

IHDs

As described in the New Analysis section in Part I of this assessment, there have been a number of changes to modelling of IHD costs. The cost of IHDs are now assumed to be paid for in the year that they are purchased rather than annuitised over their lifetime, and the optimism bias applied to this cost has been reduced from 15% to 5%. It is also assumed that overall costs of IHDs will be lower than previously assumed due to innovation and non-replacement.

IHDs will have dual fuel functionality so any second supplier providing gas or electricity in a split fuel home (i.e. where gas is supplied separately from electricity) can use the IHD provided by the first supplier. It will be at any second suppliers' discretion whether they wish to provide a second display. This will allow for continued competition and customer choice. For modelling purposes it is assumed that suppliers will operate rationally and so only one IHD per household is assumed[7].

The total present value costs for IHDs are £510m.

Smart meters

The unit cost assumptions for a standard 2.4GHz meter asset have remained unchanged since the 2014 IA. However, as described in the New Analysis section in Part I of this assessment, new assumptions for differential costs of 868MHz metering equipment have been made and the optimism bias applied to meter assets has been reduced from 15% to 5%. The latter is based on evidence collected from energy suppliers that suggests meter asset costs will be at or below the 2014 IA cost assumptions. Equipment costs of any traditional meters installations carried out are also reflected in this cost category.

The total present value gross costs for meters are £2.04bn.

Operating and maintenance (O&M) costs of metering equipment

No further evidence has been brought forward at this point and we have retained previous assumptions for the present assessment. The assumption used is an annual operation and maintenance cost for smart meters of 2.5% of the meter purchase cost as O&M costs are likely to be incurred in the form of having to replace faulty equipment. The same optimism bias uplift of 5% which is applied to metering equipment is added to the O&M allowance.

Operating and maintenance costs accrue to £626m in present value terms.

Communications equipment

The unit cost estimates for communication hubs remain the same as they were in the 2014 IA. The volume weighted average cost of a standard communications hub across the three Communication Service Provider (CSP) regions is around £29. In addition and as outlined in the New Analysis section in Part I of this assessment, allowances have been made for dual band communications hubs that are deployed in properties where the standard 2.4GHz HAN solution does not work (i.e. does not provide sufficient propagation to link all components of the smart metering system in the premises).

The gross present value cost of communications equipment in the domestic assessment is £1.02bn.

[7] Two exceptions to this are a) foundation stage split fuel premises where the cost modelling assumes a worst case outcome of all such premises receiving two communications hubs and two IHDs and; b) initial SMETS meters where the risk for duplication of parts of the equipment is reflected in the cost uplifts that are applied – as set out in section 1.3.10.

Installation costs

As described in the New Analysis section in Part I of this assessment, the installation costs have been updated based on information received by the majority of the larger energy suppliers and also Meter Operators. Table 1-2 below shows the latest installation costs that have been used in this assessment. The dual fuel efficiency saving reflects the cost savings from installing two meters with a single visit to a customer's premise, for example because travel costs or costs for arranging an installation are reduced.

Table 1-2: Breakdown of installation costs

Type of installation	Cost
Electricity only	£67
Gas only	£67
Dual fuel efficiency saving	-£27
Total dual fuel installation	£107

In present value terms installation costs to suppliers equate to £1.94bn over the appraisal period. This includes cost estimates for uncompleted installation visits and installation of traditional metering equipment during Foundation.

Installation costs do not include any potential value of the time spent by consumers who stay at home to be present for the installation visit. This is because meter installations would have also taken place in the counterfactual, as traditional metering equipment reaches the end of its lifetime and needs to be replaced. The roll-out of smart meters will result in an acceleration of such instances as the replacement cycle, which would normally be spread over 20 years, will be more compressed. This effect, which remains unquantified, only results in bringing forward any such potential time spent by consumers when the meter is replaced rather than in creating a new cost. It is also important to reflect that there are convenience gains for consumers relating to potential time gains which are also not quantified in the analysis. Such benefits arise for example from not having to be present for a meter read, spend time submitting a read on-line, disputing bills that are thought to be inaccurate, or from not needing to be present for a meter to be changed between credit and prepay modes.

Development of equipment cost over time

We continue to use the cost erosion assumptions used in the 2014 IA and modelled on observed cost developments over time for traditional metering equipment. This assumes a decrease in the costs of equipment deployed in the home of 13.1% by 2024 compared to 2012 levels. This erosion is applied to the costs of smart meters (electricity and gas), communications equipment and IHDs.

1.3.2 DCC related costs

The four broad categories into which DCC related costs are now broken down are:

- The costs that the DCC licensee is expected to face;
- The costs that the Data Service Provider (DSP) will incur;
- The costs that the Communications Service Provider (CSP) is expected to incur for the provision of the communications services (i.e. excluding the costs for the provision of communications hubs, which are covered separately in section 1.3.1);
- The cost other service providers who provide services directly to the DCC are expected to incur.

DCC licensee costs

As outlined in the New Analysis section in Part I of this assessment, changes to the timing of the DCC commencing its live service operations and the development of additional requirements on DCC have resulted in increased DCC licensee costs. A total cost of £230m over the appraisal period is now reflected, containing elements for the initial set-up of services, on-going service provision as well as potential costs incurred in the re-procurement of DCC services.

Data Service Provider (DSP) costs

Costs for the provision of the data services have increased following the integration of cost information from the DCC's latest forward projections. The aggregate changes to set-up costs as well as on-going service provision result in an updated total costs of £377m over the appraisal period.

Communication Service Provider (CSP) costs

Costs for the provision of the communication services across the three regions (North, Central and South) have increased following the integration of cost information from the DCC's latest forward projections and now amount to a total of around £1.33bn. This cost contains elements of setting up a communications infrastructure as well as on-going elements for the provision of communications services.

Other service providers

Previously, some costs to organisations that provide services directly to the DCC were captured under "organisational costs" (for example the costs for the provision of security keys). These have now been moved into a new sub-category within the DCC-related cost category to reflect that these are costs that will be procured or invoiced through the DCC.

As described in the New Analysis section in Part I of this assessment, the allowance for these costs has marginally increased resulting in total present value costs of approximately £95m over the appraisal period.

1.3.3 Suppliers' and other industry participants' system costs

Energy suppliers will have to make investments to upgrade their IT systems so that they are able to take advantage of smart metering. Network operators and energy industry agents are also expected to upgrade their IT systems.

These costs are broken down into two categories:

1. Capital expenditure
2. Operational expenditure

1. Capital expenditure (Capex)

In 2010 the Programme issued a request for information (RFI) to relevant industry stakeholders to obtain information for a range of IT system related costs. Through this RFI the Programme received a very broad range of figures for large supplier IT costs, including two significant outliers. The upper outlier was excluded on the basis that it represented counterfactual development associated with a new suite of systems. The lower outlier was included, since this was a factor of the existing system suite, but was increased to bring it closer to the other estimates. The overall figures were moderated to an average of £30m per large supplier. Figures for small suppliers and other participants were included as provided at the time. Responses from other industry participants included network operators and existing industry agents.

Since the original RFI, the structure of the energy market has changed significantly, with the entry and expansion of a number of independent suppliers. As described in the New Analysis section in Part I of this assessment, the IT cost estimates for small suppliers have been updated based on evidence collected on the cost of DCC adaptor services that small suppliers are expected to procure.

We model the vast majority of IT investment to be carried out upfront, ahead of the time the DCC commences its service provision. A small incremental investment is assumed to be incurred in 2019 for the additional function of registration being added as a DCC service. A cost allowance of around £4m for establishing an interim registration system before this function is added to the DCC's services has also been included reflecting evidence provided by industry stakeholders. For modelling purposes we also reflect further incremental investment in 2021 supporting the provision of data aggregation services by the DCC.

The supplier IT capex cost estimate also includes the broader allowance of £30m covering the costs involved in an interim data solution ahead of availability of the DCC's data and communication services. The Programme has not included supplier specific smart metering IT refresh costs as smart metering changes are typically being applied to large scale Customer Relationship Management (CRM) and billing systems and market interface systems. The former are predominantly strategic investments by suppliers and will not be refreshed specifically for smart metering. Further, our expectation is that the introduction of DCC will provide major opportunities for market simplification which will be developed on the back of these systems, changing the scope and depth of these components.

The total present value for supplier IT capex is £536m, while the costs estimate for other industry participants' (including other DCC users) IT capex is £69m.

2. Operational expenditure (Opex)

For modelling large suppliers' IT operational expenditure, the 2014 IA used an industry standard figure of 15% of total IT capex to estimate initial opex for smart metering IT, except where more specific evidence has been available. This initial figure is reduced gradually to 5% by 2030. This is in line with best practice IT application and infrastructure management where on-going performance improvement is a key feature of contracts and has been observed in IT systems of comparable scale and complexity.

Cost estimates are based on the 2010 RFI referred to above, and were further updated in the January 2013 IA to reflect operational expenditure arising from changes to IT systems as a result of a refined technical architecture. Similarly, for other industry participants' IT opex the Programme has utilised the responses received to the 2010 RFI.

For smaller suppliers, operational expenditure estimates are based on information collected from DCC adaptor service providers in 2015. These operational costs include a fixed annual service charge and per meter service charges that suppliers are expected to pay as part of their contracts with adaptor service providers.

The resulting overall present value cost estimates for suppliers' and other industry participants' IT opex are £306m and £90m respectively.

1.3.4 Cost of capital

While not presented as a separate cost item, the costs of assets and installation are assumed to be subject to a private cost of capital, i.e. resources committed to assets and installation have an opportunity cost. As noted above, the following cost of capital assumptions have been applied:

- For meter assets and installation costs the cost of capital is assumed to be 6% (real). These costs are generally financed through Meter Asset Providers who charge suppliers a rental fee to cover the costs of the asset and installation. MAPs business models are perceived as lower risk than energy suppliers and they can therefore access cheaper finance.
- For communication hub costs, the cost of capital is assumed to be the level set in contracts with the DCC.
- For all other costs, such as IT costs, the cost of capital is assumed to be 10% (real). This reflects a conservative estimate of the cost of capital of an energy supplier who would be expected to finance these costs directly.

Cost of capital continues to be a significant driver of overall costs. For example, reducing capital costs for components funded by MAPs by just 1% would increase NPV by £250m.

Cost of capital is included in the cost figures relating to the components to which financing costs are applied and a total figure is therefore not specified separately.

1.3.5 Energy cost

Smart metering assets will consume energy, and we continue to assume that a smart meter system (meter, IHD and communications equipment) would consume 2.6W more energy than current metering systems. These assumptions are therefore unchanged.

The total present value of energy costs over the appraisal period is £652m.

1.3.6 Increased costs of manually reading remaining basic meters

The smart meter cost benefit analysis captures an inefficiency effect of having to manually read a decreasing number of traditional meters as the roll-out of smart meters progresses. This is based on the rationale that, as fewer traditional meters remain in place, it becomes more time consuming to read them (for example because travel times increase or because meter readers are in a particular area for shorter time periods, making revisits to a premise where no access had been gained more difficult). The April 2008 IA first set out the rationale for an equation to capture the decreasing efficiency of reading traditional meters as the roll-out of smart meters proceeds – described as pavement reading inefficiency. The May 2009 IA included some modifications to this equation to better represent the increasing cost of reading non-smart meters as the total number of non-smart meters decreases. The assumption of the maximum additional cost of these readings was increased and they increase exponentially to a limit of two times the existing meter reading cost of £3 – resulting in a maximum increase of £6 and cost of a successful meter read of £9. These reads are treated as an additional cost per meter and the costs are spread across the roll-out. The assumptions underlying these costs have not been changed at this point in time, but some of the changes described in section 2.6 of Part I of this assessment (i.e. changes to the rollout profile in the New Analysis section) have impacted the overall quantum of these costs.

The present value of these pavement reading inefficiencies is £271m.

1.3.7 Disposal costs

There is a cost from having to dispose of meters as they reach the end of their lifetime, including the costs of disposing of mercury from basic gas meters.

These costs would have been encountered under business as usual basic meter replacement programmes, but will be accelerated by a mandated roll-out of smart meters. The underlying cost assumption of £1 per meter has not changed and the cost-benefit model continues to reflect that meters would have had to be disposed of regardless of the implementation of the Programme and only takes into account the acceleration and bringing forward of the disposal over and above the counterfactual. The costs therefore are incurred earlier and are subject to less discounting. The calculations also apply the £1 disposal cost assumption to smart meters, with resulting costs for the first generation meters to be replaced from 2027. Present value costs amount to £11m.

1.3.8 Legal and organisational costs

There will be costs for the legal, institutional and organisational set up of the smart meter roll-out across both the energy industry and Government.

As discussed in the New Analysis section in Part I of this assessment, the allowance for such activities has been increased as a result of further work carried out on the detailed arrangements. This includes changes to industry costs for SEC related activities, DCC user privacy and security assessments and SMKI assurance. In addition, since the 2014 IA some costs have been moved from the legal and organisational cost category to the other service provider cost category.

Total present value costs over the appraisal period are approximately £258m.

1.3.9 Costs associated with consumer engagement activities

Energy suppliers will have the primary consumer engagement role as the main interface with their customers before, during and after installation. However, the rollout mandate requires that supplier engagement should be supported by a programme of centralised activities undertaken by a central delivery body, funded by larger suppliers, with smaller suppliers contributing to the body's fixed costs. Smart Energy GB was established to fulfil this role.

Trusted third parties, such as charities, consumer groups, community organisations, local authorities and housing associations will also have an important role to play in delivering effective consumer engagement. Many of these groups will not have the resources to work with each individual supplier. It is therefore expected that Smart Energy GB will facilitate and coordinate their involvement by producing materials for them to use when engaging consumers or help them to undertake localised engagement campaigns.

In 2013, Smart Energy GB was launched. By the end of each year, Smart Energy GB is required to set its budget for the following year, and to have developed its annual engagement plan, the first of which was published at the end of 2013. At the time of the drafting of the 2014 IA, Smart Energy GB had not completed the budget setting process and therefore the 2014 IA used evidence from the Digital UK campaign as a proxy. Smart Energy GB has since concluded the process of setting its budget. This budget forecast has been used to replace the previous cost estimate provide in the 2014 IA. Between 2013 and 2021, Smart Energy GB's budget is projected to be £192m in present value terms. Annual budgets will be set and are subject to energy supplier sign-off.

The potential impact of centralised consumer engagement on consumer energy savings is briefly discussed under section 1.4.1.1 below. Centralised engagement has the potential to reduce some costs of the Programme, in particular those associated with installation visits. Part of its purpose will be in supporting suppliers' own communications by developing standardised communications material, messaging and a common brand and providing independent reassurance about privacy and/or safety, among others. All of these are intended to increase the willingness of consumers to agree to installations and reduce the need for multi-channel outreach by suppliers and repeat visits.

1.3.10 Costs arising from uncertainty during Foundation

Smart meters are being installed in two stages: the Foundation Stage and main installation stage. The Foundation Stage started in April 2011 and is due to end with the start of the main installation stage in late 2016. On the basis of information received from suppliers, the Government expects a significant number of smart meters to be installed during the Foundation Stage. In addition, suppliers will be allowed to install SMETS1 meters into 2017.

There are a number of benefits from early roll-out activity and counting Foundation meters towards suppliers' roll-out obligations. In particular this:

- Maintains early momentum and allows a structured approach to roll-out during Foundation, with early meters meeting common technical requirements;
- Generates learning from installations during Foundation at an operational and technical level as well as allowing the testing of alternative approaches to consumer engagement;
- Provides early adopting consumers the opportunity to receive smart meters and realise benefits;
- Avoids unnecessary stranding of traditional meter assets (e.g. where existing meters need replacement);
- Allows for the development of further evidence regarding requirements for a HAN standard without delaying overall progress;
- Takes some pressure off peak installation rates; and
- Supports ambitious roll-out completion target.

Alongside these benefits, three areas of potential risk have been identified for smart meters installed during Foundation:

- **Interoperability**. There could be potential difficulties arising from equipment utilised by different suppliers. This may result in additional costs upon change of supplier (COS), but potentially also at point of installation for consumers that receive electricity and gas from different suppliers.

- **Functionality differences**. Differences in functionality between the initial (SMETS1) and the second-generation (SMETS2) are limited. The main difference is that outage notification functionality (formerly referred to as last gasp) will not be provided from smart meters installed during the Foundation Stage as the functionality will be provided through the CSP communication hubs which won't be available during Foundation. Since the benefits that are driven by this functionality are subject to a critical mass of meters being available (see section 1.4.3.1 for further detail), an absence of this functionality from early meters could result in some delay in the realisation of outage management benefits which are of greatest interest to the DNOs.

- **DCC adoption and enrolment**. The DCC are currently undertaking an assessment of the feasibility of different options for enrolling SMETS1 meters into the DCC's systems. The DCC are due to submit their Initial Enrolment Project Feasibility Report (IEPFR) to the Secretary of State in late 2016. Any DCC capability to enrol SMETS1 meters could be available in the second half of 2018 and may result in additional costs.

For the interoperability and DCC risk categories the cost modelling considers how the risks could materialise in costs, and estimates what a worst-case scenario cost impact per meter would be. Under consideration of mitigating factors (both policy dependent and driven by commercial incentives) a probability is derived, with which the worst case cost increase is weighted. The risk adjustments are applied to meters installed during the period in which the risk prevails. Any optimism bias uplifts already applied to that cost category continue to be considered (and continue to be subject to the risk uplift).

The introduction of Licence Condition 3 ('no backward step') supports the incentives for an incoming supplier to use smart equipment that has been installed by the previous supplier. Under this condition, a gaining supplier will be required to take all reasonable steps to install a SMETS-compliant smart metering system if it replaces a SMETS-compliant smart metering system on change of supplier.

To take account of potential residual risks (including a smart meter installed by the previous supplier being run in 'dumb' mode and resulting in a loss of supplier benefits) we apply a 5% uplift to costs. This uplift is applied to the costs of the metering equipment, the communications equipment in the home, the IHD and the installation costs for both domestic and non-domestic installations during Foundation. We also apply a 15% uplift to IHD and communication hub costs to reflect the risk that suppliers might have to install two communications hubs and IHDs for split fuel households (i.e. where different suppliers are responsible for gas and electricity).

For the functionality differences – the lack of outage notification from Foundation SMETS 1 meters – the impact is not translated into a cost increase factor but directly applied to the roll-out modelling. Smart installations ahead of availability of CSP communication hubs will not provide outage notification functionality. This is modelled by adjusting the point in time from which network operators will have sufficient coverage of outage management functionality to realise savings. Costs for the provision of outage notification functionality are excluded from early installations.

1.4 Benefits of smart metering

We classify benefits in three broad categories: consumers, businesses (energy suppliers, network-related and peak load shifting) and carbon & air quality. To the extent that businesses operate in a competitive market – in the case of energy suppliers – or under a regulated environment – in the case of networks – benefits or cost savings are expected to be passed down to end energy users i.e. consumers. For example, avoided meter reads are a direct, first order, cost saving to energy suppliers. As energy suppliers operate in a competitive environment, we expect these to be passed on to consumers.

1.4.1 Consumer benefits

Significant benefits from smart meters can be driven by changes in consumers' energy consumption behaviour. Two areas of change in average consumption behaviour may arise:

- A reduction in overall energy consumption as a result of better information on costs and use of energy which drives behavioural change; and
- A shift of energy demand from peak times to off-peak times.

1.4.1.1 Energy demand reduction

There is a significant evidence base demonstrating that consumer feedback using smart metering leads to energy demand reductions. Actual levels of reduction will depend on a range of factors, which Programme design has taken into account and which it seeks to influence further through ongoing policy development and by other means.

The main quantitative sources of evidence on the impacts of feedback are the series of large-scale international review studies, and two major GB studies: the 2011 Energy Demand Research Project (EDRP) and the 2015 Early Learning Project (ELP) an extensive programme of research into how best to deliver consumer benefits through effective engagement.

A review of 57 feedback studies in nine different countries by the American Council for an Energy-Efficient Economy (ACEEE)[8] found that on average feedback reduces energy consumption between 4-12%, with higher (9%) savings associated with real-time feedback. A further study by ACEEE[9] reported residential electricity savings from real-time feedback in the nine pilots reviewed ranging from 0 to 19.5%, with average savings across the pilots of 3.8%.

Darby (2006)[10] and Fischer (2008)[11] also show that feedback can result in dramatic behavioural changes with average reductions in energy consumption of over 10%. The European Smart Metering Industry Group (ESMIG) report[12], a review of 100 pilots and 460 samples covering 450,000 consumers suggested savings from around 5-6% from interventions without an IHD, to an average of 8.7% with an IHD.

Trials in European countries resulted in energy savings within the same range[13]. International studies also provide some evidence on the likely persistence of savings. The ACEEE study quoted above found that feedback-related savings are often persistent, including from the longer-term studies (12 – 36 months) considered. However given the differences of situation and approach between different countries, it is difficult to transfer evidence on levels and persistence of savings directly to the GB context.

The EDRP[14] was co-funded by the Government to provide information on GB consumers' responses to a range of forms of feedback, including smart meter-based interventions. EDRP trials generally found that the combination of a smart meter with an IHD was

[8] Erhardt-Martinez, Donnelly, Laitner, *Advanced Metering Initiatives and Residential Feedback Programs: A Meta-Review for Household Electricity-Saving Opportunities*, June 2010.
[9] ACCEE, *Results from Recent Real-Time Feedback Studies*, 2012, available at http://www.aceee.org/research-report/b122.
[10] Sarah Darby, *The Effectiveness of Feedback on Energy Consumption*, April 2006.
[11] Corina Fischer, *Feedback on household energy consumption: a tool for saving energy?*, 2008.
[12] ESMIG, *The potential of smart meter enabled programs to increase energy and systems efficiency*, October 2011.
[13] CER, *Electricity Smart metering Customer Behaviour Trials (CBT) Findings Report, Information paper, CER11080a,* May 2011. In Germany, a recent smart meter trial suggests savings of around 5% due to a combination of indirect feedback and energy efficiency advice: Schleich, J.; Klobasa, M.; Brunner, M.; Gölz, S.; Götz, K.; Sunderer, G., *Smart metering in Germany and Austria - results of providing feedback information in a field trial*, 2011.
[14] Ofgem, *Energy Demand Research Project, final analysis*, June 2011.

associated with significant electricity savings; the trials more closely comparable to the GB roll-out showed statistically robust electricity savings of 2% to 4%. For gas, it was the provision of a smart meter rather than the IHD which was most significant in delivering savings, with savings of around 3%.

In 2015 the Government published the findings of the ELP. This included an independent synthesis report which summarised and analysed evidence from three ELP research projects exploring how GB consumers who received smart meters between 2011 and early 2013 engaged with smart metering; GB and international evidence on smart metering and energy feedback; and evidence from public health behaviour change programmes. ELP research included a statistical study which quantified the impact of early smart-type meters on household energy consumption in the year following installation as: electricity 1.6 – 2.8%; gas 0.9 – 2.1% (95% confidence intervals). The synthesis report concluded that there was scope to improve on this through effective consumer engagement, and it was realistic to expect durable savings of 3% based on the evidence to date and potential improvements identified, and that greater savings may be achievable over time[15].

The ELP provides evidence on consumer engagement requirements to optimise consumer benefits, in particular energy saving. Its analysis draws both on findings from the primary research conducted with early recipients of smart-type meters in GB and on wider evidence, and considers the adequacy of the policy framework for consumer engagement. The conclusions support existing policy requirements; they also highlight the value of high quality engagement before, at and following the installation visit (including information tailored to the varying needs of consumers); the importance of the IHD; that pre-payment customers have particular information and support requirements; and the benefits of post-installation, preferably face to face, support for some consumer groups[16]. These areas are being addressed as part of the Government's ongoing policy development, and will continue to be examined in its monitoring and evaluation work (see section 7.2).

The ELP notes that different forms of feedback (such as home energy reports) are likely to be complementary to the IHD and support benefits in the future over and above current projections. Innovation in the use of smart meter data to provide novel types of feedback and any future changes to the IHD mandate[17] may also affect the level of energy demand reduction in the future.

Cost-benefit analyses in other countries have adopted broadly similar energy savings assumptions. Kema's cost-benefit analysis for the Dutch Ministry of Economic Affairs[18] assumes 6.4% electricity savings with direct feedback through an IHD (3.2% with indirect feedback), and 5.1% (3.7%) for gas[19]. The recent Irish CBA adopts a 3% electricity savings assumption to compute illustrative estimates of the change in consumer welfare resulting from the installation of smart meters.

In light of our current analysis of the available evidence and given the continuing uncertainty, we retain a conservative approach and continue to assume that the gross annual reductions in demand will be as follows:

- 2.8% for electricity (credit and PPM); 2% for gas credit and 0.5% for gas PPM.

[15] DECC, *Smart Metering Early Learning Project: Synthesis report*, March 2015, p.9.
[16] DECC, Smart Metering Early Learning Project: DECC's Policy Conclusions, March 2015, p.43-44.
[17] See https://www.gov.uk/government/consultations/smart-meter-in-home-display-licence-conditions.
[18] KEMA, *Smart meters in the Netherlands, a revised financial analysis and recommendation for policy*, 2010
[19] The CBA assumes options for refusing the installation of a smart meter due to recent changes in Dutch political circumstances, and the CBA assumes a 20% voluntary uptake of IHD.

We also apply sensitivity analysis to these benefits as follows:

- In the higher benefits scenario: 4% for electricity (credit and PPM), 3% for gas credit and 1% for gas pre-payment meter (PPM).
- In the lower benefits scenario: 1.5% for electricity (credit and PPM), 1% for gas credit and 0.3% for gas PPM.

Energy is valued consistently with guidance produced by BEIS (formerly DECC)[20]. The energy baseline from which energy savings are calculated is consistent with the most recently published energy projections accounting for a number of energy efficiency policies in place before smart metering[21].

Incorporating direct rebound effects is necessary to accurately estimate net energy savings. When physics-based or theoretical energy savings potentials are used for the analysis (e.g. the efficiency gain effect of a certain strength of insulation), rebound effects have to be explicitly estimated and subtracted from the theoretical estimate. The real, net energy savings effect in such cases will always depend on the behaviour that the consumer displays as a result and income gains from increased energy efficiency might well partly be spent by increasing the consumption of the energy service (so called comfort taking).

However, the approach taken for the estimation of smart meter energy savings is fundamentally different and is based on empirical trial results, i.e. observed impacts. These observed values are net of any potential comfort taking and direct rebound effects. Therefore, no further adjustment is necessary to apply to the smart meter energy savings estimates.

A second source of change in consumption patterns enabled by smart meters is a shift of energy demand from peak to off-peak times. Even though this shift will likely result in bill reductions for those taking up Time of Use (TOU) tariffs, bill savings for some customers may be offset by bill increases for other customers, as the existing cross-subsidy across time of use unwinds. Benefits from load shifting are therefore valued in this assessment to the extent that they produce a resource benefit to the UK economy. This benefit falls as a first order benefit on various agents in the energy market, and hence it is discussed under the “business benefits” heading.

Overall, reduced energy demand accounts for £3.81bn gross benefits in present value terms.

In addition, a range of consumer benefits is expected, including those around improved customer satisfaction and financial management benefits, which have so far not been quantified. The 2015 ELP found that customers with smart meters were more satisfied with their meters than customers with traditional meters and that customers commonly identified the ability to better plan and budget for bills as an advantage of having a smart meter. The programme will continue to collect information on these non-quantified consumer benefits through planned activities on research and evaluation.

[20] DECC, *Valuation of Energy Use and Greenhouse Gas (GHG) Emissions*, December 2015, available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/483278/Valuation_of_energy_use_and_greenhouse_gas_emissions_for_appraisal.pdf

[21] Hence avoiding double-counting energy savings and accounting for policies’ overlap. Policies accounted for in the baseline are Warm Front, Building Regulations 2002 and 2005, EEC1,2 and CERT (excluding CERT +20%), and product policy tranche 1.

1.4.1.2 Microgeneration

Smart meters can be used to deliver export information, reducing the need to install an export meter for microgeneration devices. To estimate the size of this benefit, an estimate of the number of microgeneration devices that will be in use by 2020 has been multiplied by the expected cost savings from not having to install a second meter. These cost savings have been spread over the smart meter population as of the end of 2020 to provide a savings per annum per meter of £0.12. The modelling assumes no increase in microgeneration deployment post 2020 and is therefore a conservative estimate of the savings.

Microgeneration benefits amount to £49m in present value terms over the appraisal period.

1.4.2 Supplier benefits

The following sets out the range of benefits and cost savings the energy supply industry is expected to realise. Discussions with energy suppliers in workshops and bilateral meetings have validated at an aggregate level across the industry that the supplier benefit assumptions are valid and achievable. Individual suppliers may however have different commercial positions.

1.4.2.1 Avoided site visits

Currently energy suppliers have to visit their customers' premises for a number of reasons, namely to take meter reads and carry out safety inspections. The roll-out of smart meters will have implications for the requirement to carry out such visits in a number of ways.

1. <u>Regular visits</u>

   - <u>Regular meter read visits</u>

Smart meters will allow meter reading savings for suppliers as soon as a basic meter has been replaced by a smart meter. We continue to assume that avoided regular meter reading will bring in benefits (cost savings) of £6 per (credit) meter per year in our central scenario taking into consideration both actual and attempted reads. This is reflective of the avoided costs of two meter reads per year under the regular meter reading cycle, for which meter reading operatives cold call premises in an area to read a meter and repeat to do so if access is not gained at the first instance. A cost of £3 per successful meter read is the cost figure that has been quoted by industry as the commercial rate that is charged by meter reading companies.

   - <u>Regular safety inspection visits</u>

Smart meters will require regular safety inspections to check the meter is functioning properly and safely, and there is no evidence of tampering or theft. This is expected to lead to additional costs, as safety inspection visits would be expected to be completed during regular meter read visits for dumb meters.

At the time of the 2014 IA, suppliers were required to carry out regular safety inspection visits every two years. In 2016, Ofgem repealed these requirements in licence conditions, on the basis that health and safety obligations in legislation and industry codes, and enhanced theft detection and billing accuracy supplier licence conditions, provide a more effective and proportionate way to achieve the desired outcomes from inspections.[22]

[22] Ofgem, *Letter on Modification of Electricity Supply Licence, Gas Supply Licence, and Gas Transporter Licence*, February 2016.

For modelling purposes we have made assumptions on the costs to suppliers of carrying out safety inspections after the roll-out of smart meters. The model assumes a new risk-based regime to apply to all meters with different requirements for different risk categories. The model contains no incremental costs for safety inspections for dumb meters in the counterfactual. This probably understates the cost in the counterfactual, and overstates the cost of smart metering, but in the absence of evidence is used as a basis for modelling.

- Lower risk group:
    - 90% of meters
    - Require a safety inspection every 5 years
    - Area based approach with £3 cost per successful visit
    - Equivalent to an annual cost per meter of £0.6

- Higher risk group:
    - 10% of meters
    - Require a safety inspection every 2 years (or 5% of meters every year)
    - Approach of scheduled appointments with £17.5 cost per successful visit[23]
    - Equivalent to an annual cost per meter of £8.75

There is uncertainty around what proportion of meters might be considered higher risk under the new safety inspection regime, but for modelling purposes it seems reasonable to assume that the population currently requiring special safety inspection visits will continue to require dedicated costs at a greater frequency than the majority of meters (see next section).

2. Special visits

In addition to regular visits, suppliers may have to undertake “special visits”, for example to take a meter read because of bill disputes or to carry out a safety inspection outside the regular safety inspection cycle. With smart meters, these costs will be avoided The analysis reflects benefits of £0.5 per credit meter p.a. from avoided special meter reads and benefits of £0.88 per meter p.a. from avoided special safety inspections.

- Special meter read visits:

We assume a benefit of £0.5 per credit meter reflecting the following activities in the current situation that will be redundant once smart meters are rolled out:

- 5% of credit meter customers p.a. request a dedicated visit for a special read (e.g. because of bill disputes).
- Such a visit costs £10, as access at first attempt is assumed.

- Special safety inspection visits:

We assume a benefit of £0.88 per meter reflecting the following activities in the current situation that will be redundant once smart meters are rolled out:

- 5% of the meter population p.a. requires a dedicated visit for a safety inspection.
- Such a visit costs £17.5, reflecting the requirement for repeat visits.

[23] This results from using the current commercial rate of £10 for an appointed special visit and reflecting that first time access rates will be below 100%. Only 50% of premises are expected to provide access at the first attempt, with 25% of premises each requiring a second and third visit. The same assumption is used for modelling the benefits from avoided special safety inspection visits in the current situation, further outlined below.

The table below summarises the items discussed in this section and outlines the overall impact. These costs and cost savings are applied to smart meters as they are rolled out. Overall, avoided site visits account for £2.86bn gross benefits in present value terms.

Table 1-3: Cost and benefit impacts from avoided site visits (per meter per year)[24]

Visit type	Current world cost	Cost with smart meters	Effect
Regular meter read	£6 per credit meter pa, £0 per PPM meter pa	None	saving
Regular safety inspection	No incremental cost	£0.6 per low risk meter pa, £0.88 per high risk meter pa	cost
Special meter read requested by customer	£0.5 per credit meter pa, £0 per PPM meter pa	None	saving
Special safety inspection	£0.88 per meter pa	No longer required as captured under the risk based approach	saving
Total cost:	**£6.49**	**£0.64**	**cost saving of £5.85**

1.4.2.2 Reduction in inbound enquiries and customer service overheads

Smart meters will mean the end of estimated bills and this is expected to result in lower demand on call centres for billing enquiries and complaints. We assume this cost saving to be £2.20 per meter per year in the central scenario (£1.88 for reduced inbound enquiries and £0.32 for reduced customer service overheads). This estimate is in line with the original assumption developed by Mott MacDonald[25], which has been verified by suppliers at an aggregate level. No new information was gathered and our assumption is based on previous supplier estimates that inbound call volumes could fall by around 30%, producing a 20% saving in call centre overheads.

In total gross benefits of £1.16bn in present value terms are expected from reduced call volumes.

1.4.2.3 Pre-payment cost to serve

Smart meters are expected to bring savings in the cost to serve customers with pre-payment meters (PPM). These savings arise primarily from avoided site visits to replace credit with pre-payment meters and vice versa as smart meters will allow the remote switching of a meter between pre-payment and credit mode. While the number of pre-payment customers as a proportion of the total population has remained relatively constant over time, there is a considerable churn within this subpopulation of households switching to pre-payment or back to credit. In a simplified way this can be envisioned as a constant pool of pre-payment meters, with a customer only being equipped with a pre-payment meter as a previous pre-payment customer switches to a credit meter. Ofgem reported a total of around 620,000

[24] Please note that the total cost row is not derived directly from the sum of the cost items. This also takes into consideration the proportion of credit and PPM meters.
[25] Mott MacDonald, *Appraisal of costs and benefits of smart meter roll out options*, April 2008.

PPM installations in 2014[26]. The installation visit to fit a PPM could be avoided once smart meters are rolled out and meters can be remotely switched between credit and pre-payment functionality.

In addition, smart meters in pre-payment mode are likely to require less maintenance and service than current key meters since there is less mechanical interaction and there is no need to replace lost keys. Lastly, it might be possible to achieve some savings in the pre-payment infrastructure, for example through streamlining of the credit upload system as new payment approaches (over the phone or the internet) become possible or because suppliers might decide to manage payments in house. Consumers on pre-pay could benefit if these operational cost savings were passed on as lower prices.

For this assessment we have assumed the additional cost to serve PPM customers relative to a direct debit customer is £30 for electricity and £40 for gas. This is broadly within the range estimated by Ofgem[27] in their Energy Supply Probe and more recently by the Competition Markets Authority[28] in their investigation of the energy market. We continue to assume smart meters result in a 40% reduction in the difference in cost to serve, providing savings of £12 per year per electricity PPM customer and £16 per year per gas PPM customer. Smart meters are therefore expected to reduce, but not eliminate, the additional costs to serve a PPM customer.

The present value of this benefit is £1.09bn.

1.4.2.4 Debt management and remote switching between credit and pre-payment

Smart metering can help to avoid debt – both on the consumer and the supplier side – in a number of ways.

For the consumer, information about energy consumption and cost implications communicated via the IHD can help to manage consumption and raise awareness of its costs. This can be used to avoid large energy bills and therefore the risk of debt arising.

For energy suppliers, two core functionalities will drive debt management benefits. On the one hand, more frequent and accurate consumption data for billing purposes will enable suppliers to identify customers at risk of building up debt sooner and will enable them to discuss and agree reactive measures. The supplier might for example provide energy efficiency advice to reduce energy expenditure, or might offer a different payment arrangement or develop with the consumer a debt repayment plan.

Bills based on remote meter reads and therefore actual energy consumption will avoid large arrears where customers receive a succession of estimated bills. It will also allow more timely adjustments to direct debits where customers currently pay a fixed monthly / quarterly amount and any over- or underpayments are only settled at the end of the year.

On the other hand, debt management benefits will be delivered by the ability to remotely and promptly switch a customer onto a pre-payment arrangement (subject to customer safeguard arrangements by Ofgem[29]). It will be possible for the supplier to discuss sooner with an indebted customer some potential reactive measures, including the offer to switch to a pre-

[26] Ofgem, *Domestic Suppliers' Social Obligations: Annual Report*, September 2015.
[27] Ofgem, *Energy Supply Probe Initial Findings Report*, October 2008
[28] CMA, *Energy market investigation, Provisional decision on remedies report*, March 2016
[29] See https://www.ofgem.gov.uk/publications-and-updates/smart-prepayment-proposals.

payment arrangement. An indebted customer might already under current circumstances eventually receive a pre-payment meter, but once smart meters are in place this will be possible sooner. This is both because a payment issue can be identified earlier and also because the actual switch to pre-payment can be exercised quicker as all the required equipment is already in place in the customer's premise. There is also only a minimal cost to the supplier in making the change between the payment types. With easier payment arrangements for PPM more customers may opt for PPM if they are having difficulty managing their payment. We do not, however, model an increase in PPM customers over time.

The avoidance of debt (both in terms of the total amount of outstanding charges and the duration for which customers remain indebted) reduces the working capital requirements of suppliers. Since the provision of this working capital is not free (it could be utilised elsewhere and therefore carries opportunity costs), reducing the working capital requirements equate to an operational cost saving that suppliers can realise and consequently pass on to consumers.

Based on estimates originally derived by Mott MacDonald and since endorsed by energy suppliers, we estimate the per (credit) meter saving from better debt management to be £2.2 per year, resulting in a present value benefit of £970m.

1.4.2.5 Switching Savings

The introduction of smart metering will allow a rationalisation of the arrangements for handling the change of supplier process. Trouble shooting teams employed to resolve exceptions or investigate data issues will no longer be needed. Suppliers will be able to take accurate readings on the day of a change of supplier, resolving the need to follow up any readings that do not match and instances of incorrect billing will reduce.

As outlined in section 1.3.2, the Programme carried out an extensive request for information in 2010 to determine the costs and benefits that the energy industry expects from the establishment of the smart metering system and the DCC.

The main category of benefits examined through this Information Request relates to customer switching, but also includes cost savings from the centralisation of registration and data aggregation functions. The Information Request asked for views of the potential scale of this benefit and the extent to which the benefits are contingent on DCC providing a centralised supplier registration system covering both electricity and gas.

Suppliers were asked to estimate the value of benefits that could be realised and to comment on the factors which could constrain the realisation of benefits. The benefit estimates provided included the potential benefits of reducing the complexity and cost associated with interfacing with a variety of registration agents when a customer switches suppliers. If a potential DCC activity resulted in the transfer of functions from suppliers' agents to DCC (e.g. data aggregation), suppliers were asked to estimate the costs that would be avoided. Network Operators and Metering Agents were asked to provide evidence on the extent to which each option will facilitate the realisation of customer switching and related benefits (e.g. the avoided costs of handling registration-related queries from energy suppliers).

Following analysis of responses to the request for information, we consider customer switching benefits of £3.11 per smart meter per year where the DCC offers registration and data aggregation services (assumed to be for modelling purposes from 2022). Where the DCC offers registration services (assumed to be from 2020 for modelling purposes) benefits of £2.22 per smart meter per year are considered. From the go-live date of DCC services in

2016 benefits of £1.58 per smart meter per year are considered. Before the establishment of DCC benefits are assumed to be of £0.8 per meter per annum. The timing of each of these events has been moved to a later date to reflect the ongoing work across the energy industry and Ofgem and the later point in time at which the DCC is expected to go live, as explained in the New Analysis section in Part I of this assessment.

In total present value terms, switching savings generate £1.43bn in gross benefits.

1.4.2.6 Theft

The implementation of smart metering could improve the ability for suppliers to detect and manage theft. Estimating theft is problematic by nature and levels of theft are difficult to quantify. Detailed analysis carried out by industry in 2010 suggested that levels of theft for gas and electricity come to 1.6 TWh and 5.5 TWh respectively. Using the DECC domestic retail energy prices, in 2012 this translates to a retail value of about £240 million each. In Ofgem's consultation response to their impact assessment on tackling gas theft[30] and in Ofgem's strategy consultation for the RIIO-ED1 electricity distribution price control[31], the value of gas and electricity theft in 2012 is estimated to be between £220m-£400m and £400m per year respectively.

Gas theft estimates are based on independent industry analysis of the measurement error encountered when reconciling gas consumption data, from which the share attributable to theft is derived. Levels of electricity theft are extrapolated from the gas figure by assuming that there is the same level of electricity theft as there is gas theft. This is conservative as evidence suggests that levels of electricity theft may actually be higher than for gas (Ofgem, 2005) and is apparent in the figures above.

In our central scenario we continue to assume that the roll-out of smart meters will reduce theft by 10%, which is also conservative given estimates that smart meters could reduce theft by 20-33% in previous consultation responses. We continue to assume that the amount of theft is likely to decrease as suppliers will have access to more accurate and frequent data and will detect theft more quickly; however we also recognise that new methods of theft will arise. Following standard Government practice, we value theft reductions for domestic customers at the resource rather than the retail value of energy, resulting in benefits of £0.29 per meter per annum for electricity and £0.36 per meter per annum for gas.

This results in present value gross benefit of £219m.

1.4.2.7 Remote disconnection

The meter functionality that is specified in SMETS will enable the remote enablement or disablement of the electricity and/or gas supply. The direct benefits associated with these capabilities are the avoided site visits in instances where an authorised supplier operator is despatched to a customer's premise to disconnect supply. The number of such instances is limited – Ofgem data show the number of disconnections for debt purposes averaged 670 per year between 2011 and 2014 for gas and electricity combined - but are potentially costly as they might involve multiple personnel[32]. A disconnection is most likely to occur where an indebted customer cannot be provided with a pre-payment meter, but might also occur for safety reasons (e.g. in instances of flooding). Ofgem have introduced licence changes as

[30] Ofgem, *Tackling gas theft: Final impact assessment*, March 2012
[31] Ofgem, *Strategy consultation for the RIIO-EDI electricity distribution price controls outputs, incentives and innovation*, September 2012
[32] Ofgem, *Supplier performance on social obligations*, accessed June 2016, available at https://www.ofgem.gov.uk/about-us/how-we-work/working-consumers/supplier-performance-social-obligations.

part of the Spring Package[33] of regulatory measures to strengthen protections for consumers and there is no expectation that the number of disconnections will increase as a result of smart metering. We continue to assume a benefit of £0.5 per smart meter per year is realised which is unchanged from the 2014 IA. The present value benefit from remote disconnection is £221m.

1.4.3 Network-related benefits

Since the publication of the 2014 IA, there have been a number of substantial developments in the evidence base on network benefits, particularly with the conclusion of the RIIO-ED1 price control process undertaken by Ofgem[34].

In light of this, in 2015 the Programme commissioned PA Consulting to critically re-assess and update the assessment of network benefits in the 2014 IA. This has resulted in a significant improvement in the evidence base and reflects the expected benefits to both DNOs and customers from the use of smart meter data.

PA Consulting undertook a literature review of the available evidence published by DECC, the Energy Networks Association (ENA), individual Distribution Network Operators (DNOs) and Ofgem, as well as reports on operational network benefits from the implementation of smart metering in other countries. This was used to identify a range of network benefits that could be realised through the use of smart metering data (including alerts).

Data from Ofgem and DNO business plans was used to quantify these benefits for the RIIO-ED1 period (2015 to 2023). For the RIIO-ED2 period (2023 to 2031) the identified annual benefit for each category of benefit has been increased by 25% to reflect the view that benefits in ED2 will be higher (for example in light of an expected increase in the deployment of low carbon technologies).

The following sections describe the revised categorisation of benefits, the underlying evidence base and the method used to quantify each benefit.

1.4.3.1 Outage detection and management for electricity DNOs

The availability of detailed information from smart meters will improve electricity outage management and enable more efficient resolution of network failures once a critical mass of meters and the resulting geographical coverage is reached.

In the 2014 IA this functionality was categorised into benefits from a reduction in unserved energy (customer minutes lost), a reduction in operational costs to fix faults and a reduction in calls to fault and emergency lines. In addition, for this assessment, in order to reflect the different recipients of benefits, the benefits from the reduction in unserved energy has been split into the faster restoration of supply and earlier fault notification. All benefits related to outage management are assumed to be realised for outages on the entire low voltage network as DNOs currently have no systems in place to detect and report outages on this part of the network. Benefits are also assumed to be realised for 10% of outages on high voltage networks, based on data provided by DNOs on the percentage of customers in areas where the high voltage network is not currently covered by remote monitoring systems.

[33] Ofgem, *Smart Metering Spring Package – Addressing Consumer Protection Issues*, available at: https://www.ofgem.gov.uk/publications-and-updates/smart-metering-spring-package-addressing-consumer-protection-issues.
[34] RIIO-ED1 is the first electricity distribution price control to reflect the new RIIO (Revenue = Incentives + Innovation + Outputs) model for network regulation.

We have assumed that a critical mass of smart meters is required for these benefits to be realised. This is so that sufficient regional coverage is provided to identify the location and the scope of an outage. The critical mass threshold is only passed once 60% of all meters are SMETS2 meters which have outage detection functionality.

The individual elements of outage management benefits are outlined in more detail below:

1. Earlier fault notification

This captures the customer benefit from the reduction in the average length of an outage because smart meters will provide DNOs with earlier notification of outages than under the current system.

In order to calculate benefits we valued the estimated reduction in customer minutes lost (CML) with the average CML price incentive under the RIIO-ED1 regulatory period, running from April 2015 to 2023. The CML incentive rate reflects end customers' willingness to pay for quality of supply improvements with regards to a reduction in minutes lost. It also acts as one part of the overall interruptions incentive scheme for network companies to improve the quality of their service (the other part being the number of interruptions experienced). The distribution companies earn additional revenue if they beat their CML target (i.e. their CML for the year in question is lower than their target for that year) and suffer a reduction in revenue if their CML exceed their target. There are several methodologies available to estimate the value of quality of supply improvements to consumers, however as a measure of the benefits to DNO customers, this figure seems the most appropriate to use.

The reduction in CML has been estimated by comparing the time it takes for a DNO to become aware of an outage under the current system and under a smart metering system. Under the current system, DNOs rely on customers calling in to report outages on the low voltage network and require two customers to call for an outage to be classified as a fault under the CML regulatory framework. On average, this is estimated to take 7 minutes. This captures the time required for two customers to become aware of the problem, locate the DNOs phone number, call the DNO and log the outage. With smart meters, we have assumed this would be reduced to 3 minutes. This is based on target levels in a two year trial period which will commence following DCC Live to be carried out by CSPs, using a randomised notification delay of a maximum of two minutes, along with an assumption that it will take up to 1 minute for the message to be sent from the meter to the DNO (in line with service level agreements in the Smart Energy Code).

The present value benefits from earlier fault notification are £34m.

2. Faster restoration of supply

Outage notifications from smart meters will provide DNOs with information on the nature, location and scope of an outage. This will enable them to reduce the time it takes to resolve a fault once they have become aware of it, reducing CML.

This benefit has been estimated by multiplying the number of customer minutes lost on the low voltage network and the part of the high voltage network that currently has no remote monitoring by a 5% reduction factor. This has been multiplied by the CML incentive rate for RIIO-ED1 to arrive at the total benefit and this has been split between customer and DNO benefits using the Information Quality Incentive (IQI) sharing factor specified by Ofgem.

International evidence shows a large range of potentially achievable reductions in CML, ranging from 5% to 35%. The combination of reduced CML from earlier fault detection and faster restoration of supply are close to the bottom end of this range and are therefore relatively conservative assumptions.

The total present value benefits from faster restoration of supply are £25m.

3. Reduction in operational costs to fix faults

Information on the exact location and scope of an outage will also allow DNOs to deploy fault resolution teams in a more targeted manner, and avoid instances where they return to the depot only to have to be redeployed because a nested fault was not fully resolved. It will also reduce the need for unnecessary visits, where the outage is the result of a fault in the premises rather than with the distribution network. These instances will provide operational cost savings for DNOs.

The operational savings associated with deploying teams in a more targeted manner and reducing redeployment is estimated to be £50 per fault. This is towards the lower end of estimated savings reported in DNO Smart Metering Strategy papers. This value has been multiplied by the number of customer interruptions on the low voltage and high voltage parts of the network not covered by monitoring equipment to estimate the total value.

Expected savings from unnecessary visits were only reported by one DNO in their business plan, but would be expected to be realised by other DNOs as well. A frontier-DNO approach has been adopted for this category of benefit, with the annual saving reported by the one DNO being scaled to all other DNOs.

The total present value benefit from the reduction in fault fixing costs is £28m.

4. Reduction in calls to faults and emergencies lines

In the long-term customers will be confident that networks are already aware of outages due to smart meter information. In the short-term we envisage a reduction in the number of calls that need to be answered by DNOs through the introduction of automated messages that inform callers of the geographic scope and expected restoration time, facilitated by more accurate information from smart meters.

International evidence suggests that the number of calls that have to be answered by networks regarding outages can be reduced by up to 60%. Over time customers will develop trust in the ability of networks to detect outages through the functionality provided by smart meters without them calling in to provide notification. This will enable network operator call centre operations to adjust their resources. DNOs have suggested they would redeploy call centre staff to other areas of call centre services and that these changes would not result in an overall reduction in call centre costs. However, this redeployment is only possible at no additional cost because of smart metering, and it is therefore appropriate to reflect these benefits in this assessment.

To estimate this benefit, the annual call centre costs of DNOs have been multiplied by an assumption of a 10% reduction in cost as a result of smart metering. This has been reduced from 15% which was assumed in the 2014 IA and reflects a conservative view of the potential benefits.

The present value gross benefits from a reduction in calls are £19m.

1.4.3.2 Better informed investment decisions for electricity network enforcement

Having more detailed historical information will allow bottlenecks in the network to be identified more easily. Better planning data will result in investment in network reinforcement being better directed. Information received through the ENA cost benefit analysis[35] indicates that the required network enforcement investments might be reduced by 5% to 10% through the availability of better information from smart meters, in particular historical data on power flow and voltage information. We have adopted this assumption for our base scenario, assuming savings of 5% for RIIO-ED1 (2015 to 2023) rising to 10% for RIIO-ED2 (2023 to 2031) once a critical mass of meters has been reached. This reflects the expectation that the benefits from smart metering will increase over time, for example due to the deployment of more low carbon technologies.

Our analysis uses the actual annual investment requirement figure from the fifth Distribution Price Control Review (DPCR5) as the baseline to reflect the latest information on expected costs from network investment[36]. This baseline investment figure reflects general reinforcement costs, attributable to normal increases in electricity demand from housing[37]. Hence, we do not model any benefits to DNOs from active demand control and real-time network management, and advanced notification to consumers of planned outages.

In addition, we also capture the benefit from reduced cost of new connections, based on evidence published by the ENA and DNOs. Smart meters will enable DNOs to optimise design requirements, minimising the costs of connecting new sites to the existing network. These benefits have been estimated by multiplying the actual annual investment for new connections by the cost saving assumptions described above. There are also expected to be benefits to customers as a result of the streamlining of the quotation process.

In total, this results in an estimated £46m and £151m benefit respectively from reduced investment in the existing network and new connections over the appraisal period.

1.4.3.3 Avoided cost of investigation of customer complaints about voltage quality of supply[38]

With smart meters electricity Network Operators will be able to monitor voltage remotely, removing the need to visit premises to investigate voltage complaints.
Information collected by Ofgem indicates the total number of notifications that require a visit to the premises. For the base scenario we have used a cost per visit of £450. This reflects a cost per site visit to check the status of £121 and the cost of a follow up visit to fit and remove equipment to monitor the fault of £369. Ofgem data suggests that under the current system around 90% of faults need to be followed up with a visit to fit and remove monitoring equipment.

The resulting benefit is £0.09 per electricity meter per year, generating a total present value gross benefit of £24m.

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[35] See http://www.energynetworks.org/electricity/futures/smart-meters.html.
[36] Every five years Ofgem sets price controls for the 14 electricity Distribution Network Operators (DNOs). Price controls both set the total revenues that each DNO can collect from customers and incentivises DNOs to improve their efficiency and quality of service. As part of this process the total volume of investment required over the next price control period is also set.
[37] These figures do not reflect any investment to accommodate significant uptake of electric vehicles and heat pumps; upgrade of existing or new exit points, or new generation connections.
[38] While the benefit of better informed investment decisions is subject to the same assumption of critical mass, the argument can be made that the avoided costs for investigating voltage complaints is not dependent on a critical mass and will be realised for the proportion of premises where a smart meter has been installed. For modelling purposes we have therefore translated the identified benefits from voltage investigation into per meter benefits and linked them to the roll-out profile. This assumes that each household within the system has the same probability of experiencing voltage issues and the same probability of having received a smart meter.

1.4.3.4 Avoided losses

We continue to assume that smart meters facilitate some reduction in losses and that the benefits per meter per year will be £0.5 for electricity and £0.1 to £0.2 for gas. This represents an initial assessment of the range of possible benefits by Mott MacDonald. The Programme recognises that benefits from reduced losses, similar to the benefits to customers included in this section, do not constitute a direct monetary saving to Network Operators. However, our classification of benefits is based on where in the energy supply chain the benefits arise. In practice, the benefits from avoided losses would fall to energy suppliers and would be expected to be passed on to customers given suppliers operate in a competitive energy market.

The total present value gross benefits from avoided losses are £378m.

1.4.3.5 Non-quantified

There are a number of operational areas where smart metering could provide additional benefits that it has not been possible to fully quantify in this assessment, due to a lack of evidence at this point in time. These areas include:

- Active network management;
- Improved asset management;
- Vegetation management[39];
- Regulatory and reporting requirements.

The programme remains committed to working with DNOs and the energy industry more widely to ensure these and other network-related benefits are realised. This will ensure that the maximum value is extracted from the smart investment, in order to minimise the costs from the management of the overall energy system to consumers.

Further work in the energy industry is also underway to unlock wider smart grid benefits such as cost savings from the introduction of Demand Side Response measures, for which smart metering is an important enabling technology. While not quantified at this stage in light of the continued uncertainty over eventual cost saving levels, work in BEIS continues to assess the contribution that smart metering makes to the realisation of those benefits.

1.4.4 Benefits from electricity load shifting

Smart meters make time-varying and other sophisticated type of tariffs possible by recording the time when electricity is used, and by allowing two-way communications. Such tariffs can incentivise demand-side response (DSR) or load shifting[40], which can potentially bring significant benefits to the electricity system.

There are three main types of tariffs that can incentivise DSR/load shifting:

- **Static time of use tariffs (STOU).** STOU use different prices depending on the time of day in order to incentivise consumers to shift their energy consumption from peak to off-peak times, in doing so flattening the load demand curve. STOU have fixed price

[39] DNOs incur regular costs for managing vegetation, such as cutting trees and branches that are close to overhead lines. This helps to maintain the effectiveness of the power network, reduce outages and manage fire hazards. With smart metering data, DNOs may be able to better target their vegetation management activities based on information on outages, which could provide costs savings.

[40] We here refer equally to DSR and load shifting.

structures, which do not vary according to real time network conditions. An example of its simplest expression is the Economy 7 tariff in the UK.

- **Dynamic TOU tariffs.** These offer consumers variable prices depending on network conditions – for example, during a period of plentiful wind, consumers may receive an alert that electricity will be cheaper for the next few hours. This could include critical peak pricing (CPP), where alert of a higher price is given usually one day in advance, for a pre-established number of days a year[41] or a critical peak rebate (CPR), where the consumer is offered a rebate to reduce its energy consumption at peak time.
- **Other tariffs** could also include automation, for example through remote control of appliances by a third party or programmable appliances, and could be driven by price or non-price factors (such as network conditions). Although automated TOU tariffs may have the largest potential for load shifting, consumers' willingness to use such automated tariffs has not yet been fully tested, while communications requirements and protocols are yet to be fully costed.

Consistent with the 2014 IA, we only consider load shifting from STOU tariffs, even though we recognise that over time some consumers might take up more sophisticated tariffs with the potential to realise larger benefits (Jamasb and Pollitt, 2011[42]). We treat benefits from load shifting as distinct from demand reduction, even though some studies and trials have found that time-varying tariffs can lead to demand reduction in addition to shifting (King and Delurey, 2005[43]; Customer-Led Network Revolution Trials, 2013[44]).

We derive the potential load shifting by assessing (1) the level of uptake of STOU tariffs up to 2030, (2) the potential discretionary load, and (3) the number of times load will actually be shifted.

Based on the international evidence, we expect a 20% take up of STOU tariffs by consumers (in addition to the existing group using Economy 7), starting from 2018. The 2014 IA had considered the take-up of STOU tariffs to start occurring as early as 2016. We have revised this assumption in order to present a more conservative view as to when energy suppliers are likely to start offering time of use tariffs to their customers and also latest timelines with regards to relevant industry work (e.g. Ofgem's work on settlement reform).

Over time the introduction of, for example, heat pumps with storage capacity and more widespread charging of electric vehicles is likely to increase the total amount of load that can be shifted in the future and will therefore increase the attractiveness of TOU tariffs. As outlined in the New Analysis section in Part I of this assessment, in light of recent developments in the energy industry and the recognition of there being significant potential benefits from STOU tariffs, we assume in our central scenario an increase in the take up of TOU tariffs over time (up to 30% by 2030 from 20% initially).

To assess the potential discretionary load, it is possible to disaggregate the components of domestic demand to provide a 'bottom-up' approach of electricity consumption by use type. Of total household demand, 'wet' goods (i.e. washing machine, dishwasher) are expected to provide in the short-term the most probable base for load shifting – these account for 19% of household electricity consumption (DECC, 2015[45]). Additionally, those customers with higher

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[41] Sustainability First, *Smart Pre-payment in Great Britain,* March 2010 and *Smart tariffs and households demand response for Great Britain*, March 2010.
[42] Jamasb and Pollitt*, Future of Electricity Demand,* Cambridge University Press, 2011.
[43] King, C and Delurey, D, *Twins, siblings or cousins? Analyzing the conservation effects of demand response programs. Public Utilities Fortnightly*, March 2005.
[44] See http://www.networkrevolution.co.uk/default.aspx.
[45] DECC, *Energy Consumption in the UK (2015)*, 2015.

than average discretionary consumption at peak time are expected to be presented with above average incentives for taking up TOU tariffs. It must be noted that some of the existing electric heating storage capacity, which provides discretionary load, is already utilised under Economy 7 tariffs, and therefore we do not account for electric heating storage as part of our bottom up calculation. We estimate the current amount of discretionary load at present to be 20% of total consumption at peak (19% from wet appliances + 1% from above average incentives for those taking up TOU tariffs). The total discretionary load assumed is the same as in the 2014 IA, despite the larger proportion of energy demand that is now estimated to be accounted for by wet goods.

Based on this evidence, we estimate that today, the current amount of discretionary load in the non-domestic sector is 20% of total consumption at peak. Because EVs, heat pumps, and smart appliances take up is likely to be driven by future policies, in our central scenario we assume an increase in take up and discretionary load (up to 30% by 2030 from 20% initially) in order to accommodate for example the expected growth in number of electric cars (DfT, 2008[46]) and heat pumps.

Over time the introduction of, for example, heat pumps with storage capacity and more widespread charging of electric vehicles is likely to increase the total amount of load that can be shifted in the future and will therefore increase the attractiveness of TOU tariffs. As outlined in the New Analysis section in Part I, in light of recent developments in the energy industry and the recognition of there being significant potential benefits from STOU tariffs, we assume in our central scenario an increase in the take up of TOU tariffs over time (up to 30% by 2030 from 20% initially).

Finally, in the short run, we assume that those customers on STOU 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 intervention by the householder.

These assumptions are in line with recent trial results. In Great Britain, initial results from the Customer-Led Network Revolution Trials indicate that TOU customers in the trials reduced their overall electricity demand by 3%, with 10% reduction during the evening peak[47]. The EDRP final report also presents two trials that tested the impact of TOU tariffs on electricity consumption. Those trials showed effects on load shifting from the peak period, with bigger shifts at weekends than on weekdays. Estimates of the magnitude of shifting effect vary between trials but were up to 10%.[48] The CER report on Irish smart meters trials[49] also found peak reductions of 8.8% due to the combination of different types of demand-side interventions and time of use tariffs. The ESMIG study suggests peak shifting of around 5% from TOU, and up to 16% with more sophisticated tariffs[50].

Sensitivity analysis is carried out on the level of take up at 10% and 40%, and also on the potential discretionary load available to accommodate for higher levels of penetration of electric vehicles, growth in heat pumps with storage capacity and the introduction of smart

[46] BERR & DfT, *Investigation into the Scope for the Transport Sector to switch to Electric Vehicles and Plug-in Hybrid Vehicles*, *2008*.
[47] See http://www.networkrevolution.co.uk/industryzone/projectlibrary.
[48] Neither of the TOU tariff trials involved any automation of energy-consuming appliances to facilitate load shifting.
[49] CER, *Electricity Smart Metering Customer Behaviour Trials (CBT) Findings Report,* May 2011 and *Electricity Smart Metering Customer Behaviour Trials (CBT) , Information paper*, May 2011.
[50] E.g. 12% with Real-time pricing and Critical Peak Rebate and 16% with Critical Peak Pricing.

appliances. These are not considered in our central case in order to avoid claiming benefits from developments which are likely to involve an extra cost over and above the business as usual case. For illustrative purposes we have assessed two scenarios[51] which consider such increases in discretionary load, leading to increases in benefits from load shifting by around £50m and around £800m respectively over and above the figures presented in the summary sheets of this assessment.

The methodology employed for the valuation of benefits from load shifting has not been changed. We value benefits from load shifting in four different areas.

1.4.4.1 Generation short run marginal cost savings from electricity demand shift

Load shifting can create benefits for utilities as on average energy can be generated at a lower cost, producing a resource cost saving to the economy as a whole. A number of studies (Faruqui & Sergici, 2009; Ofgem, 2010; ESMIG, 2011) find that economic savings are possible due to the differential between peak and off-peak costs as generation plants are utilised in ascending order of short run marginal cost.

If load is shifted from peak to off-peak periods, a short run marginal cost saving will be realised as a given amount of energy can be generated at a lower average generation cost, minimising production-related costs within the wholesale market by balancing generation and demand in a more cost effective way.

The present value gross benefit of short run marginal cost savings is £122m.

1.4.4.2 Generation capacity investment savings from electricity demand shift

For generation, this would mean a lower required generating plant demand margin (the difference between output usable and forecast demand, i.e. spare capacity), which could be reduced in line with reductions in peak demand reductions.

In the long run, once the existing generation plants have been replaced by new plant capacity, inclusion of both capacity investment savings and short run marginal cost savings would mean double-counting of benefits. However, in the short run (i.e. up to 2030), both benefits from utilising the existing capacity more efficiently and reducing the need for investing in future capacity are realised.

The expected present value benefits are £777m.

1.4.4.3 Network capacity investment savings from electricity demand shift

Lower peak demand due to the expected uptake of static TOU tariffs also means that long term capacity investment in transmission and distribution networks can be reduced, as peak loads will be lower than at business as usual levels. If consumers shift to off-peak consumption some of the investment in capacity will be unnecessary, therefore realising savings to energy utilities. For distribution, we use the actual annual investment from the DPCR5 as the baseline[52]. This baseline investment figure reflects general reinforcement

[51] In the mid scenario the penetration of electric vehicles is based on central projections by DfT (2008), whereas the high case also considers the introduction of smart appliances and heat pumps, based on central cases of market penetration from Kema (2010), DECC (2009), as well as the high case of penetration of electric vehicles (DfT, 2008).

[52] Every five years Ofgem sets price controls for the 14 electricity Distribution Network Operators (DNOs). Price controls both set the total revenues that each DNO can collect from customers and incentivises DNOs to improve their efficiency and quality of service. As part of this process the total volume of investment required over the next price control period is also set.

costs attributable to normal increases in electricity demand from housing[53]. Consequently, we do not account for potential additional benefits driven by more responsive demand solutions to minimise the impact of significant penetrations of EV and HP, for which DNOs would require real time data.

The expected present value benefits to networks are £44m.

1.4.4.4 Carbon savings from electricity demand shift

Some studies (Sustainability First, 2010; Ofgem, 2010), show that peak load shifting could lead under some scenarios to carbon savings, as the generation mix during the peak period is typically more carbon intensive than off-peak. We assume that overall, peak demand is on average more carbon intensive than off-peak demand, and therefore we present modest savings from the reduced cost to the UK energy generators of purchasing permits under the current EU ETS arising from an on average less carbon intensive generation mix. Carbon reductions are valued following IAG guidance, with marginal emissions factor differentials between peak and off-peak assumed to be those for coal and gas respectively, at 0.32 and 0.18 kg CO2/ kWh.

The expected present value benefit is £45m.

1.4.5 Carbon related and UK-wide benefits

1.4.5.1 Valuing avoided costs of carbon from energy savings

We have valued the avoided costs of carbon from energy savings in line with Government guidance. We also test whether the UK is introducing a cost-effective policy to reduce carbon emissions through the roll-out of smart meters, which is discussed in some more detail in the Carbon Test (section 8.3).

For electricity, reductions in energy use will mean the UK purchasing fewer (or selling more) allowances from the current EU ETS and this saving is assimilated as a benefit. In our analysis it accounts for PV benefits of approximately £179m.

For gas, the value of carbon savings from a reduction in gas consumption uses the non-traded carbon prices under BEIS's carbon valuation methodology. This corresponds to a net reduction in carbon emissions and corresponds to benefits of approximately PV £599m.

1.4.5.2 Reduction in carbon emissions

Over the period covered in this assessment, we assume that as a result of a reduction in energy consumption, CO_2 emissions reductions will be realised in both the traded and non-traded sectors[54]. The table below presents the CO_2 emissions associated with the energy savings in the central scenario across options.

[53] This figure does not include any investment to accommodate significant uptake of electric vehicles and heat pumps, nor includes upgrade at or new exit points, or new generation connections.

[54] Note that the impact of a tonne of CO_2 abated in the traded (electricity) sector has a different impact to a tonne of CO2 abated in the non-traded (gas) sector. Traded sector emissions reductions lead to a reduction in UK territorial greenhouse gas emissions, but do not constitute an overall net reduction in global emissions since the emissions will be transferred elsewhere to member countries in the EU-ETS. The UK gains a cost saving from buying fewer emissions allowances, but these allowances will be bought up by other member states – the total size of the EU-wide 'cap' on emissions does not change during each phase of the EU-ETS. Non-traded sector emissions reductions will reduce both UK and global emissions.

Table 1-4: Reductions in CO_2 emissions and energy savings

Carbon savings in the traded sector (Millions of tonnes of CO_2 saved equivalent)	Carbon savings in the non-traded sector (Millions of tonnes of CO_2 saved equivalent)	Avoided cost of carbon – electricity (£m, PV)	Avoided cost of carbon – gas (£m, PV)
7.87	11.72	179	599

1.4.6 Air quality benefits

In line with guidance from the Department for Environment, Food and Rural Affairs' (Defra) Inter-departmental Group on Cost and Benefits of Air Quality[55] a benefit reflecting air quality improvements from reduced emission of pollutants as a result of energy savings is estimated. Air quality improvements are estimated to deliver benefits of £69m in present value terms.

1.4.7 Non-quantified benefits

Smart metering will facilitate the uptake or management of new services or enable new, smart approaches to energy supply and grid management – especially in the medium to longer term. These remain largely unquantified but are key benefits from the roll-out. BEIS will continue to monitor the overall impacts of the smart meter rollout and will explore whether any these (and potentially other) additional benefits can be quantified and monetised in the future.

1.4.7.1 Enabling a Smart Energy System

A smart grid is a modernised electricity grid that uses information and communications technology to monitor and actively control generation and demand in near real-time, which provides a more reliable and cost effective system for transporting electricity from generators to homes, businesses and industry. Smart meters are a key enabler of a smart grid, providing information to help improve network management (subject to data, privacy and access controls), facilitating demand shifting and supporting distributed and renewable energy generation[56].

The Government's intention is to better understand opportunities to build a smart, more flexible energy system which could help us build less power generation, turn off generation when it exceeds demand, and avoid significantly reinforcing our energy networks. It could also reduce the cost of balancing our energy system in real time. DECC's 2015 report, towards a smart energy system, explained that smart solutions – including demand side response (DSR), storage and smart networks – would help reduce overall system costs and move us towards a more flexible energy system[57].

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[55] Defra, *Air quality appraisal-damage cost methodology*, February 2011.
[56] Smart Grid Forum (2014) *Smart Grid Vision and Routemap,* available at: www.gov.uk/government/uploads/system/uploads/attachment_data/file/285417/Smart_Grid_Vision_and_RoutemapFINAL.pdf
[57] DECC, *Towards a smart energy system, December 2015.*

Although precise benefits are likely to be significant in the medium term, external estimates suggest that overall system costs could be reduced in the order of tens of billions (£) in the period to 2050. The 2014 Smart Metering Impact Assessment discussed a number of attempts to quantify potential benefits arising from a smarter grid[58]. Further studies include:

- Analysis by Ernst & Young for SmartGrid GB, which found that deployment of smart upgrades could save UK DNOs £18 billion between 2012 and 2050, creating 8,000 to 9,000 new jobs in the 2020s and 2030s and delivering export potential of £5 billion to the UK economy between 2012 and 2050[59].
- The National Infrastructure Commission's Smart Power report, which found that interconnectors, storage and demand flexibility could save consumers up to £8 billion a year by 2030, help the UK meet its 2050 carbon targets, and secure the UK's energy supply for generations[60].

Only network benefits directly driven by the roll-out of smart meters have been considered in this assessment, while potential smart energy system benefits are not included.

The presence of smart meters is a critical enabling step to the realisation of the above benefits and BEIS will continue to monitor the developments in this area.

1.4.7.2 Competition benefits

There is a strong argument that the introduction of smart meters will have an effect on the competitive pressure within energy supply markets. Accurate and reliable data flows from smart meters will support easier and quicker switching between suppliers. In addition, the information on energy consumption provided to consumers via IHDs will enable them to seek out better tariff deals, switch suppliers and therefore drive prices down. The CMA's final report on their Energy Market Investigation confirms that "smart meters are likely to have a positive impact in helping to address some of the supply- and demand-side problems we have identified in the domestic retail energy markets"[61].

Already the market is seeing an influx of small suppliers that differentiate themselves through the provision of a smart meter to their customers and/or new products (e.g. new tariff packages structured around time of use). In addition, the improved availability of information should create opportunities for energy service companies to enter the domestic and smaller business markets.

While we judge that greater levels of competition may result in lower prices, it is difficult to quantify these competition-related benefits and therefore no attempt has been made to quantify these in this assessment. A competition assessment is included in the Specific Impact Tests section at the end of this document (see section 8.1).

1.4.7.3 Future products

We expect the existing home energy management sector to experience strong growth as a result of the roll-out of smart meters. The availability of detailed consumption data will create

[58] BEIS does not necessarily endorse these, and emphasises the uncertainty surrounding a future smart grid. See: www.gov.uk/government/uploads/system/uploads/attachment_data/file/276656/smart_meter_roll_out_for_the_domestic_and_small_and_medium_and_non_domestic_sectors.pdf, page 63-64.

[59] Ernst & Young/SmartGrid GB, *Smart grid – a race worth winning?,* April 2012

[60] National Infrastructure Commission, *Smart Power,* March 2016.

[61] CMA, *Energy market investigation final report*, June 2016, available at https://assets.publishing.service.gov.uk/media/5773de34e5274a0da3000113/final-report-energy-market-investigation.pdf.

significant new opportunities to these companies in offering services and products on appliance diagnostics, more refined automation of heating and hot water controls and the analysis of heating patterns.

It has also been suggested that smart metering might contribute to addressing some of the challenges facing the UK's ageing society and that the health system could realise savings through the availability of real-time smart meter energy consumption information. People requiring care might be enabled to remain in the familiar surroundings of their own home for longer by using tele-care systems and granting family members or carers access to their energy consumption information in real time. This way, if unexpected consumption patterns are detected (for example no increase in energy consumption for cooking at meal times; no changes in level of consumption over extended periods of time) appropriate steps can be taken. The delay in transferring people into full time care could generate considerable savings to the healthcare system.

2 Domestic Results

2.1 Costs, benefits and NPV

The results below are produced by running a cost-benefit estimation model using the assumptions outlined above. Within the model, the upfront costs are annuitised over either the lifetime of the asset or over the period 2013-2030. The cost numbers are risk-adjusted, i.e. they have been adjusted for optimism bias where appropriate (see section 2.3.1 on risk). We have applied sensitivity analysis to benefits and we present benefits in terms of low, central and high scenarios (see section 2.3.2). Section 2.2.1 shows the impact of smart meters on energy bills of domestic customers. This builds on existing BEIS modelling on energy prices to estimate the impact of the deployment of smart meters on domestic energy bills in cash terms.

The present value base year of the analysis is 2016. Cost and benefit information is reflected in 2011 real prices.

Table 2-1: Total costs and benefits

Total Costs £bn	**Total Benefits £bn**	**Net Present Value £bn**
10.55	14.35	3.79

Table 2-2: Consumer and supplier benefits

Consumer Benefits £bn	**Business Benefits £bn**	**Carbon & Air Quality Benefits £bn**	**Total Benefits £bn**
3.86	9.60	0.89	14.35

Table 2-3: Low, central, and high estimates

Total Costs £bn	**Total Benefits £bn**			**Net Present Value £bn**		
	Low	**Central**	High	Low	**Central**	High
10.55	10.55	14.35	18.51	0.02	3.79	7.93

Table 2-4: Benefits

Consumer Benefits £bn			**Business Benefits £bn**			**Carbon & Air Quality Benefits £bn**		
L	**C**	H	L	**C**	H	L	**C**	H
1.84	3.86	5.78	8.31	9.60	11.33	0.40	0.89	1.40

The benefit-cost ratio, which is a good indicator of the cost-effectiveness of the policy, remains constant at 1.4 in the central scenario, with a value of 1.7 in the high scenario and of 1.0 in the low case scenario.

2.2 Cost impacts on different stakeholder groups

2.2.1 Impacts of smart meters on household energy bills

We expect any costs to energy suppliers to be recovered through higher energy prices, although any benefits to energy suppliers, networks and generators will also be passed on to consumers[62]. The results below show the average impact on household energy (electricity and gas) bills. It is expected there will be variation between households depending on the level of energy they save and on how different suppliers decide to pass through the costs.

The rollout is expected to result in a relatively small transitional bill increase in the short term, followed by larger savings for consumers in the medium and long term. The short term increase on the household energy bill is expected to peak in 2016 at an average of around £13 per household (or around 1% of an average bill). From 2019 the predicted impact on central scenarios is a bill reduction. By 2020 we expect savings on household energy bills to average around £11 per annum per household.

From 2020 onwards bill savings generated from smart metering continue to increase as a result of higher energy prices (which make energy savings from smart meters more valuable) and a reduction of costs when compared to the counterfactual (where dumb meters are assumed to continue to be replaced and therefore incur new costs). By 2030 we estimate average bill savings will be approximately £47 per household (Table 2-5).

Differences in both the profile and the magnitude of bill impacts in comparison to the 2014 IA are driven primarily by two factors.

Firstly, a significant reduction in the projection of energy retail prices in the short to medium term (on the back of fossil fuel price expectations) has resulted in a material reduction of the monetary value of the consumption savings that are facilitated by smart metering. In light of global fossil fuel market developments the short term energy retail price projections are up to 30% lower than the expectation applied in the 2014 IA bill impact analysis, translating directly into a reduction of the total energy bill before smart metering and consequently a reduction in the value of the smart meter effect (which is derived as a proportion of the baseline bill).

Secondly, the changes in the Programme timeline and smart meter deployment profile have resulted in meter installations shifting to the right, resulting in a delay in the realisation of energy consumption savings and operational cost savings to the energy industry, both of which will reduce bills. The level of bill savings previously achieved in 2020 is now being realised in 2022.

[62] For this analysis we have assumed that energy suppliers, networks and generators pass 100% of the costs and benefits on to consumers due to the pressures of the competitive market and the regulatory regime.

Table 2-5: Impact on average domestic energy bill for a dual fuel customer (£, real 2012)

	Household energy bill impact, £
2020	-11
2025	-35
2030	-47

Even without taking the impact of energy consumption savings into account, the roll-out of smart meters, and the operational efficiencies facilitated within the energy industry, result in a reduction of energy costs over time. This effect of smart meters in the domestic sector is reflected in Table 2-6 below. A small price increasing impact per unit of energy is expected during the main installation phase (although energy consumption savings help offset the impacts on bills). After the main installation phase is complete, cost savings to the energy industry arising from the roll-out are expected to outweigh total costs, resulting in the price impact becoming negative from 2022.

Table 2-6: Impacts on household energy prices (£, real 2012)

	Electricity	**Gas**
Year	**price impact (£/MWh) (Inc VAT)**	**price impact (£/MWh) (Inc VAT)**
2020	+1.20	+0.40
2025	-0.71	-0.26
2030	-1.82	-0.67

The bill impact analysis continues to apply the methodology established in the 2014 IA and does not add stranding costs for traditional metering equipment into the energy industry cost, in order to avoid double-counting.

The bill analysis estimates the impact of the smart meter roll-out on a baseline which includes only policies firmly set before the smart meter roll-out mandate was announced.

The analysis assumes all costs and cost savings are passed on to customers given competitive pressures or regulated outcomes (where parts of the energy industry don't operate under competitive markets).

Bill impacts on different household types and income groups are not considered explicitly in this analysis given the lack of evidence on distributional impacts at this point in time. However EDRP trials have shown that households in areas with a higher propensity for fuel poverty can benefit at least as much as other households in terms of the percentage energy savings they can realise.

It should be noted that there may be further impacts on consumer bills for those customers who take advantage of peak/off-peak price differentials offered by smart tariffs and take up time-of-use tariffs. These distributional impacts have not been included in the calculation above. Analysis by the Brattle Group[63] in the US indicates that low income customers tend to benefit more than average from time-of-use tariffs. No analysis has been done in a UK context, however anecdotal feedback from suppliers is that low income customers on average tend to have flatter usage profiles and hence would benefit from taking up time-of-use tariffs through bill reductions even without changing their consumption patterns.

2.2.2 Stranding costs

The roll-out of smart meters will bring forward the replacement of some traditional meters if they are replaced before they reach the end of their useful life. This will either result in a termination charge at the point of asset removal or, in the worst case, the continuation of asset charges as if the meter continued to be in place.

While this may mean the costs for an investment that was made continue to be incurred without delivering benefits, these costs would not be additional for any 'legacy' traditional meter that was installed before the start of the Foundation Stage of the roll-out. This is because these costs would have been sunk and irrevocable as of the start of the Foundation Stage, and would be incurred in both the roll-out option and counterfactual. Any stranding costs associated with these meters have therefore been excluded from this assessment. This approach is in line with guidance set out in the HMT Green Book.

For traditional meters that are installed during the smart meter roll-out because there is no smart meter variant available that would work in the property at the time, we adopt a different approach. For these meters, we include the full cost of the traditional meter replacement over its assumed useful life (10 years for prepayment meters, 20 years for credit meters). That is, we continue to capture the costs of these traditional meters after they have been replaced by a smart meter later on in the roll-out period. The stranding costs associated with these traditional meters have been captured in the total installation and asset costs of the smart meter roll-out (see section 1.3.1).

2.2.3 Better regulation and the net impact to businesses (EANCB – Equivalent Annual Net Cost to Business)

<u>One-in, One-out</u>
Since this assessment is an update of previous analysis and reflects the latest evidence base for an agreed policy there is no new impact for the regulatory budget framework. The value and treatment of the EANCB figure as presented in the 2014 IA continues to apply.

<u>Administrative burden</u>
We have identified no significant additional administrative burdens to business from the smart meter policy. Notifying customers of planned visits to install or remove a meter is considered good business practice and helps in ensuring access to the premise, so cannot be seen as a burden to business arising from the roll-out. Following the submission of detailed evidence from energy suppliers this methodological approach was agreed with the Better Regulation Executive (BRE). The smart meters roll-out will bring forward the replacement of metering equipment and as such notifications to customers of such planned visits. Such potential effect remains unquantified in this assessment.

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[63] See http://www.brattle.com/_documents/UploadLibrary/Upload936.pdf.

A small administrative burden from having to submit data for monitoring and evaluation purposes has been identified. This amounts to £1m between now and 2020 and is included in the costs described in section 1.3.8.

Sun-setting or statutory review clauses
We have considered the case for sun-setting of the regulatory interventions required for smart metering. These interventions are intended to set out an enduring framework for the effective provision and operation of smart metering and, as such, are not candidates for sun-set clauses. In particular, interoperability of equipment deployed by different suppliers cannot be expected to become business as usual at any point in the future and therefore sun-setting is not appropriate. BEIS will keep all smart meter regulation under review as policy is developed further – as stated in section 7.2, the Programme is committed to a comprehensive review and evaluation process, both during the initial Foundation Stage as well as towards the end of the main roll-out.

2.3 Risks

2.3.1 Costs: Risk Mitigation and Optimism Bias

The roll-out of smart meters will be a major procurement and delivery exercise. The project will span several years and will present a major challenge in both technical and logistical terms.

There is a consensus that stakeholders do not explicitly make allowances for optimism bias in the estimates they provide for procurement exercises. By calling for pre-tender quotes for various pieces of equipment, suppliers are revealing the likely costs of the elements of smart metering and hence no further adjustment is necessary. However, historically, major infrastructure and IT contracts have often been affected by over–optimism and gone substantially over-budget, so we have adjusted the estimates for optimism bias, in line with guidance from HMT's Green Book.

After the publication of the April 2008 IA, it was acknowledged that more work was needed regarding the treatment of risk to the costs of a GB-wide smart meter roll-out. Baringa Partners[64] were commissioned to consider these issues, in particular to provide:

- Assessment of the international and domestic evidence available;
- Development of a risk matrix based on the identification of key risks, their potential impacts and mitigation actions;
- Assessment of the sensitivity of these risks to market model and duration of the roll-out;
- Assessment of the treatment of risk in the April 2008 IA; and
- Make recommendations, in light of the above.
- This resulted in a revised approach to optimism bias which was first reflected in the May 2009 IA.

As per HMT guidelines the application of adjustments for optimism bias and risk allowances should be kept under review as certainty increases and as substantiating evidence is identified. Some recent key points in the case of smart metering were the award of the contracts and the DCC licence in September 2013, and the increasing certainty around costs as the programme moves closer to the start of its main installation stage in 2016 and operational data from installations to date starts accumulating. We have therefore

[64] Baringa Partners, *Smart Meter Roll Out: Risk and Optimism Bias Project*, 2009.

undertaken to review the treatment of risk and the application of optimism bias factors in areas where the award of the contracts or real-world operational date increase significantly the certainty on the costs (and benefits) of the solution.

Table 2-7 below shows the updated optimism bias factors applied in this assessment.

Table 2-7: Optimism bias factors

	Optimism bias factor
IHD	5%
Meters	5%
Installation	5%
Energy industry IT Capex	10%
Energy industry IT Opex[65]	10%

Cost uplift factors are also applied to meters deployed early during the Foundation Stage. These factors are presented in section 1.3.10.

More detail on optimism bias and how it is applied can be found on the HMT website in the Green Book guidance[66].

Overall, the total cost that is added to the appraisal (across the domestic and non-domestic sector cost benefit analysis) as a result of the application of optimism bias and other cost uplifts in this assessment is still significant, amounting to around £1bn. The main areas where optimism bias and uplift factors remain include installation, metering equipment, treatment of costs in Foundation and additional roll-out costs with high peak installation rates.

2.3.2 Benefits: sensitivity analysis

Sensitivity analysis has been applied to the main elements of the benefits. Table 2-8 shows the sensitivity applied to each benefit item.

[65] Optimism bias factors are applied to energy industry IT capex and opex, which covers suppliers, other industry participants and also provision of the smart meter key infrastructure.
[66] HMT, *The Green Book*, updated 2011.

Table 2-8: Sensitivity analysis for benefits

	Low benefits	Central benefits	High benefits
Consumer benefits			
Energy consumption savings: electricity	1.5%	2.8%	4.0%
Energy consumption savings: gas Credit	1.0%	2.0%	3.0%
Energy consumption savings: gas PPM	0.3%	0.5%	1.0%
Business benefits			
Supplier benefits			
Avoided site visit	underlying visit cost + 8%	underlying visit cost	underlying visit cost - 8%
Call centre savings	£1.9	£2.2	£2.5
Avoided PPM COS premium	30%	40%	50%
Reduced theft	5%	10%	15%
Network benefits			
Faster restoration of supply	3%	5%	10%
Better informed enforcement investment decisions: ED1	3%	5%	10%
Better informed enforcement investment decisions: ED2	5%	10%	15%
Avoided investigation of voltage complaints	£217	£434	£648
Reduction in calls to emergency lines	5%	10%	15%
Reduced cost to serve new connections	3%	5%	10%
Time of Use benefits			
Uptake of STOU in 2020	10%	20%	40%

It is worth noting that the energy savings affect the total cost for each option due to the energy use by the devices, but the effect is minimal. Table 2-9 presents the results of applying the sensitivity ranges presented in Table 2-8 to each specific benefit assumption.

Table 2-9: PV of individual benefit items after sensitivity analysis

£m	Low benefits	Central benefits	High benefits
Consumer benefits			
Energy consumption savings electricity	1,361	2,779	4,087
Energy consumption savings gas	432	1,028	1,642
Business benefits			
Supplier benefits			
Avoided site visit	2,622	2,860	3,099
Call centre savings	1,018	1,157	1,293
Avoided PPM COS premium	800	1,093	1,387
Reduced theft	109	219	328
Network benefits			
Faster restoration of supply	12	25	49
Better informed enforcement investment decisions	76	151	249
Avoided investigation of voltage complaints	12	24	35
Reduction in calls to emergency lines	10	19	29
Reduced cost to serve new connections	27	46	84
Time of Use benefits			
Uptake of STOU in 2020	559	943	1,710

3 Domestic sector detailed results

Table 3-1: Domestic sector detailed results from the model (in £million) for the central case scenario:
Over period 2013-2030, in 2011 prices, with a present value base year of 2016
Totals may not sum due to rounding

Total Costs		**10,555**	**Total Benefits**		**14,349**
In premise costs		6,135	**Consumer benefits**		3,856
	Meters & IHDs	2,551		Energy saving	3,807
	Installation of meters	1,942		Microgeneration	49
	Operation and maintanance of meters	626	**Business benefits**		
	Communications equipment in premise	1,016		Supplier benefits	7,954
DCC related costs		2,035		Avoided site visits	2,860
	DCC licence	230		Inbound enquiries	986
	Data services	377		Customer service overheads	171
	Communication services	1,334		Debt handling	970
	Other service providers	95		Avoided PPM COS premium	1,093
Suppliers' and other participants' system costs		1,001		Remote (dis)connection	221
	Supplier capex	536		Reduced theft	219
	Supplier opex	306		Customer switching	1,433
	Industry capex	69		Network related benefits	748
	Industry opex	90		Earlier fault notification/detection	34
Other costs		1,384		Faster restoration of supply	25
	Energy	652		Operational savings from fault fixing	28
	Disposal	11		Reduced calls to emergency and fault lines	19
	Pavement reading inefficiency	271		Better informed enforcement investment decisions	151
	Organisational	258		Reduced cost to serve new connections	46
	Marketing	192		Avoided investigation of voltage complaints	24
NPV		***3,794***		Reduced losses	378
				Avoided investment from ToU (distribution/transmission	44
				Generation benefits	899
				Short run marginal cost savings from ToU	122
				Avoided investment from ToU (generation)	777
			Carbon and air quality benefits		892
				Global CO2 reduction	599
				EU ETS from energy reduction	179
				EU ETS from ToU	45
				Air Quality	69

Section B: Smart meter roll-out for the non-domestic sector

Summary: Analysis & Evidence **Policy Option 1**

Description: This assessment reflects a supplier led roll-out of smart meters with a centralised Data and Communications Company (DCC).

FULL ECONOMIC ASSESSMENT

Price Base Year 2011	PV Base Year 2016	Time Period Years 18	Net Benefit (Present Value (PV)) (£m)		
			Low: 1,241	High: 2,658	Best Estimate: 1,952

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	NA		NA	**NA**
High	NA		NA	**NA**
Best Estimate	1		29	**426**

Description and scale of key monetised costs by 'main affected groups'

Meter and communications equipment costs and their installation and operation, as well as cost allowances for the provision of consumption feedback amount to £392m. Disposal of metering equipment, energy consumption of metering equipment, pavement reading inefficiency and other costs amount to £34m.

Other key non-monetised costs by 'main affected groups'

N/A

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low	0		119	**1,667**
High	0		221	**3,084**
Best Estimate	0		170	**2,378**

Description and scale of key monetised benefits by 'main affected groups'

Total consumer benefits amount to £1.45bn and include savings from reduced energy consumption (£1.44bn), and avoided costs of microgeneration metering (£8m). Total supplier benefits amount to £296m and include amongst others avoided site visits (£130m), and reduced inquiries and customer overheads (£51m). Total network-related benefits amount to £91m and generation benefits to £44m. Carbon related benefits amount to £472m. Air quality improvements amount to £28m.

Other key non-monetised benefits by 'main affected groups'

These include benefits from further development of the energy services market and the potential benefits from the development of smarter energy systems including a smart grid. Smart metering is expected to result in stronger competition between energy suppliers due to increased ease of consumer switching and improved information on consumption and tariffs. An end to estimated billing will improve the customer experience.

Key assumptions/sensitivities/risks **Discount rate** 3.5%

Cost assumptions are adjusted where appropriate for risk optimism bias and benefits are presented for the central scenario unless stated otherwise. Sensitivity analysis has been applied to the benefits as energy savings depend on consumers' behavioural response to information and changes to them affect the benefits substantially. The numbers presented are based on the modelling assumption that the scope of the DCC will include data aggregation in the long term.

Annual profile of monetised costs and benefits for the non-domestic sector (undiscounted)*

£m	2013	2014	2015	2016	2017	2018
Total annual costs	15	14	12	12	18	33
Total annual benefits	59	54	58	64	87	144

£m	2019	2020	2021	2022	2023	2024
Total annual costs	49	50	45	41	39	37
Total annual benefits	216	261	281	297	302	309

£m	2025	2026	2027	2028	2029	2030
Total annual costs	35	35	43	14	12	11
Total annual benefits	315	314	312	305	300	299

* For non-monetised benefits please see summary pages and main evidence base section

Emission savings by carbon budget period for the non-domestic sector ($MtCO_2e$)

Sector		Emission Changes ($MtCO_2e$) - By Budget Period		
		CB II; 2013-2017	CB III; 2018-2022	CB IV; 2023-2027
Power sector	Traded	0	0	0
	Non-traded	0	0	0
Transport	Traded	0	0	0
	Non-traded	0	0	0
Workplaces & Industry	Traded	0.31	0.85	0.72
	Non-traded	0.82	2.62	2.89
Homes	Traded	0	0	0
	Non-traded	0	0	0
Waste	Traded	0	0	0
	Non-traded	0	0	0
Agriculture	Traded	0	0	0
	Non-traded	0	0	0
Public	Traded	0	0	0
	Non-traded	0	0	0
Total	Traded	0.31	0.85	0.72
	Non-traded	0.82	2.62	2.89
Cost effectiveness	% of lifetime emissions below traded cost comparator	100%		
	% of lifetime emissions below non-traded cost comparator	100%		

4 Non-Domestic Evidence Base

4.1 Overview

In this section we describe the main assumptions underpinning the analysis and the reasons for them, with references to the evidence where appropriate.

The main assumptions used to calculate the overall impact of the roll-out described in this section are:

1. Counterfactual/benchmarking
2. Costs
3. Benefits

These assumptions are then combined and modelled to provide cost benefit outputs (see section 5)

It should be noted that within the economic model all up-front costs are annuitised over the lifetime of the equipment or over the roll-out period, apart from the costs for providing consumption feedback (modelled in line with the analysis of IHD costs in the domestic sector analysis, see section 1.3.1). The cost of financing differs across the capital cost categories as follows:

- For meter assets and installation costs the cost of capital is assumed to be 6% (real). These costs are generally financed through Meter Asset Providers (MAPs) who charge suppliers a rental fee to cover the costs of the asset and installation. MAPs' business models are perceived as lower risk than energy suppliers and they can therefore access cheaper finance. The assumed cost of capital is based on evidence provided by commercial experts.
- For communication hub costs, the cost of capital is assumed to be the level set in contracts with the DCC. This is unchanged from the assumption in the 2014 IA.

The benefits are not annuitised but annualised, that is they are counted as they occur. The realisation of most benefits will occur as smart meters are installed in consumers' premises, so they are modelled on a per meter basis and are linked to the roll-out profile.

4.2 Differences between the domestic and non-domestic analysis

Most of the assumptions used in this assessment are shared with the assumptions used in the analysis for the domestic sector. Where this is not the case it is noted and explained within the text in this section.

4.2.1 Overview of differences in treatment of costs and benefits in the non-domestic sector

For some of the costs and benefits analysed it is not possible to determine the proportion that falls to the domestic or non-domestic sector. Therefore, for modelling purposes, we have allocated some of the costs and benefits fully to the domestic analysis, in light of the much greater number of meters in that sector. In other instances, we have made different assumptions. The key differences between the non-domestic and domestic sector analysis are:

Costs:

- IT system costs are fully allocated to the domestic sector;
- Costs associated with setting up and operating the DCC are fully allocated to the domestic sector;
- Legal, governance and administration costs, as well as costs associated with consumer engagement activities, are fully allocated to the domestic sector.

Benefits:

- Benefits from better informed investment decisions in electricity networks are fully allocated to the domestic analysis.
- We allocate all benefits from reduced theft to the domestic sector.
- We assume limited benefits for advanced meters;
- The critical mass required for outage detection benefits to start being realised takes into account both domestic and non-domestic installations[67].

It is important to note that the overall impact of the above on the combined net present value of the smart meter domestic and non-domestic roll-outs is neutral and that once aggregated neither costs or benefits are underestimated or overestimated because of the allocation between the sectors' analyses.

In addition, it is important to note that for the non-domestic sector a different counterfactual is applied than for the domestic analysis. The counterfactual is explained in section 4.4 below.

4.2.2 Meter numbers and non-domestic energy consumption baseline

Given the unique definition of the non-domestic population covered by the smart meter roll-out obligation, there remains some difficulty in establishing the accurate number of meters, in particular in relation to gas. The Smart Metering statistics collected by BEIS still contain incomplete data for small suppliers, and as such we have not yet integrated these into the model. We continue with the assumptions from the 2014 IA on the number of meters, and consumption per meter.

Assumptions about non-domestic sector growth also remain unchanged, and the analysis still assumes 51,000 new meters per annum. The model takes the conservative approach of assuming that the energy consumption baseline stays constant over time.

Table 4-1: Meter numbers and energy consumption

	Electricity	**Gas**
Meters (2011)	2,140,000	920,000
Consumption (kWh)	17,400	110,000
New meters	51,000 per annum	

[67] However, benefits accredited in the non-domestic sector are proportional to the non-domestic number of installations.

4.2.3 Advanced meters vs. smart meters

Suppliers can choose to install SMETS1 meters or advanced meters at non-domestic premises for a time-limited period and this is reflected in the analysis. To date, suppliers to non-domestic premises have predominantly installed advanced meters, with a lower percentage of SMETS1 installations. The following paragraphs set out in further detail the background to the advanced meter policy and the assumptions we have made on this basis.

4.3 Advanced Meters

As outlined in the New Analysis section in Part I of this assessment, there is currently an exception to the smart meter roll-out licence conditions that allows the installation of advanced meters to meet the roll-out obligation at designated non-domestic sites. In March 2016 the Government extended the exception period from 6 April 2016 to 28 April 2017 for large suppliers and 17 August 2017 for small suppliers[68]. After the exception end dates suppliers must install smart meters at non-domestic premises, except where there were contractual arrangements put in place with the customer prior to 6 April 2016 to continue installing advanced meters. Advanced meters must also be replaced with smart meters once they reach the end of their lives, unless they need to be advanced meters for technical reasons[69]. The current analysis reflects these conditions.

The advanced metering exception was confirmed as policy in the Government response to the Smart Metering Prospectus consultation in March 2011. The Government wished to maximise the roll-out of smart meters to smaller non-domestic sites but it also recognised that there was an established, active advanced metering market in the sector that was already providing energy and carbon savings. The Government's view was that an exemption would enable customers to continue to benefit from advanced meters without the risk of investment in such meters being stranded, and would enable those serving the advanced metering and data services market to continue to do so.

Advanced metering and data service providers offer services tailored to customers' requirements, including providing feedback on energy consumption through a variety of means, for example via an internet portal. This feedback allows consumers to monitor their consumption and to target energy and carbon savings. Service providers contract with communications companies to permit the meter to be accessed and data downloaded. These advanced metering arrangements not only carry a different cost to smart meters as defined by the Programme, but are also assumed to deliver different levels of benefits.

We expect the extended period during which advanced meters may be installed to increase the volume of advanced meters installed overall. This, and new data on actual installations of smart and advance meters has been reflected in the modelling assumptions, which now assumes that by 2020 the split between smart and advanced meters will be as follows:

[68] DECC, Government response to December 2015 consultation on non-domestic smart metering: draft legal text extending the advanced metering exception end-date, 2015, available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/497289/2016-01-02_AME_legal_text_consultation_response_FINAL.pdf

[69] Under the roll-out licence conditions, advanced metering may continue to be installed where there is a current transformer electricity meter or a larger gas meter.

- Electricity: 65% smart and 35% advanced;
- Gas: 77% smart and 23% retrofit advanced.

The proportion of benefits realisable for advanced meters is shown in the table below.

Table 4-2: Proportion of smart meter benefits realisable for advanced meters

	Advanced meters	
	Electricity	Gas
Consumer benefits		
Energy demand reduction	90%	80%
Microgeneration	0%	N/A
Supplier benefits		
Avoided site visits	100%	100%
Inbound enquiries	80%	80%
Customer service overheads	80%	80%
Debt management	20%	20%
Switching savings[70]	£0.8	£0.8
Theft	N/A	N/A
Remote switching and disconnection	0%	0%
Avoided losses	0%	0%
Network benefits		
Outage management benefits	0%	0%
Better informed investment decisions	0%	0%
Avoided cost of investigating voltage complaints	0%	0%
Benefits from load shifting		
Generation short run marginal cost savings from electricity demand shift	0%	0%
Avoided network capacity as a results of load shifting	30%	N/A

Some stakeholders have suggested that some advanced meter types can deliver a larger share of benefits than those assumed in the table above. Sensitivity analysis was conducted in scenarios where advanced meters are assumed to deliver a larger share of benefits, and these did not result in significant variations on the overall NPV.

4.3.1 Use of the DCC

Government has recently consulted on the plan to remove the option of allowing suppliers of non-domestic premises to opt-out of using the DCC (known as the DCC opt-out)[71]. With this in mind, we have made a holding assumption that the DCC opt-out will be removed and that under this mandatory approach all non-domestic smart meters will use the DCC.

[70] We assume that advanced meters would realise a flat supplier switching benefit of £0.8 per meter, which is in line with the switching benefits realised by smart meters before the DCC is established.
[71] DECC, *Further consultation on non-domestic smart metering: the DCC opt-out,* April 2016
https://www.gov.uk/government/consultations/further-consultation-on-non-domestic-smart-metering-the-dcc-opt-out

4.4 Counterfactual

A separate counterfactual case has been constructed for the non-domestic sector. This assumes no Government intervention in profile classes 3 and 4 for electricity meters and non-domestic gas meters with consumption below 732MWh/year. The counterfactual establishes the business as usual world against which the smart meter roll-out is assessed.

By determining the roll-out that would have occurred had there been no policy intervention the analysis can ensure that only incremental costs and benefits are considered.

The non-domestic counterfactual includes:

- The costs of the continued installation of traditional meters; and
- The costs and benefits from a limited roll-out of smart/advanced meters where a positive business case exists[72].

4.4.1 Advanced meters vs. smart meters

The counterfactual case assumes as in the 2014 IA that without Government intervention market participants will only install smart/advanced meters where a positive business case exists for one or more parties. We assume that this would be 50% of the market by 2030.

We assume that meter competition and choice will exist – in the model we assume that the meter take-up will be:

- Advanced meters: 40% (or 20% of total non-domestic meters) by 2030;
- Smart meters: 40% (or 20% of total non-domestic meters) by 2030; and
- Retrofit advanced: 20% (or 10% of total non-domestic meters) by 2030[73].

4.4.2 Benefits from using the DCC

As set out in section 1.4.2.5 of this document, some of the benefits identified as arising from the roll-out of smart meters are fully or to an extent dependent on the use of the DCC. Since we assume that in the counterfactual there is no DCC, we have removed all benefits in associated with using the DCC.

- In the absence of the DCC, smart meters would only realise those switching benefits that the analysis has identified to be realisable in the pre-DCC situation for the domestic sector: £0.8 per smart meter per year.
- Amongst the benefits to networks, we assume that only the savings from reduced investigations of voltage complaints could be realised for smart meters in the counterfactual. We assume that network operators would be able to access the voltage information monitored by the smart meter even if no connection to the DCC was established.

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[72] This includes limited energy savings in those non-domestic premises where an advanced/smart meter is installed.
[73] A Retrofit Advanced Meter is an ancillary device attached to a traditional meter to generate the functionality of an Advanced Meter.

4.4.3 Energy consumption in the counterfactual

For the non-domestic counterfactual the analysis uses the energy consumption baseline described above in section 4.2.2, hence assuming stable levels of energy consumption per non-domestic meter over the whole appraisal period.

4.5 Costs of smart metering

We classify the costs associated with the smart meters roll-out in the following categories: meter costs; communications equipment in the premise; installation costs; operating and maintenance costs; costs for the provision of consumption feedback; supplier and industry IT costs; DCC and related bodies' capital and operational expenditure; energy costs from smart metering equipment in the premises; meter reading costs; disposal costs; legal and organisational costs and cost associated with consumer engagement activity.

As for the domestic sector analysis and in line with the design of the end-to-end solution and technical specifications, a HAN is assumed to link different equipment components within the premises and a WAN is also assumed to provide the communications link to the DCC. Suppliers must provide consumption data to consumers and they may do this through a variety of means: web portals, stand-alone consumer access devices (i.e. IHDs for businesses) or other Consumer Access Devices (CADs). While there is not an obligation on suppliers to provide an IHD in the non-domestic market, the cost benefit analysis assumes costs at the equivalent level to an IHD for the provision of consumption feedback to non-domestic consumers. This approach has been used in the absence of evidence on the costs of different approaches to providing data access and the proportion of suppliers and consumers who would use these approaches. This is a conservative assumption, as alternative approaches that are used can be expected to be less expensive than provision of an IHD.

4.5.1 Meter, communications equipment, installation and consumption feedback costs

The tables below show the capital costs of meter and communications assets used for the analysis. These assumptions include changes introduced to the analysis as discussed in the New Analysis section in Part I of this assessment.

Table 4-3: Costs of equipment / installation in the premise per device / premises (2011 prices)

Component	Asset cost	Installation costs
Advanced meter electric	£120	£136
Advanced meter gas	£120	£136
Retrofit option gas	£120	£68
Smart meter electric	£44	£67
Smart meter gas	£57	£67
Provision of consumption feedback	£15	-
Communications equipment	£29	N/A

Note: As for the domestic sector, we assume a dual fuel installation efficiency saving of £27. This reflects cost savings from installing two meters in a single visit to a customer's premise.

Smart meters

The cost assumptions for smart meter asset costs have remained unchanged since the 2014 IA. However, as described in the New Analysis section in Part I of this assessment, the optimism bias applied to meter assets has been reduced from 15% to 5%. This is based on evidence collected from energy suppliers that suggests meter asset costs will be at or below the 2014 IA cost assumptions.

Advanced meter

The assumptions on asset costs of advanced meters have been updated in response to new evidence provided by delivery partners. The assumed costs for advanced gas and electricity meters have reduced from £247 to £120.

Retrofit advanced

This option means that the dumb meter is not replaced, but is read remotely by a device such as a pulse-reader that is retrofitted to the meter, resulting in lower installation costs and avoiding stranding any assets. This approach is most common for gas. It is assumed that the upfront communications equipment costs are part of the meter asset cost and that maintenance is 2.5% of the meter asset cost.

Provision of consumption feedback

In the non-domestic sector consumption data will be provided in a variety of ways. Customers, particularly smaller customers, may ultimately use a stand-alone consumer access device (performing an equivalent function to an IHD), that is connected to the metering system via a HAN. However, many customers will use internet or application based tools to access information, and this approach appears likely to be the main approach taken to smart installations in this sector. For prudency, we have made cost allowances for the provision of consumption feedback to non-domestic consumers at the level of an IHD as alternative approaches are expected to be less expensive.

For the non-domestic cost modelling, we assume only one device per dual fuel customer, as we do for electricity-only customers. For consumers that have different suppliers for electricity and gas, we assume the equivalent cost of two IHDs (since their approaches and the equipment deployed are likely to be incompatible).

Since the modelling is conservative with regards to the provision of two communications hubs in split fuel non-domestic premises and with regards to the cost allowance for the provision of energy consumption feedback no additional allowance for the deployment of 868MHz equipment in non-domestic premises has been made.

The combined present value cost for metering equipment (for smart and advanced meters and traditional meter installations carried out during the roll-out) and the provision of consumption feedback in the non-domestic sector is £153m.

Operating and maintenance (O&M) costs

No further substantive evidence has been brought forward at this point and we have retained previous assumptions for the present analysis. For further details on these assumptions refer to O&M costs in the domestic sector (section 1.3).

Operating and maintenance costs accrue to £31m in present value terms.

Communications equipment

The cost estimates for the provision of communication hubs remain the same as they were in the 2014 IA. The volume weighted average cost of a communications hub across the three CSP regions is around £29. For prudency this is also applied where the provision of an advanced meter is assumed. As described above, no additional allowance has been made for the deployment of 868MHz equipment in non-domestic premises.

Gross present value costs of communications equipment in the non-domestic assessment are £66m.

Installation costs

As described in section 1.3.1 (costs of smart metering for domestic sector), the installation costs have been updated based on information provided by energy suppliers and meter operators.

In present value terms installation costs now equate to £134m over the appraisal period.

Assumptions made with regards to the value of time spent by consumers for smart meter installations and with regards to the development of equipment costs apply in the same way as for the domestic analysis (see section 1.3.1 for further detail).

4.5.2 DCC related costs

Most of the costs that the DCC and other related bodies are expected to face (as described in section 1.3.2) have been fully allocated to the domestic sector, as they are of a nature that doesn't allow a sensible separation into domestic and non-domestic elements (as discussed in section 4.2.1).

The only DCC related cost item where such a distinction is possible is the variable element of the communications service charge for the operation of the communications equipment by the CSPs. This cost element amounts to around £8m for the non-domestic sector in present value terms over the appraisal period.

4.5.3 Suppliers' and other industry participants' system costs

Energy suppliers will have to make investments to upgrade their IT systems so that they are able to take advantage of smart metering. Network operators and energy industry agents are also expected to upgrade their IT systems.

These costs are fully allocated to the domestic sector.

4.5.4 Cost of capital

While not presented as a separate cost item, the costs of assets and installation are assumed to be subject to a private cost of capital, i.e. resources committed to assets and installation have an opportunity cost. For further detail concerning the assumptions on the cost of capital refer to section 1.3.4.

4.5.5 Energy cost

We assume that a smart meter system (meter, communications equipment and means to provide consumption feedback) would consume 2.6W more energy than current metering systems. These assumptions are unchanged from the 2014IA.

The total present value of energy costs over the appraisal period is £29m.

4.5.6 Increased costs of manually reading remaining traditional meters

The smart meter cost-benefit analysis captures an inefficiency effect of having to manually read a decreasing number of traditional meters as the roll-out of smart meters progresses. The assumptions underlying these costs have not been changed for this assessment.

However, for the non-domestic counterfactual we assume a partial roll-out of smart/advanced meters in the absence of a Government mandate, resulting in pavement reading efficiencies in the counterfactual. The profile according to which pavement reading inefficiency costs are incurred in the smart meter policy roll-out is different to the counterfactual, resulting in a marginal net cost of £3m overall.

4.5.7 Disposal costs

There is a cost from having to dispose of meters as they reach the end of their lifetime, including the costs of disposing of mercury from basic gas meters. Refer to the domestic evidence base (section 1.3.7) for further detail. The present value costs for the non-domestic sector amount to £2m.

4.5.8 Legal and organisational costs

These costs are fully allocated to the domestic sector.

4.5.9 Costs associated with consumer engagement activities

While Smart Energy GB has a remit to also engage microbusinesses as energy consumers, it is not meaningful to split their budget in terms of activities aimed at domestic consumers and those aimed at non-domestic customers. All marketing costs are therefore allocated to the domestic sector analysis.

4.5.10 Cost arising from uncertainty during early deployment

Smart meters will be installed in two stages: the Foundation Stage and main installation stage. The Foundation Stage started in April 2011 and is due to end with the start of the main installation stage in late 2016. The Government expects a significant number of meters to be installed during the Foundation Stage. For the non-domestic sector, these installations are expected to be heavily weighted towards Advanced Meters rather than SMETS1 meters.

There are a number of benefits from early roll-out activity and counting foundation meters towards suppliers' roll-out obligations. These are the same for both the domestic and non-domestic sector. For further detail, refer to domestic evidence base (section 1.3.10).

Alongside these benefits, three areas of potential risk have been identified for non-domestic smart meters installed during Foundation: risks to interoperability, risks because of functionality differences, and risks around DCC adoption and enrolment. These are detailed in the domestic evidence base in section 1.3.10. In most cases, the same risks exist for SMETS1 in the non-domestic sector and we have addressed them in the same way as described for the domestic sector. However, for the domestic analysis an additional risk uplift of 15% is applied to IHD and communications hub costs, to reflect the risk that suppliers may have to install two communications hubs and IHDs for split fuel households. For the non-domestic sector, the analysis already assumes that split fuel premises will need two sets of communications and consumption feedback equipment, so no further uplifts are applied.

4.6 Benefits of smart metering

We classify benefits in three broad categories: consumers, businesses (energy suppliers, network-related and peak load shifting) and carbon and air quality. To the extent that businesses operate in a competitive market – in the case of energy suppliers – or under a regulated environment – in the case of networks – benefits or cost savings are expected to be passed down to end energy users i.e. consumers. For example, avoided meter reads are a direct, first order, cost saving to energy suppliers. As energy suppliers operate in a competitive environment, we expect these to be passed on to consumers.

For the non-domestic assessment, it is important to note that the consumer category in this case captures businesses as customers of the energy industry.

4.6.1 Consumer benefits

In the context of the non-domestic analysis we refer to consumers as non-domestic entities that purchase energy from energy suppliers. A range of consumer benefits is expected, including those around improved customer satisfaction and financial management benefits, which have so far not been quantified.

Significant benefits from smart meters can be driven by changes in consumers' energy consumption behaviour. Two areas of change in average consumption behaviour may arise:

- A reduction in overall energy consumption as a result of better information on costs and use of energy which drives behavioural change; and
- A shift of energy demand from peak times to off-peak times.

4.6.1.1 Energy demand reduction

We assume that smart / advanced meters, together with provision of data, will reduce energy consumption by between 2.8% (electricity) and 4.5% (gas) per meter in the central case. This is in line with the changes seen in trials carried out by the Carbon

Trust. This controlled trial, published in 2007, involved the installation of advanced metering in 538 SME sites.

We also apply sensitivity analysis to these benefits as follows:

- In the higher benefits scenario: 4% for electricity, 5.5% for gas; and
- In the lower benefits scenario: 1.5% for electricity, 3.5% for gas.

Energy is valued consistently with guidance produced by BEIS[74]. Expected energy savings are applied to the tailored non-domestic energy baseline as described in section 4.2.2 above.

The total value of this benefit over the appraisal period amounts to £1,438m in present value terms.

4.6.1.2 Microgeneration

Smart meters can be used to deliver export information, reducing the need to install an export meter for microgeneration devices. To estimate the size of this benefit, an estimate of the number of microgeneration devices that will be in use by 2020 has been multiplied by the expected cost savings from not having to install a second meter. These cost savings have been spread over the smart meter population as of the end of 2020 to provide a savings per annum per meter of £0.70 The modelling assumes no increase in microgeneration deployment post 2020 and is therefore a conservative estimate of the savings.

The total value of this benefit over the appraisal period amounts to £8m in present value terms.

4.6.2 Supplier benefits

The following sets out the range of benefits and cost savings the energy supply industry is expected to realise. Discussions with energy suppliers have validated at an aggregate level across the industry that the supplier benefit assumptions, are valid and achievable. Individual suppliers may however have different commercial positions.

4.6.2.1 Avoided site visits

Currently energy suppliers have to visit their customers' premises for a number of reasons, namely to take meter reads and carry out safety inspections. The roll-out of smart meters will result in avoided costs for the requirement to carry out such visits. The underlying assumptions behind these costs are the same for both the domestic and non-domestic sector. For further information, refer to the domestic evidence base (section 1.4.2.1).

The avoided site visits account for £130m present value benefits over the appraisal period.

[74] https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

4.6.2.2 Reduction in inbound enquiries and customer service overheads

Smart meters will mean the end of estimated bills and this is expected to result in lower demand on call centres for billing enquiries and complaints. We assume this cost saving to be £2.20 per meter per year in the central scenario (£1.88 for reduced inbound enquiries and £0.32 for reduced customer service overheads). This estimate is in line with the original assumption developed by Mott MacDonald[75], and the benefit has been verified by suppliers at an aggregate level. No new information was gathered for this assessment and our assumption is based on previous supplier estimates that inbound call volumes could fall by around 30% producing a 20% saving in call centre overheads.

In total gross benefits of £51m in present value terms are expected from reduced call volumes.

4.6.2.3 Prepayment cost to serve

The non-domestic analysis does not assume any prepayment meters in non-domestic premises and therefore does not consider non-domestic benefits from such meters.

4.6.2.4 Debt management

Smart metering can help to avoid debt – both on the consumer and the supplier side – in a number of ways.

For the consumer, information about energy consumption can be communicated alongside cost information, which can help raise awareness of consumption and its costs.

For energy suppliers, more frequent and accurate consumption data for billing purposes will enable suppliers to identify customers at risk of building up debt sooner and will enable them to discuss and agree reactive measures. The supplier might for example provide energy efficiency advice to reduce energy expenditure, or might offer a different payment arrangement or develop with the consumer a debt repayment plan.

Further, bills based on remote meter reads and therefore actual energy consumption will avoid large arrears where customers receive a succession of estimated bills. It will also allow more timely adjustments to direct debits where customers currently pay a fixed monthly / quarterly amount and any over- or underpayments are only settled at the end of the year.

The avoidance of debt (both in terms of the total amount of outstanding charges and the duration for which customers remain indebted) reduces the working capital requirements of suppliers. Since the provision of working capital is not free (it could be utilised elsewhere and therefore carries opportunity costs), reducing the working capital requirements equate to an operational cost saving that suppliers can realise and consequently pass on to consumers.

[75] Mott MacDonald, *Appraisal of costs and benefits of smart meter roll out options*, April 2008.

While there are no precise figures for energy debt in the non-domestic sector it can nonetheless be deduced from the information available that energy debt is an issue. Data collected in 2011 from Consumer Focus[76] indicated that non-domestic disconnections as a result of unpaid debt were on the rise, which results in costs for suppliers and inconvenience for non-domestic customers.

Consistent with the 2014 IA, and based on estimates originally derived by Mott MacDonald and since endorsed by energy suppliers, we estimate per meter savings from better debt management to be £2.2 per year, resulting in a present value benefit of £43m.

4.6.2.5 Switching Savings

The introduction of smart metering will allow a rationalisation of the arrangements for handling the change of supplier process. Trouble shooting teams employed to resolve exceptions or investigate data issues will no longer be needed. Suppliers will be able to take accurate readings on the day of a change of supplier, resolving the need to follow up any readings that do not match and reducing instances of misbilling.

In total present value terms, switching savings generate £67m. For further detail, the assumptions underlying these savings are captured in section 1.4.2.5 in the domestic evidence section.

4.6.2.6 Theft

The approach to benefits from reduced theft differs between the domestic and the non-domestic analysis. All benefits from the reduction in theft are allocated to the domestic sector.

4.6.2.7 Remote disconnection

The meter functionality that is specified in SMETS will enable the remote enablement or disablement of the electricity and/or gas supply. The direct benefits associated with these capabilities are the avoided site visits in instances where an authorised supplier operator is despatched to a customer's premise to disconnect supply.
We continue to assume that a benefit of £0.5 per smart meter per year is realised, which is unchanged from the 2014 IA. This results in a present value benefit of £6m over the appraisal period.

4.6.3 Network-related benefits

Since the publication of the 2014 IA, there have been a number of substantial developments in the evidence base on network benefits. In light of this, in 2015 the Programme commissioned PA Consulting to critically re-assess and update the network benefits assessment.

For further detail, changes to the underlying evidence base and the method used to quantify each benefit can be found in the domestic evidence base (section 1.4.3).

[76] Consumer Focus, *Small business, big price - Depth interviews with disconnected micro-business energy customers*, May 2011.

The following section sets out the revised categorisation of benefits that energy consumers and DNOs are expected to realise.

4.6.3.1 Outage detection and management for electricity DNOs

For more details, see the domestic evidence base. Listed below are the non-domestic values of these benefits:

1. <u>Earlier fault notification</u>

The non-domestic present value gross benefit from earlier fault notification is £2m.

2. <u>Faster restoration of supply</u>

The non-domestic total present value benefit from faster restoration of supply is £2m

3. <u>Reduction in operational costs to fix faults</u>

The non-domestic present value gross benefit from the reduction in fault fixing costs is £2m.

4. <u>Reduction in calls to faults and emergencies lines</u>

The non-domestic present value gross benefit from a reduction in calls is £1m.

4.6.3.2 Better informed investment decisions for electricity network enforcement

One area of difference between the domestic and the non-domestic analysis are benefits from better informed investment decisions, including the benefit of the reduced cost to serve new connections. As these are realised across the whole electricity network infrastructure, the decision has been taken to allocate them to the domestic side of the analysis only, to reflect that the full picture of investment requirement can only be established under consideration of both domestic and non-domestic demand and to avoid double-counting.

4.6.3.3 Avoided cost of investigation of customer complaints about voltage quality of supply[77]

For more details see the domestic evidence base. The non-domestic present value gross benefit is less than £1m.

4.6.3.4 Avoided losses

We continue to assume that smart meters facilitate some reduction in losses and that the benefits per meter per year will be £0.5 for electricity and £0.1 to £0.2 for gas. This represents an initial assessment of the range of possible benefits by Mott MacDonald. BEIS recognises that benefits from reduced losses, similar to the benefits to customers included in this section, do not constitute a direct monetary saving to Network Operators. However, our classification of benefits is based on where in the energy supply chain the benefits arise. In practice, the benefits from

[77] While the benefit of better informed investment decisions is subject to the same assumption of critical mass, the argument can be made that the avoided costs for investigating voltage complaints is not dependent on a critical mass and will be realised for the proportion of premises where a smart meter has been installed. For modelling purposes we have therefore translated the identified benefits from voltage investigation into per meter benefits and linked them to the roll-out profile. This assumes that each site within the system has the same probability of experiencing voltage issues and the same probability of having received a smart meter.

avoided losses would fall to energy suppliers and would be expected to be passed on to customers given suppliers operate in a competitive energy market.

The total present value gross benefits from avoided losses are £83m.

4.6.3.5 Non-quantified DNO benefits

For more details on benefits which have not been quantified at this point in time see the domestic evidence base.

4.6.4 Benefits from electricity load shifting

Smart meters make time-varying and other sophisticated type of tariffs possible by recording the time when electricity is used, and/allowing two-way communications. Such tariffs can incentivise demand-side response (DSR) or load shifting[78], which can potentially bring significant benefits to the electricity system.

For further detail, see the domestic evidence base (section 1.4.4). We model the main types of tariff that can incentivise load shifting in the same way as domestic.

We derive the potential load shifting for non-domestic in the same way as domestic, by assessing (1) the level of uptake of STOU tariffs up to 2030, (2) the potential discretionary load, and (3) the number of times load will actually be shifted. Steps (1) and (3) are modelled in the same way as for domestic. Step (2), modelling the potential discretionary load is modelled slightly differently for non-domestic:

In the non-domestic sector, electricity demand from lighting, catering and computing are typically not flexible, while electricity demand from hot water, heating, cooling, ventilation and some other small loads such as refrigeration and cold storage, can provide flexibility. While not fully matching the definition of non-domestic premises for purposes of the smart meter roll-out, BEIS statistical data provides the breakdown of energy consumption for the service sector (DUKES, 2011). This data shows that 25% of total electricity consumption in the service sector comes from heating, cooling and ventilation. Including heating, hot water, and other uses, the share increases to 40%, however, not all of this can be considered as fully flexible.
Over time, the introduction of, for example, smart appliances, heat pumps with storage capacity and more widespread charging of electric vehicles is likely to increase the total amount of load that can be shifted in the future. EA Technology[79] estimates bottom up SME discretionary load to be around 21%, based on heating and cooling demands. Ofgem (2012)[80] also estimates a significant potential for load shifting in the non-domestic sector.

Because EVs, heat pumps, and smart appliances take up is likely to be driven by future policies, in our central scenario we assume an increase in take up and discretionary load (up to 30% by 2030 from 20% initially) in order to accommodate for example the expected growth in number of electric cars (DfT, 2008[81]) and heat pumps.

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[78] We here refer equally to DSR and load shifting.
[79] In 2009 EA Technology produced a report within the context of task 19 of the International Energy Agency Energy Demand Side Management Programme and made the findings of this report available to DECC.
[80] https://www.ofgem.gov.uk/ofgem-publications/57014/demand-side-response-non-domestic-sector.pdf
[81] BERR & DfT, *Investigation into the Scope for the Transport Sector to switch to Electric Vehicles and Plug-in Hybrid Vehicles*, *2008*.

The methodology employed for the valuation of benefits from load shifting has not been changed. We consider benefits from load shifting for non-domestic in the same four areas for non-domestic as domestic:

4.6.4.1 Generation short run marginal cost savings from electricity demand shift

The non-domestic present value gross benefits of short run marginal cost savings are £23m for the non-domestic sector.

4.6.4.2 Generation capacity investment savings from electricity demand shift

The non-domestic present value benefits of this are £22m.

4.6.4.3 Network capacity investment savings from electricity demand shift

The non-domestic present value benefits are £1m.

4.6.4.4 Carbon savings from electricity demand shift

The non-domestic present value benefit is £17m.

4.6.5 Carbon related and UK-wide benefits

4.6.5.1 Valuing avoided costs of carbon from energy savings

We have valued the avoided costs of carbon from energy savings in line with Government guidance. We also test whether the UK is introducing a cost-effective policy to reduce carbon emissions through the roll-out of smart meters, which is discussed in some more detail in the Carbon Test (section 8.3).

For electricity, reductions in energy use will mean the UK purchasing fewer (or selling more) allowances from the current EU ETS. In our analysis it accounts for Present Value (PV) of approximately £41m.

For gas, the value of carbon savings from a reduction in gas consumption uses the non-traded carbon prices under the Government's carbon valuation methodology. Carbon emission savings from gas are valued at PV £414m.

4.6.5.2 Reduction in carbon emissions

Over the period covered in this cost-benefit analysis, we assume that as a result of a reduction in energy consumption, CO_2 emissions reductions will be realised in both the traded and non-traded sectors[82]. The table below presents the CO_2 emissions associated with the energy savings in the central scenario across options.

[82] Note that the impact of a tonne of CO_2 abated in the traded (electricity) sector has a different impact to a tonne of CO2 abated in the non-traded (gas) sector. Traded sector emissions reductions lead to a reduction in UK territorial greenhouse gas emissions, but do not constitute an overall net reduction in global emissions since the emissions will be transferred elsewhere to member countries in the EU-ETS. The UK gains a cost saving from buying fewer emissions allowances, but these allowances will be bought up by other member states – the total size of the EU-wide 'cap' on emissions does not change during each phase of the EU-ETS. Non-traded sector emissions reductions will reduce both UK and global emissions.

Table 4-4: Reductions in CO_2 emissions

EU ETS permits savings (Millions of tonnes of CO_2 saved equivalent) – traded sector	Millions of tonnes of CO_2 saved – non-traded	Avoided cost of carbon from electricity savings (£bn, PV)	Avoided cost of carbon from gas savings (£bn, PV)
2.21	8.05	0.04	0.41

4.6.5.3 Air quality benefits

In line with guidance from the Department for Environment, Food and Rural Affairs' (Defra) Inter-departmental Group on Cost and Benefits of Air Quality[83] a benefit reflecting air quality improvements from reduced emission of pollutants as a result of energy savings is estimated. Air quality improvements are estimated to deliver benefits of £28m in present value terms.

4.6.6 Non-quantified benefits

See section 1.4.7 in the domestic evidence base for a discussion of the non-quantified benefits. These do not differ for the non-domestic sector.

[83] Defra, *Air quality appraisal-damage cost methodology,* February 2011.

5 Non-Domestic Results

5.1 Costs, benefits and NPV

The results below are produced by running a cost benefit estimation model using the assumptions outlined above. Within the model, the upfront costs are annuitised over either the lifetime of the asset or over the period 2013-2030. The cost numbers are risk-adjusted, i.e. they have been adjusted for optimism bias where appropriate (see section 5.3.1 on risk). We have applied sensitivity analysis to benefits and we present benefits in terms of low, central and high scenarios (see section 5.3.2). Table 5-5 shows the impact of smart meters on energy bills of non-domestic customers. This builds on existing BEIS modelling on energy prices to estimate the impact on non-domestic energy bills in cash terms of the deployment of smart meters.

The present value base year of the analysis is 2016. Cost and benefit information is reflected in 2011 real prices.

Table 5-1: Total costs and benefits

Total Costs £bn	**Total Benefits £bn**	**Net Present Value £bn**
0.43	2.38	1.95

Table 5-2: Consumer and supplier benefits

Consumer Benefits £bn	**Business Benefits £bn**	**Carbon & Air Quality Benefits £bn**	**Total Benefits £bn**
1.45	0.43	0.50	2.38

Table 5-3: Low, central, and high estimates

Total Costs £bn	**Total Benefits £bn**			**Net Present Value £bn**		
	Low	**Central**	High	Low	**Central**	High
0.43	1.67	2.38	3.08	1.24	1.95	2.66

Table 5-4: Benefits

Consumer Benefits £bn			**Business Benefits £bn**			**Carbon & Air Quality Benefits £bn**		
L	**C**	H	L	**C**	H	L	**C**	H
0.91	1.45	1.96	0.39	0.43	0.49	0.37	0.50	0.64

The benefit-cost ratio, which is a good indicator of the cost-effectiveness of the policy, has a value of 5.6 in the central scenario, with a value of 7.2 in the high scenario and of 3.9 in the low case scenario.

5.2 Cost impacts on different stakeholder groups

5.2.1 Impacts of smart/advanced meters on non-domestic energy bills

We expect any costs to energy suppliers to be recovered through higher energy prices, although any benefits to suppliers and networks will also be passed on to consumers[84]. The results below show the average impact on GB non-domestic dual fuel energy bills. It is expected there will be variation between non-domestic premises depending on the level of energy they save and on how different suppliers decide to pass through the costs.

The results show long term reductions in energy bills for customers. By 2020, we expect savings on energy bills for the average non-domestic dual fuel costumer of around £128 per annum and £147 per annum by 2030. In the short term, transitional costs from the roll-out will be passed on to consumers, and energy savings will only be realised by those consumers who have already received a smart or advanced meter.

Table 5-5 shows the incremental bill impact generated from smart and advanced meters that would not have been installed without a mandate.

Revised fossil fuel and energy price projections have had a material effect on the monetary value of energy consumption savings generated by smart meters in the non-domestic sector compared to the 2014 IA. In light of significantly lower energy price projections the projected bill reductions from smart metering have reduced in value.

Between 2020 and 2025 savings to non-domestic consumers increase in value. From 2025 onwards bill impacts are estimated to reduce as in the counterfactual the deployment of smart and advanced meters is assumed to increase gradually in the period to 2030. The bill savings from that counterfactual deployment would have been realised anyway and are therefore deducted from the bill reductions presented here.

Table 5-5: Impact on average non-domestic energy bills for a dual fuel customer (£, real 2012)

	Non-domestic dual fuel bill impact, £
2020	-128
2025	-157
2030	-147

Even without taking the impact of energy consumption savings into account, the rollout of smart meters and the operational efficiencies facilitated within the energy industry result in a reduction of energy costs over time. This effect is reflected Table 2-6 below. A small price increasing impact per unit of energy is expected during the main installation phase (although energy consumption savings will help offset the impacts on bills). After the main installation phase is complete, cost savings to the energy industry arising from the roll-out are expected to outweigh total costs, resulting in the price impact becoming negative from 2022.

[84] For this analysis we have assumed that suppliers and networks pass 100% of the costs and benefits on to consumers due to the pressures of the competitive market and the regulatory regime respectively.

Table 5-6: Price impacts on non-domestic energy bills – all smart and advanced meters (£, real 2012)

	Electricity	Gas
Year	price impact (£/MWh) (Inc VAT)	price impact (£/MWh) (Inc VAT)
2020	+0.14	+0.05
2025	-0.09	-0.03
2030	-0.34	-0.13

As for the calculation of bill impact projections in the domestic sector, the analysis excludes stranding costs from this calculation.

The approach of considering that costs and cost savings to other agents in the energy market are fully passed down to consumers has not changed. The analysis assumes all costs and cost savings are passed on to customers given competitive pressures or regulated outcomes (where parts of the energy industry don't operate under competitive markets).

It is important to note that there may be further impacts on consumer bills for those customers who take advantage of peak/off-peak price differentials offered by smart tariffs and take up time of use tariffs. These distributional impacts have not been included in the calculation above.

5.2.2 Stranding costs

The roll-out of smart meters will bring forward the replacement of some traditional meters if they are replaced before they reach the end of their useful life. This will either result in a termination charge at the point of asset removal or, in the worst case, the continuation of asset charges as if the meter continued to be in place.

While this may mean the costs for an investment that was made continue to be incurred without delivering benefits, these costs would not be additional for any 'legacy' traditional meter that was installed before the start of the Foundation Stage of the roll-out. This is because these costs would have been sunk and irrevocable as of the start of the Foundation Stage, and would be incurred in both the roll-out option and counterfactual. Any stranding costs associated with these meters have therefore been excluded from this assessment. This approach is in line with guidance set out in the HMT Green Book.

For traditional meters that are installed during the smart meter roll-out because there is no smart meter variant available that would work in the property at the time, we adopt a different approach. For these meters, we include the full cost of the traditional meter replacement over its assumed useful life (10 years for prepayment meters, 20 years for credit meters). That is, we continue to capture the costs of these traditional meters after they have been replaced by a smart meter later on in the roll-out period. The stranding costs associated with these traditional meters have been captured in the total installation and asset costs of the smart meter roll-out (see section 4.5.1).

5.2.3 Better regulation and the net impact to businesses (EANCB – Equivalent Annual Net Cost to Business)

<u>One-in, One-out</u>
Since this assessment is an update of previous analysis and reflects the latest evidence base for an agreed policy there is no new impact for the regulatory budget framework. The value and treatment of the EANCB figure as presented in the 2014 IA continues to apply.

<u>Administrative burden</u>
We have identified no significant additional administrative burdens to business from the smart meter policy. Notifying customers of planned visits to install or remove a meter is considered good business practice and helps in ensuring access to the premise, so cannot be seen as a burden to business arising from the roll-out. Following the submission of detailed evidence from energy suppliers this methodological approach was agreed with the Better Regulation Executive (BRE). The smart meters roll-out will bring forward the replacement of metering equipment and as such notifications to customers of such planned visits. Such potential effect remains unquantified in this assessment.

A small administrative burden from having to submit data for monitoring and evaluation purposes has been identified. This amounts to £1m between now and 2020 and is further detailed in section 1.3.8.

<u>Sun-setting or statutory review clauses</u>
We have considered the case for sun-setting of the regulatory interventions required for smart metering. These interventions are intended to set out an enduring framework for the effective provision and operation of smart metering and, as such, are not candidates for sun-set clauses. In particular interoperability of equipment deployed by different suppliers cannot be expected to become business as usual at any point in the future and therefore sun-setting is not appropriate. BEIS will keep all smart meter regulation under review as policy is developed further – as stated in section 7.2, the Programme is committed to a comprehensive review and evaluation process, both during the initial Foundation Stage as well as towards the end of the main roll-out.

5.3 <u>Risks</u>

5.3.1 Costs: Risk Mitigation and Optimism Bias

The roll-out of smart meters is a major procurement and delivery exercise. The project spans several years and presents a major challenge in both technical and logistical terms.

There is a consensus that stakeholders do not explicitly make allowances for optimism bias in the estimates they provide for procurement exercises. By calling for pre-tender quotes for various pieces of equipment, suppliers are revealing the likely costs of the elements of smart metering and hence no further adjustment is necessary. However, historically, major infrastructure and IT contracts have often been affected by over–optimism and gone substantially over-budget, so we have adjusted the estimates for optimism bias, in line with guidance from HMT's Green Book.

After the publication of the April 2008 IA, it was acknowledged that more work was needed regarding the treatment of risk to the costs of a GB-wide smart meter roll-out. Baringa Partners[85] were commissioned to consider these issues, in particular to provide:

[85] Baringa Partners, *'Smart Meter Roll Out: Risk and Optimism Bias Project'*, 2009.

- Assessment of the international and domestic evidence available;
- Development of a risk matrix based on the identification of key risks, their potential impacts and mitigation actions;
- Assessment of the sensitivity of these risks to market model and duration of the roll-out;
- Assessment of the treatment of risk in the April 2008 IA; and
- Make recommendations, in light of the above.

This resulted in a revised approach to optimism bias which was first reflected in the May 2009 IA.

As per HM Treasury guidelines the application of adjustments for optimism bias and risk allowances should be reviewed as certainty increases and substantiating evidence is identified. Some recent key points in the case of smart metering were the award of the contracts and the DCC licence in September 2013, and the increasing certainty around costs as the programme moves closer to the start of its main installation stage in 2016 and operational data from installations to date starts accumulating. We have therefore undertaken to review the treatment of risk and the application of optimism bias factors in areas where the award of the contracts or real-world operational date increase significantly the certainty on the costs (and benefits) of the solution.

Table 7-7 reflects the updated optimism bias factors applied in this assessment:

Table 7-7: Optimism bias factors

	Optimism bias factor
Cost for providing consumption feedback	5%
Meters	5%
Installations	5%
Energy industry IT CAPEX	10%
Energy industry IT OPEX	10%

Cost uplift factors are also applied to meters deployed early during the Foundation Stage. These factors are presented in section 4.5.10.

More detail on optimism bias and how it is applied can be found on the Treasury website in the Green Book guidance[86].

Overall, the total cost that is added to the appraisal (across the domestic and non-domestic sector cost benefit analysis) as a result of the application of optimism bias and other cost uplifts in this assessment is still significant, amounting to around £1bn. The main areas

[86] https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent

where optimism bias and uplift factors remain include installation, metering equipment, treatment of costs in Foundation and additional roll-out costs with high peak installation rates.

5.3.2 Benefits: sensitivity analysis

Sensitivity analysis has been applied to the main elements of the benefits. We apply the following sensitivities to the benefit assumptions:

Table 7-8: Sensitivity analysis for benefits

	Low benefits	Central benefits	High benefits
Consumer benefits			
Energy consumption savings electricity	1.5%	2.8%	4.0%
Energy consumption savings gas	3.5%	4.5%	5.5%
Business benefits			
Supplier benefits			
Avoided site visit	underlying visit cost + 8%	underlying visit cost	underlying visit cost -8%
Call centre savings	£1.9	£2.2	£2.5
Network benefits			
Faster Restoration of Supply	3%	5%	10%
Reduced cost to serve new connections	3%	5%	10%
Avoided investigation of voltage complaints	£217	£434	£648
Reduced outage notification calls	5%	10%	15%
Time of Use benefits			
Uptake of STOU in 2020	10%	20%	40%

It is worth noting that the energy savings affect the total cost for each option due to the energy use by the devices, but the effect is minimal. Table 7-9 presents the results of applying the sensitivity ranges presented in Table 7-8 to each specific benefit assumption.

Table 7-9: PV of individual benefit items after sensitivity analysis

£m	Low benefits	Central benefits	High benefits
Consumer benefits			
Energy consumption savings electricity	357	729	1,073
Energy consumption savings gas	542	708	875
Business benefits			
Supplier benefits			
Avoided site visit	119	130	141
Call centre savings	45	51	57
Network benefits			
Reduction in customer minutes lost	1	2	3
Operational savings from fault fixing	2	2	2
Avoided investigation of voltage complaints	<0.5	<0.5	1
Reduced outage notification calls	1	1	2
Time of Use benefits			
Uptake of STOU in 2020	27	46	83

6 Non-Domestic sector detailed results

Table 6-1: Non-domestic sector detailed results from the model (in £million) for the central case scenario
Over period 2013-2030, in 2011 prices, with a present value base year of 2016
Totals may not sum due to rounding

Total Costs		**426**		**Total Benefits**		**2,378**
In premise costs		384		**Consumer benefits**		1,446
	Meters & IHDs	153			Energy saving	1,438
	Installation of meters	134			Microgeneration	8
	Operation and maintanance of meters	31		**Business benefits**		
	Communications equipment in premise	66			Supplier benefits	296
DCC related costs		8			Avoided site visits	130
	DCC licence	-			Inbound enquiries	43
	Data services	-			Customer service overheads	7
	Communication services	8			Debt handling	43
	Other service providers	-			Avoided PPM COS premium	-
Suppliers' and other participants' system costs		-			Remote (dis)connection	6
	Supplier capex	-			Reduced theft	-
	Supplier opex	-			Customer switching	67
	Industry capex	-			Network related benefits	91
	Industry opex	-			Earlier fault notification/detection	2
Other costs		34			Faster restoration of supply	2
	Energy	29			Operational savings from fault fixing	2
	Disposal	2			Reduced calls to emergency and fault lines	1
	Pavement reading inefficiency	3			Better informed enforcement investment decisions	-
	Organisational	-			Reduced cost to serve new connections	-
	Marketing	-			Avoided investigation of voltage complaints	0
NPV		***1,952***			Reduced losses	83
					Avoided investment from ToU (distribution/transmission	1
					Generation benefits	44
					Short run marginal cost savings from ToU	23
					Avoided investment from ToU (generation)	22
				Carbon and air quality benefits		500
					Global CO2 reduction	414
					EU ETS from energy reduction	41
					EU ETS from ToU	17
					Air Quality	28

Section C: General Information

7 General information

7.1 Enforcement

The policy outlined in this assessment will be implemented via regulation, for example licence obligations. New licence requirements are enforced in the same manner as existing licence obligations – by Ofgem as the gas and electricity markets regulator. Ofgem has the power to investigate any licensed energy company which it has reason to believe may be breaching the conditions of their licence (including any consumer protection provisions) or acting anti-competitively, and has powers of enforcement. The Competition and Markets Authority also has a range of other enforcement powers in respect of consumer protection.

In addition, a new cross-industry Code is in place to define obligations, roles and responsibilities of different parties involved in the smart metering arrangements - the Smart Energy Code (SEC). The SEC is a multi-lateral contract, and parties to the SEC have the right to take enforcement action against other parties if they do not meet their obligations under it. The SEC also contains dispute resolution arrangements, for example on which matters Parties can seek arbitration and which matters are referred to Ofgem for determination. The SEC Panel also plays a role in dispute resolution and enforcement.

7.2 Monitoring and Evaluation

The Government published its Smart Meters Programme Strategy and Consultation on Information Requirements for Monitoring and Evaluation in May 2012. This set out its plans for monitoring and evaluation both during Foundation and main installation stages, and identified relevant data requirements. Where these data requirements entail placing new obligations on suppliers or network operators, the Government has consulted on draft licence conditions. This section gives a high-level overview of our approach. The Government's response to the consultation as well as final licence conditions were published in December 2012[87]. See also section 7.3 on plans for a Post Implementation Review (PIR).

The Programme will collect monitoring and other information in order to:

- Ensure that sufficient evidence about consumer impacts and the effectiveness of different approaches to consumer engagement is available, to inform the on-going development of the approach to consumer engagement;
- Monitor the capability and readiness of industry participants to meet their roll-out obligations;
- Track progress towards completion;
- Report on the full range of costs and benefits attributable to smart metering and inform actions to optimise benefits realisation;
- Identify any additional benefits that may accrue to the Programme as the roll out progresses and consider quantification of those benefits.

It is intended that a range of types of information and data will be required, including:

- Data about smart meter installations, collected by suppliers and reported quarterly;
- Annual reports from suppliers on plans for roll-out and progress to date;

[87] DECC, Smart Meter Programme: Government response to consultation on information requirements for monitoring and evaluation, 2012, available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/43136/7206-gov-resp-cons-sm-monitor-evaluation.pdf

- Data relating to costs and benefits attributable to the Programme collected from suppliers (and potentially in future the DCC);
- Other smart meter-related data collected by the Programme, including customer surveys and linking to other Government datasets;
- Wider data sources e.g. as collected by Ofgem and Smart Energy GB, to inform BEIS's monitoring and evaluation.

We have consulted on proposals for collecting data in the first three categories using information-gathering powers in Section 88 of the 2011 Energy Act and the licence conditions to give effect to these have now been published. Results from piloting schemes and trialling are also expected to inform the monitoring and evaluation of the roll-out. This includes both previous pilots such as the EDRP, and piloting and trialling carried out during the Foundation Stage and early roll-out (for example into alternative forms of consumer feedback).

Monitoring and evaluation results will be published by Government as follows:

- An annual progress report will draw together data and information gathered from suppliers and other sources. The most recent Annual Report was published in November 2015[88]. The precise content will build over time.
- Quarterly updates on key metrics.
- Evaluation reports which will provide an initial analysis of progress that has been achieved to date in delivering consumer benefits especially in relation to energy saving, and where further steps are likely to be effective in increasing such benefits. This includes the Early Learning Project in relation to domestic consumers, which was published in April 2015.

7.3 Post Implementation Review (PIR) Plan

Basis of the review: the Government will ensure that the Smart Metering Implementation Programme is subject to a comprehensive and integrated review and evaluation process, both during the initial Foundation Stage and towards the end of the main installation phase. The Secretary of State has powers that have been extended until the end of 2018 for introducing regulatory requirements on suppliers regarding the roll-out of smart meters, and licence conditions on the process for collecting information from suppliers and network operators for monitoring and evaluation purposes were laid in Parliament in December 2012. This process will ensure evidence is available to help the Government maximise the benefits of the Programme and report on outcomes.

A Post Implementation Review will be carried out by the Government once the roll-out has been completed and will take a broad perspective on the results of Government intervention and the results of the approaches taken to policy and benefits realisation, in order to feed back into the policy making process.

Review approach and rationale:

The PIR will include evaluation of the impacts of smart metering on consumers, in particular on the consumer experience and energy consumption, as well as the effectiveness of different approaches in delivering consumer benefits(e.g. ease of switching, availability and uptake of smart-enabled products and services). It will evaluate the impacts on industry

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[88] DECC, *Smart Metering Implementation Programme: Fourth Annual Progress report on the roll-out of Smart Meter*s, November 2015. https://www.gov.uk/government/publications/fourth-annual-report-on-the-roll-out-of-smart-meters

costs and process simplification, on the availability and uptake of energy management products and services. The PIR has yet to be designed but is likely to draw on a range of evidence including evidence collected under the smart meters Monitoring and Evaluation Strategy and Early Learning Project as described in the previous section.

8 Specific Impact Tests

This section sets out the specific impact tests that have been conducted for this cost-benefit analysis. Some of the tests listed in the table below have not changed since the 2014 IA and have for brevity been excluded from the section below. For further details please refer to the 2014 IA[89].

Type of testing undertaken	***Results included in Evidence Base? (Y/N)***	***Results set out in this section? (Y/N)***
1. Competition Assessment	No	Yes
2. Small Firms Impact Test	No	Yes
3. Legal Aid	No	No (see 2014 IA)
4. Sustainable Development	No	No (see 2014 IA)
5. Carbon Assessment	Yes	Yes
6. Other Environment	No	Yes
7. Health	No	Yes
8. Equality IA (race, disability and gender assessments)	No	No (see section 14.9 in the 2014 IA)
9. Human Rights	No	No (see 2014 IA)
10. Privacy and data	No	Yes
11. Rural Proofing	No	Yes

8.1 Competition assessment

Consumers

From a consumer point of view the introduction of smart meters will improve competition in the energy supply markets – in particular because accurate and reliable data flows facilitate faster switching, encouraging consumers to seek out better deals, helping to drive prices down.

In addition, the improved availability (subject to appropriate privacy controls) of more accurate and timely information should create opportunities for energy services companies to enter the domestic and smaller business markets; and for other services to be developed, for example new tariff packages and energy services, including by third party providers. Overall, smart metering should enhance the operation of the competitive market by improving performance and the consumer experience, encouraging suppliers' and others' innovation and consumer participation.

Industry

Great Britain is the geographical market affected by the roll-out of smart meters. The products and services affected will be:

[89] DECC, *Smart Metering Implementation Programme: Smart Meters Impact Assessment, January 2014.* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/276656/smart_meter_roll_out_for_the_domestic_and_small_and_medium_and_non_domestic_sectors.pdf

- Gas and electricity supply;
- Gas and electricity meters;
- Provision of energy services (including information, controls, energy services contracting, demand side response) and smart homes;
- Meter ownership, provision and maintenance;
- Other meter support services;
- Gas and electricity network services; and
- Communications services.

In terms of competition the roll-out would therefore affect:

- Gas and electricity suppliers;
- Gas and electricity networks;
- Meter manufacturers;
- Meter owners, providers, operators and providers of ancillary services;
- Energy services businesses and providers of smart home services; and
- Communications and data businesses.

8.1.1 The competition impact of the DCC

There is an impact on competition through the establishment of the DCC.

The DCC is responsible for managing the procurement and contract management of data and communications services that underpin the smart metering system. All domestic suppliers are obliged to use the DCC. For non-domestic suppliers, the Programme are analysing responses to its recent consultation on the Government's minded-to position to remove the option of allowing suppliers of non-domestic premises to opt-out of using the DCC (known as the DCC opt-out). Should the Government confirm its minded-to position all non-domestic suppliers will also be obliged to use the DCC.

The DCC is a licensed entity, which is granted an exclusive licence, through a competitive tender process for a fixed term. In effect the DCC secures the communications services for a fixed period of time. Ofgem is able to exert direct regulatory control over it to ensure that it applies its charging methodology in line with its licence obligations as well as regulating the quality and service levels delivered by the DCC.

Competition is maximised within the chosen model by re-tendering for services on a periodic basis, but a balance needs to be struck to take account of the length of contract needed to achieve efficiencies.

Centralised communications should lead to improved supplier competition as a result of making switching between suppliers easier. This is because many of the complexities involved in switching will be stripped away, making the process simpler, shorter and more robust, resulting in a faster and more reliable consumer experience and thereby encouraging more consumers to switch.

In late 2015, Ofgem launched a Significant Code Review to radically overhaul switching arrangements in the energy market to enable faster, more reliable switching. As a result of these reforms, customers should be able to request to change energy supplier the next day[90]. Ofgem's current ambition is to introduce this by the end of 2019. As part of this

[90] Ofgem, "Decision on moving to reliable next-day switching", 2015, Available at: https://www.ofgem.gov.uk/sites/default/files/docs/2015/02/fast_and_reliable_switching_decision_final.pdf

programme of work being led by Ofgem, there will be a new centralised registration service (CRS) to provide a long-term, common platform for gas and electricity consumer switching that replaces the various existing systems run by electricity and gas networks (which will need to be decommissioned). The precise scope of the CRS is still to be determined but it will provide the master record of change of supplier events (as well as other functions supporting regulatory requirements e.g. settlement). Ofgem have announced that the DCC will procure and manage the CRS given efficiencies with their smart meter role.

8.1.2 Speed of Roll-out

There is a risk that smaller energy suppliers might be disadvantaged through being unable to obtain equipment and services at the same cost and rate as larger suppliers. This risk is increased in the case of a faster roll-out. Similarly, if resources are scarce for all under a roll-out (i.e. equipment and installers), small suppliers might feel a greater cost impact than larger suppliers due to the relative size of the costs in proportion to the size of the business.

8.2 Small and Micro Business Assessment

The small and micro business assessment is a requirement that is intended to ensure that all new regulatory proposals are designed and implemented to mitigate disproportionate burdens on such businesses.

Smart metering will benefit all end consumers including small businesses, through providing accurate information on energy use. This will give domestic and non-domestic consumers the opportunity to engage with their energy use and make savings on the basis of better information about their consumption. Smart metering will underpin the transition towards a smarter energy system, for example by providing the functionality that supports time of use tariffs, and enabling consumers to access the benefits this can provide them should they wish to.

While smart metering will therefore bring benefits to small- and micro-business consumers, a number of energy suppliers may themselves be categorised as small businesses. We have therefore taken steps to minimise where possible the regulatory burden they face, as discussed below.

8.2.1 Consideration for small suppliers (who may also be small businesses)

Many of the energy supply companies are large companies and in some instances part of multi-national corporations. Establishing electricity or gas supply services involves a minimum size of operations. These are complex businesses, requiring significant back office system investment and customer support operations (e.g. to establish a billing system).

The structure of the energy market has changed significantly over recent years, with the entry and expansion of a number of new small and independent suppliers, some of which may fall below the threshold for small businesses. These suppliers are also expected to make investments to upgrade and connect their IT systems to the DCC. However, costs are expected to be scalable depending on the size of the business, therefore reducing the burden on smaller suppliers (also see section 2.8 of Part I for new assumptions about DCC adaptor service costs depending on supplier size).

In designing the smart meter regulations Government has engaged in extensive consultation with all affected parties, including smaller energy suppliers, to ensure that a broad range of stakeholders' views was taken into account in the policy making and to help ensure proportionality between regulatory burden and benefits. Small suppliers inevitably have fewer resources available to devote to responding to consultations. Nevertheless, small suppliers have contributed views on a wide range of points and these have been taken into account in the regulatory design.

The Government has put in place a range of measures to minimise or mitigate the potential burden on smaller companies. For example, the smart metering roll-out regulations allow for:

- Exemption from the early roll-out obligation: unlike large suppliers, small suppliers are not required to install a de minimis amount of smart meters within 6 months of DCC-Live[91].

- DCC user mandate: There is a specific obligation on large suppliers to become a User by the 16 February 2017, whereas small suppliers have more time before they must become a User (by 17 August 2017)[92].

- Greater flexibility in rolling out advanced meters in the non-domestic sector: Small suppliers may install advanced meters up to August 2017 whereas large supplier can only do so up to April 2017. For both supplier groups advanced meters can be installed until December 2020 if contracts were in place prior to April 2016, ensuring greater flexibility and reducing the regulatory burden.

- Reduced requirements with regards to the provision of monitoring and reporting information by small suppliers. Large suppliers have to provide information on a quarterly basis to the Programme to track the progress towards the completion of the roll-out, whereas small suppliers only have to report annually.

- A cost sharing arrangement for the funding of Smart Energy GB that significantly reduces the cost burden on smaller suppliers[93], while benefitting in full from the consumer awareness campaign to help minimise the roll-out costs for all supply companies.

In addition to the roll-out obligation, the SEC was designated as a new energy industry code in September 2013. Further stages of the Code continue to be introduced in a phased approach to support the DCC starting to offer its services in 2016. The SEC requirements have also been designed with a view to ensuring that the regulatory burden is proportionate to the benefits that can be realised and to minimise the burden on smaller companies. For example, the audits required to provide assurance that DCC users have met security requirements allow for a more streamlined assessment of smaller companies, thereby reducing compliance costs. Further, the code constitutes a contract between DCC users and all code signatories - including small energy suppliers - can propose changes to existing arrangements. Modifications to the Code must be approved by Ofgem and assessed against its general regulatory objectives which include the supervision and development of markets and competition. Supporting this, the SEC governance arrangements make provision for small suppliers and unlicensed businesses to elect members to the main decision making bodies.

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[91] Large suppliers are required to take all reasonable steps to install, commission and enrol 1,500 SMETS 2 meters, or 0.025% of total meter points (whichever is the lower), by 16 February 2017 (i.e. DCC Live plus 6 months).

[92] In the instance where a new supplier enters the market after 17 August 2017 they will instead be required to become a User before they supply to a customer (whether through a smart meter or otherwise).

[93] Small suppliers will only have to contribute to the running costs of Smart Energy GB the Central Delivery Body in accordance with their market share, while the activity costs will be fully borne by the large suppliers.

Lastly, with regard to distribution network operators, at national level Great Britain is divided into 8 gas and 14 electricity distribution areas, which are serviced by just four distinct companies in the case of gas and six companies for electricity[94].

There are also independent gas distribution networks and independent electricity distribution network operators, which can build, own or operate distribution assets in sometimes more limited geographic areas (e.g. housing developments or industrial parks). Given their limited size smart metering obligations currently don't apply to these independent network operators and Government will keep the current arrangements under review.

8.3 Carbon assessment

Following Government guidance[95], we have carried out cost effectiveness analysis of the smart meter roll-out in terms of addressing climate change. The existence of traded (electricity) and non-traded (gas) sources of emissions means that the value of a tonne of CO_2 abated in the traded sector has a different value to a tonne of CO_2 abated in the non-traded sector. Reductions in emissions in the traded sector deliver a benefit in the form of avoided purchase of ETS allowances under the current EU ETS, but do not reduce net greenhouse gases (GHG), whereas reductions in the non-traded sector do reduce net GHG emissions.

Cost effectiveness analysis provides an estimate of the net social cost/benefit per tonne of GHG reduction in the traded sector and/or an estimate of the net social cost/benefit per tonne of GHG reduction in the non-traded sector.

We calculate the cost-effectiveness of traded and non-traded CO_2 separately:

Cost-effectiveness (traded sector) = (NPV – PV traded carbon savings)/tonnes of CO_2 saved in the traded sector

Cost-effectiveness (non-traded sector) = (NPV – PV non-traded carbon savings)/tonnes of CO_2 saved in the non-traded sector

The tables below outline the present value of costs and non- CO_2 benefits as well as the tonnes of CO_2 saved in the traded and non-traded sectors, the corresponding cost effectiveness figures and the traded and non-traded cost comparators (TCC and NTCC) for the domestic and the non-domestic sectors. The Cost Comparators are the weighted average of the discounted traded and non-traded cost of carbon values in the relevant time period. If the cost per tonne of CO_2 saving of the policy (cost-effectiveness) is higher than the TPC/NTPC the policy is not cost-effective.

[94] See https://www.ofgem.gov.uk/network-regulation-riio-model/energy-network-how-it-works-you
[95] DECC, *Valuation of energy use and greenhouse gas (GHG) emissions*, December 2015, available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/483278/Valuation_of_energy_use_and_greenhouse_gas_emissions_for_appraisal.pdf.

Table 8-1: Domestic cost effectiveness

PV costs (£,million)	PV Non-CO_2e benefits (£,million)	EU ETS permits savings (Millions of tonnes of CO_2e)	Millions of tonnes of CO_2e saved – non-traded sector	Traded sector cost comparator (£/CO_2e)	Cost-effectiveness – traded sector (£/CO_2e)	Non-traded sector cost comparator (£/CO_2e)	Cost-effectiveness – non-traded sector (£/CO_2e)
10,555	13,526	7.87	11.72	19.13	-453	43.04	-273

The above table shows how the domestic roll-out is expected to save around 8 million tonnes of CO_2 equivalent in the traded sector and around 12 million tonnes of CO_2e in the non-traded sector over an 18 year period. The cost per tonne of CO_2e abated (cost-effectiveness) is lower than the cost comparator for both the traded and non-traded sector, showing that the smart meter rollout is a cost-effective policy for reducing GHG emissions.

Table 8-2: Non-domestic cost effectiveness

PV costs	PV Non-CO_2benefits (£million)	EU ETS permits savings (Millions of tonnes of CO_2e saved equivalent)	Millions of tonnes of CO_2e saved – non-traded sector	Traded sector cost comparator	Cost-effectiveness – traded sector	Non-traded sector cost comparator	Cost-effectiveness – non-traded sector
426	1,906	2.16	7.94	15.82	-877	44.02	-194

The above table shows how the non-domestic roll-out is expected to save over 2 million of tonnes of CO_2 equivalent in the traded sector and approximately 8 million tonnes of CO_2e in the non-traded sector over an 18 year period. The cost per tonne of CO_2e abated (cost-effectiveness) is lower than the cost comparator for both the traded and non-traded sector, indicating the smart meter roll-out is a cost effective policy for reducing GHG emissions.

8.4 Other Environmental Impacts

The Smart Metering Implementation Programme could have some negative environmental impacts. The first is the costs of traditional meters. Most significant among these would be the cost of disposal of mercury from gas meters, estimated at around £1 per meter. These costs would have to be met under usual meter replacement programmes, but will be accelerated by a mandated roll-out.

The smart metering assets will consume energy. It is assumed that the metering equipment will consume 1 W/h over and above current equipment, a display 0.6 W/h and the communication equipment 1 W/h. These assumptions are unchanged from the 2014 IA. Gas meters would require batteries for transmitting data and some display devices may also use batteries. The batteries will be subject to the Directive on Batteries and Accumulators. Both the costs of energy and disposing traditional meters have been captured as a separate category in the domestic and non-domestic assessment and are therefore captured in our overall cost assessment. Refer to section 1.3.5 and 1.3.7 for further detail.

The Government’s view is that the positive environmental impacts of smart meters clearly outweigh any negative impacts.

8.5 Health

There are a number of positive health impacts from the roll-out of smart meters. In particular, smart meters enable suppliers to target energy efficiency measures more effectively and encourage customers to take up such measures. These measures in turn confer health benefits to individuals – particularly vulnerable individuals – deriving from greater thermal comfort. Smart meters could also, with appropriate privacy arrangements, provide a basis for using tele-care systems or for giving carers access to real-time consumption information.

Many of the benefits of smart metering are underpinned by the ability to access the meter remotely and to provide customers with real time data on their gas and electricity consumption. In the home or premises the system will comprise various elements including a wide area communication module to provide communications to the DCC and a home area system linking devices within the home or premises to the smart metering system (including the IHD).

Smart meters are covered by product safety legislation, which requires manufacturers to ensure that any product placed on the market is safe. The Government recognises that some consumers remain concerned that their health may be affected by radio waves and draws attention to the work by the Health Protection Agency (now Public Health England), showing that the evidence to date suggests exposure to radio waves produced by smart meters does not pose a risk to health[96]. The Agency has committed to keeping the evidence under review.

8.6 Data and Privacy

Smart metering will result in a step change in the amount of data available from electricity and gas meters. This will in principle enable energy consumption to be analysed in more detail (e.g. half-hourly) and to be ‘read’ more frequently by suppliers, subject to consumer consent. It will allow consumers to view their consumption history and compare usage over different periods (e.g. through the IHD or internet applications). We believe it is essential consumers can readily share the information with third parties, should they choose to, for example to seek tailored advice on energy efficiency or to consider which supplier or tariff is best for them.

Energy consumption data for the purposes of the Data Protection Act 1998 is considered to be personal data where it relates to a living individual who can be identified either from those data or from those data in combination with other information in the possession of the organisation/individual e.g. address details.

In order to protect consumers’ privacy, whilst enabling proportionate access to data by authorised parties the government has developed a Data Access and Privacy Framework. The details of the Framework were published in 2012[97] and determine the levels of access that suppliers, network operators and third parties can have to energy consumption data from smart meters. It also establishes the purposes for which data can be collected and the

[96] Further information on the Public Health England’s advice can be found at: https://www.gov.uk/government/publications/smart-meters-radio-waves-and-health/smart-meters-radio-waves-and-health
[97] DECC, *Smart Metering Implementation Programme: Data Access and Privacy,* December 2012.

choices available to consumers. The core principle is that, other when it is required for billing and other regulated duties, consumers will have control over access to their energy consumption data. The provisions of the Data Access and Privacy Framework are enacted through relevant licence conditions and in the Smart Energy Code.

We are committed to continually monitoring use of the Data Access and Privacy Framework and in December 2015[98] we confirmed that a holistic review of the Framework would conclude in 2018.

8.7 Rural proofing

The obligations on energy suppliers to take all reasonable steps to install smart meters for all of their domestic and smaller non-domestic customers by the completion date will apply equally to customers in rural areas as to others. A key criterion for selection of the DCC and the CSPs has been the ability to meet the aspiration of delivering communications to smart meters at all domestic gas and electricity consumer premises regardless of location.

The DCC is incentivised to maximise communications coverage, and the CSPs' contracts include a binding commitment to deliver a minimum of 99.25% connectivity across their territories by the completion date. However, the contracts recognise that there are areas of Great Britain where WAN coverage may not be achieved at reasonable cost by the completion date. This results in difficulties in delivering a fully smart service, which requires two-way communications between the DCC and the meter and a fully operative HAN that enables the customer to access up-to-date information about energy costs.

The areas where WAN coverage is projected to be more difficult to achieve are primarily rural areas, and principally remote and/or mountainous. As technology progresses, it may be possible to achieve WAN coverage above the level in the binding commitment of the CSPs' contract. In these premises, it is expected that suppliers will install smart meters to meet their enduring smart meter obligations and because it is in their commercial interest to do so.

[98] DECC, *Consultation on the timing of the review of the Data Access and Privacy Framework,* December 2015, available at https://www.gov.uk/government/consultations/consultation-on-the-timing-of-the-review-of-the-data-access-and-privacy-framework

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