Smart meter framework CBA

Assessment of BEIS's 2019 smart meter roll-out CBA

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1 Summary

BEIS's CBA of the smart meter roll-out program suggests it has a cost benefit ratio of 1.44 over the appraisal period. Using common benchmarks for appraisal of projects this would put the smart meter rollout in the 'low value for money' category.

Having reviewed BEIS's CBA of the smart meter roll-out we have found a range of issues with the appraisal of the program which suggest the benefits are overstated and not all the costs have been included.

On the benefits there is a lack of quantitative evidence of the size and permanency of the savings; BEIS appear not to have accounted for the costs of enabling technologies, such as IoT, to achieve the demand shifts claimed and while the meters are intended to lower barriers to switching the implementation so far suggests they may have unintended consequences of limiting switching.

On the costs, the assumptions around smart meter cost appear very optimistic relative to the available market data, while the costs of alternative technologies, such as advanced meters, appear to be over-estimated.

In addition we find that the approach to risk has been very aggressive with only a 5% adjustment for optimism bias, an assumption that the rollout will not be delayed further despite being delayed considerably already and no adjustment made for the risks of asset stranding due to the reliance on 2G technology.

When adjusted for, these factors are likely to reduce the benefit-cost ratio further and reduce the value for money of the scheme.

We also identify that BEIS has not conducted a distributional analysis of the net benefits to consumers but provided an aggregate combination of costs and benefits to consumers and producers. Given that consumers are likely to bear a significant proportion of the scheme costs it is important to evidence that they receive high value for money.

The finding that this programme is set to deliver low value for money, at face value, appears counterintuitive.

Relative to traditional metering, smart metering should improve billing timing and accuracy, as well as provide transparency on intensity of domestic and non-domestic consumption. Providing consumers with cost-effective tools to control their energy consumption should lead to more responsiveness to price signals and more efficient resource allocation.

There are several policy design factors that may be limiting the effectiveness of the programme:

- The roll-out is led by suppliers, which complicates the design and rollout coordination of the programme.
- The success of the programme is dependent on consumer engagement which is undermined if the claimed benefits do not materialise; and
- A one-size-fits-all solution is being applied to a heterogenous market, to address a wide range of issues.

There may be ways that BEIS could improve and protect the programme to ensure that consumer benefits are delivered. We would suggest the following.

1. **exploring areas to reduce the programme scope and complexity**. BEIS and Ofgem can limit their interventions and address only the market failures that remain (i.e. those people who want a smart meter and do not have one). Interventions should avoid parts of the metering market that are well served by competition and ensure that the funding of monopoly activities is limited to the licence conditions and permitted activity of operators. For example, Oxera understand that DCC has recently opened a new innovation and testing facility.[1] BEIS and Ofgem should monitor such developments and ensure that regulated revenue is not distorting the adjacent markets.

2. **supporting choice**. The homogenous smart metering solution chosen by BEIS might not suit all consumers, in particular those in the smaller non-domestic sector and domestic consumers who are unlikely to see a benefit. Given that Advanced metering can be cost effective, supports the same policy objectives and addresses a variety of technical issues inherent to SMETS, BEIS should consider allowing discretion in the metering they can offer consumers. In particular, in the non-domestic sector this could accelerate a more efficient roll-out and in the domestic sector this could avoid large amounts of money being spent on marketing smart meters to those who are unlikely to see benefits.

3. **obtaining better evidence on energy savings**. A robust difference-in-difference study should be possible on household level data both pre and post smart meter installation. BEIS should also explore whether data retained in SMETS1 meters that have reverted to 'dumb' mode (i.e. at the point of switching) presents an opportunity to conduct a natural experiment to explore consumption habits. Sufficient time should now be available to ascertain whether energy savings are credible and sustained. This should be conducted on a wide sample, and reflect the different user groups, including non-domestic users.

4. **using improved evidence** as part of a concerted engagement campaign, alongside improved evidence of the effect on bills. This will need to address the differing capabilities and capacity of the suppliers operating in the market.

5. **identifying, modelling and containing risks** to eliminate further hostages to fortune. The programme has had several rounds of assessment that have revealed cost overruns and the over-estimation of benefits. The original plan may have been over-optimistic, while subsequent decisions have added complexity. BEIS should include more detailed cost modelling in relation to meter assets, a benchmarked approach to optimism bias and more detailed scenario analysis.

6. **apply a rigorous monitoring of realisation plan.** A benefits realisation plan is a critical part of project management. It should ensure that common problems are solved and the measurable improvement actually occurs. In this regard, BEIS could be more ambitious in monitoring and assessing the benefits. BEIS's benefits realisation plan does not appear to systematically define the programme's key performance indicators, or how these should be gathered and assessed.[2] Given that smart meters unlock such a rich set of

[1] See Grundy, A. (2019), 'Ofgem ready to take 'tough action' if suppliers fail to meet smart meter targets, Current[±], 30 October, https://www.current-news.co.uk/news/ofgem-ready-to-take-tough-action-if-suppliers-fail-smart meter-targets, accessed 6 November 2019.
[2] BEIS (2019), 'SMART METERING IMPLEMENTATION PROGRAMME: A report on progress of the realisation of smart meter consumer benefits', September.

data, more could be done to ensure that consumption data is leveraged in order to demonstrate the benefits in energy savings, demand shifting and resilience. The current plan appears to devolve the responsibility for analysing domestic data to the Smart Energy Research Lab (SERL).[3] The plan is unclear on how it intends to measure success in the non-domestic sector. Similarly, BEIS could also set out more clearly how it intends to monitor quality-of-service and competition indicators, and how it will assess them.

7. **give consumers transparent information on the costs and benefits of smart meters including the full impact on their bill.** Consumers, both domestic and non-domestic, have not yet been given the information on the costs and benefits of the program from their perspective, rather than society's. It is unclear what assumptions are used to construct the bill impact as presented in the analysis.[4] Using standard appraisal methods, transfers (such as a supplier's margin) are excluded, however when presenting an analysis on household bills, these factors need to be included. The other relevant factors also include the ongoing costs of the meter, such as meter rental. Consumers should also be presented with evidence on the magnitude and permanence of likely savings, as discussed above.

[3] BEIS (2019), 'SMART METERING IMPLEMENTATION PROGRAMME: A report on progress of the realisation of smart meter consumer benefits', September, p. 66.
[4] BEIS (2019), 'SMART METER ROLL-OUT: Cost-Benefit Analysis (2019)' CBA, September, p. 66.

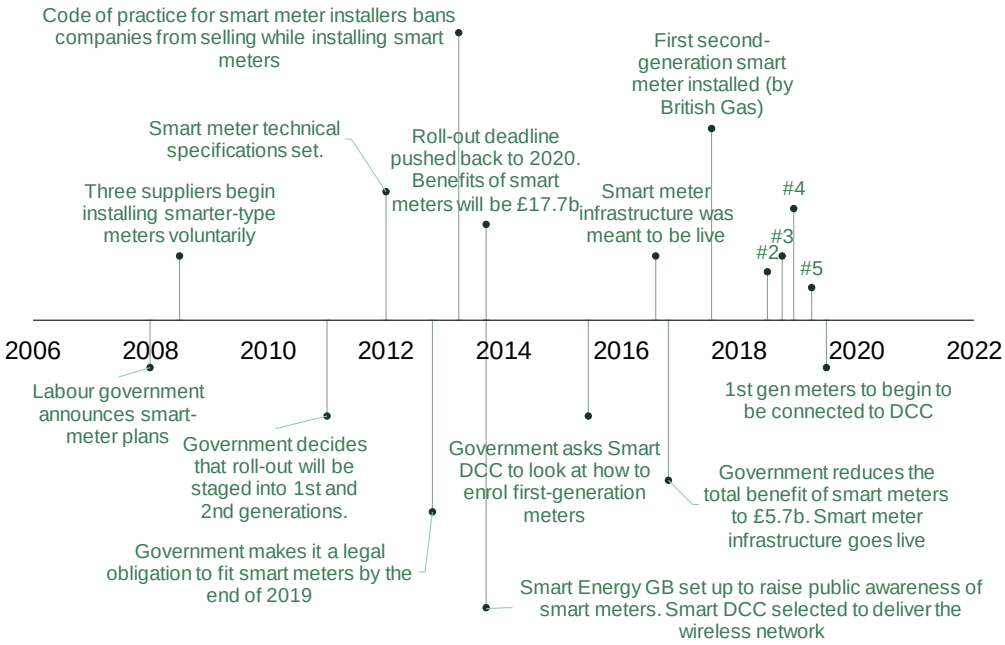
2 Introduction

The electricity and gas markets in Great Britain are undergoing a transition to smart metering. Smart meters can capture consumption data at half-hourly intervals and communicate in real time with suppliers and network operators. Smart meters are intended to save consumers time and encourage energy efficiency via the provision of displays located within consumers' homes.

As part of a broader energy policy framework, smart meters are intended to enable 'smart' grid features to enhance resilience, enable more supply from renewable energy sources and support the transition to electric vehicles.

The policy to roll out smart meters dates back to 2008, when the UK government committed to mandate suppliers to provide their customers with smart meters. A review of developments in the programme is shown below in Figure 2.1.

Figure 2.1 Timeline of smart meter programme developments, 2008–20



Note: Markers #2, #3, #4 and #5 refer to subsequent revisions to the deadline for installing first-generation meters.

Source: Oxera analysis of Which? material, https://www.which.co.uk/reviews/smart meters/article/smart meters-explained/smart meter-roll-out, accessed 6 November 2019

The UK Department for Business, Energy & Industrial Strategy (BEIS) conducted a cost–benefit analysis (CBA) of the smart meter roll-out in 2016.[5] This work was subsequently reviewed by the National Audit Office (NAO) in 2018.[6]

The NAO found several weaknesses in BEIS's analysis; these weaknesses related to the ambition of the roll-out, the level of complexity involved and gaps in consumer engagement.

BEIS has now responded with an updated CBA and a consultation on a new framework for smart metering beyond 2020. In the consultation, BEIS proposes

[5] BEIS (2016), 'SMART METER ROLL-OUT COST-BENEFIT ANALYSIS Part I', CBA, August.
[6] NAO (2018), 'Rolling out smart meters', Report by the Comptroller and Auditor General, 20 November.

to apply further obligations on energy suppliers in relation to smart meter deployment.

Oxera has been commissioned by Norton Rose Fulbright on behalf of Stark Software International ('Stark') to assess the latest CBA as part of its response to BEIS's post-2020 policy consultation. Stark is a meter asset provider (MAP) and data/analytics firm that is active in the non-domestic segment of the market. Oxera's remit is to assess the robustness and credibility of BEIS's analysis and comment on potential improvements within the context of the post-2020 consultation. This report is structured as follows:

- Section 3 assesses BEIS's approach to modelling the benefits of the smart meter programme;
- Section 4 provides analysis of BEIS's cost estimation;
- Section 5 reviews BEIS's treatment of risk and uncertainty;
- Section 6 combines the findings of sections 3, 4 and 5 and comments on the implications for the programme's value for money. It also summarises some of the factors that may undermine the success of the programme, as well as suggesting possible improvements.

3 Benefits of the smart meter programme

3.1 Energy savings

Energy savings make up the largest single category of benefit in BEIS's CBA. The evidence base draws on the findings of the Early Learning Project (ELP) and the Energy Demand Research Project (EDRP), both of which are now quite dated and may not reflect programme specifics.[7, 8]

The ELP is based on behavioural studies and data from an early stage of the roll-out (2011–14), when suppliers were still developing their consumer engagement approaches. The report also stresses that the findings are not a prediction of the future benefits of the main roll-out stage.[9] The quantitative evidence on energy savings is based on a comparison of energy use in the 12 months following a smart meter installation in 2011.

Since neither the ELP report nor the EDRP report include estimates of non-domestic consumption savings, BEIS's CBA uses even older data, from a Carbon Trust trial of advanced meters conducted in 2007.[10] While BEIS asserts that it does not expect the results to change, the use of more recent studies that reflect the reality of the programme would lend credibility to this assertion.

Moreover, even if one were to assume that the insights from the studies above (the ELP, the EDRP and the Carbon Trust) were still relevant, it is important to note that all of these studies assess changes over a short period of time.

None of the reports describe the extent to which external supply or demand factors (e.g. seasonal variation) are controlled for in the counterfactual.

It is therefore unclear that the evidence base on energy savings is reflective of current market realities. In relation to the 2016 CBA, the NAO specifically recommended that BEIS should systematically monitor actual energy savings that smart meters achieve.[11] A systematic data gathering and analysis process could provide more recent and relevant evidence in support of BEIS's 2019 CBA, as well as help with consumer engagement activities.

3.2 Demand shifting

Demand-shifting benefits occur when consumers move their consumption from peak demand periods to off-peak periods. All else equal, this means that transmission and distribution networks, which need to be dimensioned to handle peak loads, will require less re-enforcement, and thus energy supplied will have a lower marginal cost.

BEIS uses its Dynamic Dispatch Model (DDM) to analyse the changes in energy use, and combines this with some assumptions on the uptake of time-of-use tariffs.[12] It is unclear how the net benefit is applied and transformed into this setting. For instance, on the domestic side, it is not clear to what extent other technologies (such as connected devices leveraging the Internet of

[7] DECC (2015), 'Smart Metering Implementation Programme: DECC's Policy Conclusions: Early Learning Project and Small-scale Behaviour Trials', March.
[8] AECOM (2011), 'Energy Demand Research Project: Final Analysis', report for Ofgem, June.
[9] DECC (2015), 'Smart Metering Implementation Programme: DECC's Policy Conclusions: Early Learning Project and Small-scale Behaviour Trials', March, para. 2.29.
[10] BEIS (2019), 'SMART METER ROLL-OUT: Cost-Benefit Analysis (2019)' CBA, September, p. 36.
[11] NAO (2018), 'Rolling out smart meters', Report by the Comptroller and Auditor General, 20 November, para. 29.
[12] BEIS (2019), 'SMART METER ROLL-OUT: Cost-Benefit Analysis (2019)' CBA, September, p. 51.

Things, third-party products and stand-alone in-house displays) could deliver some of these demand-shifting benefits absent the intervention.[13]

If BEIS is including the entire envelope of demand-shifting benefits, it is unlikely that all of these can be attributed to the programme. BEIS admits that further interventions and policies would be needed to unlock these benefits.[14] These additional requirements should be included on the costs side—otherwise the CBA is claiming benefits arising from costs incurred outside of the programme.

3.3 Time savings

BEIS assumes that the smart meter programme will deliver time savings via avoided meter readings (for consumers). From these savings, BEIS nets off time spent by consumers attending the installation of a new smart meter. BEIS applies a non-work value of time to monetise these savings, while in its sensitivity testing it has modelled time savings at the value of working time.[15]

This approach does not account for a potential asymmetry between the different sources of time savings and costs across the activities. It is likely that consumer time spent reading meters is abstracted from leisure time, as this is typically not a time-sensitive or scheduled event. In contrast, time spent attending a meter install is more likely to be taken from a domestic consumer's working time, especially as it takes several hours to replace a meter and involves disconnecting the energy supply.[16] As an example of the potential magnitude of the difference, DfT suggest an average value of working time of £16.19 per hour for all working persons, whereas the value of non-working time is recommended to be £4.54 per hour (both 2010 prices)[17]. In this situation, the valuations of the costs and savings would be significantly different, lowering the net benefit.

3.4 Consumer switching

The smart meter programme is intended to enable accurate meter readings for the purpose of switching suppliers. The reality is that many consumers have experienced trouble when attempting to switch supplier with the SMETS1 smart meters. According to the report by the NAO, approximately 70% of installed meters lose smart functionality when switching supplier.[18] This may inhibit consumer switching, a view supported by the Competition and Markets Authority (CMA).[19]

This may be an unintended consequence of the supplier-led programme, and one that has been compounded by BEIS's decision to accelerate the deployment of SMETS1 meters prior to the completion of the centralised management infrastructure. A workaround has been included in the plan to enrol SMETS1 meters into the DCC system by the end of 2020. BEIS claims that once SMETS1 meters have been enrolled in the centralised data management system, the meters should be able to facilitate switching. Therefore, a part of the customer switching benefit depends on the timely

[13] BEIS's own material recognises that the demand-side response can operate independently from smart metering. See BEIS (2016), 'Smart Meters and Demand Side Response', leaflet, 29 November 29,.
[14] BEIS (2019), 'SMART METER ROLL-OUT: Cost-Benefit Analysis (2019)' CBA, September.
[15] BEIS (2019), 'SMART METER ROLL-OUT: Cost-Benefit Analysis (2019)' CBA, September, p. 40, 79
[16] If working time attending an install is not made up (i.e. by working later in the day), this would result in forgone production opportunities.
[17] Department for Transport (2019), 'TAG data book', May v1.12.
[18] NAO (2018), 'Rolling out smart meters', Report by the Comptroller and Auditor General, 20 November, para. 1.27.
[19] NAO (2018), 'Rolling out smart meters', Report by the Comptroller and Auditor General, 20 November, para. 1.28.

transfer of these meters into the DCC. The NAO, however, expresses concerns over the complexity of this novel migration, and it doubts whether SMETS1 meters will ever have the same functionality as SMETS2 meters.[20]

BEIS's analysis also assumes that no further SMETS1 meters are deployed beyond March 2019.[21] This assumption is already invalid—according to balancing and settlement administrator Elexon, 422,127 SMETS1 meters were installed on the existing (i.e. not new) connections between March and September 2019.[22]

The level of the consumer switching benefits may be lower than claimed, while additional costs associated with consumer switching for households with failed SMETS1 meters (e.g. customer enquiries) do not appear to have been included. Therefore, BEIS's estimate of the consumer switching benefits is likely upwardly biased.

3.5 Improved resilience

Smart meters should enable faster fault identification and resolution, as network operators and suppliers will be able to gather timely operational data at the point of metering. BEIS counts the expected reductions in customer minutes lost (CML) due to faster fault identification and restoration as part of the scheme benefits.[23] However, BEIS does not appear to have counted the planned interruption or outage associated with the installation, which may last for several hours. While outages occur in both the factual (i.e. traditional meters also need periodic replacing) and counterfactual scenarios, the asset life and timing of installation for the two types of meters are different and should be reflected in the analysis.

Moreover, cases have been reported where the remote disconnection feature within smart meters has led to an unintended supply interruption.[24] This risk does not exist under traditional metering, as a replacement meter would need to be installed via an arranged visit.

Therefore, BEIS's analysis appears to overstate the benefits of improved resilience.

3.6 Theft and avoided losses

BEIS identifies reductions in theft and, separately, a reduction in 'avoided losses' in distribution.

However, the description of the avoided network losses cites theft as a type of loss. Moreover, the underlying analysis by Mott McDonald (from 2007) also includes theft within the category of technical and non-technical losses.[25] Furthermore, the source indicates that the figures presented were assumptions rather than quantitative findings. Overall, the use of this evidence is likely to overstate the benefits.

[20] NAO (2018), 'Rolling out smart meters', Report by the Comptroller and Auditor General, 20 November, paras 1.31, 27.
[21] BEIS (2019), 'SMART METER ROLL-OUT: Cost-Benefit Analysis (2019)' CBA, September, p. 16.
[22] See Elexon (2019), 'Smart Meter Technical Detail Report', https://www.elexon.co.uk/about/key-data-reports/smart meter-technical-detail-report/, accessed November 6 2019.
[23] BEIS (2019), 'SMART METER ROLL-OUT: Cost-Benefit Analysis (2019)' CBA, September, p. 55.
[24] See Timms, A., (2019) 'Not-so-smart Ovo disconnected my electricity by mistake', *The Guardian*, 26 June, https://www.theguardian.com/money/2019/jun/26/ovo-smart meter-readings-error-disconnected, accessed 6 November 2019.
[25] Mott MacDonald (2007), 'Appraisal of Costs & Benefits of Smart Meter Roll Out Options: Final Report, April, Table 5-3.

3.7 Benefits of data processing and aggregation

BEIS identifies benefits 'from the anticipated extension of DCC's role in centralising data aggregation and processing (removing the need to pay agents for this)'.[26] However, in its decision on the market-wide half-hourly settlement reform, Ofgem confirmed that its decision 'will not include centralisation of data collection' and that 'there may well be a case for future models where data is not aggregated for submission into central systems'.[27] With Ofgem's final position on data aggregation unconfirmed, the benefits from data aggregation should be removed from BEIS's CBA.

[26] BEIS (2019), 'SMART METER ROLL-OUT: Cost-Benefit Analysis (2019)' CBA, September, p. 43.
[27] Ofgem (2019), 'Consultation on supplier agent functions under market-wide settlement reform: Ofgem response and decision following stakeholder feedback' consultation document, 29 May, p. 1.

4 Costs of the smart meter programme

4.1 Equipment and installation costs

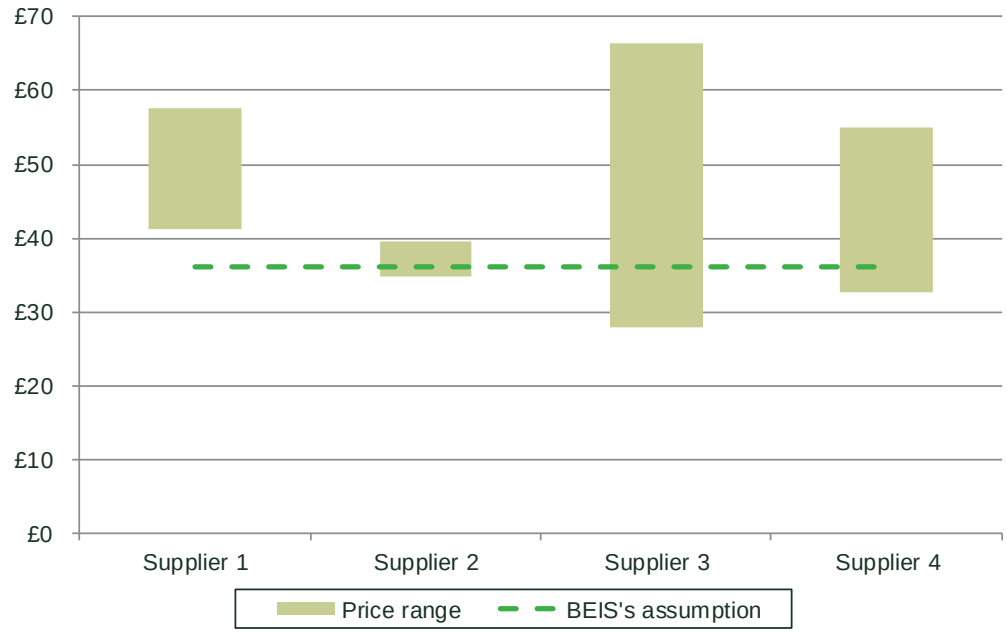
First, in its CBA, BEIS assumes that the installation cost of an advanced meter is over 50% higher than that of a smart meter.[28] However, according to meter cost information received from Stark, current market practice suggests that installing an advanced meter is no more expensive than installing a smart meter. Amending this assumption significantly reduces the counterfactual installation costs, thus decreasing the cost–benefit ratio of the programme.

Second, in calculating the cost of equipment, BEIS has assumed a price of £120 per advanced meter and a price of £36 per electric smart meter.[29] To assist Oxera in benchmarking these assumptions, Stark has provided a range of quotes from different manufacturers. Note that BEIS's CBA is conducted in 2011 prices, while the quotes received from Stark reflect recent market data. Therefore, to ensure that the figures are comparable, quotes received from Stark were deflated to 2011, using monthly RPI data.

For advanced meters, Stark provided to Oxera a recent quote of £47.50 per meter, which equates to £38.83 in 2011 prices. This is nearly 70% lower than the value assumed by BEIS. Using a more contemporaneous value for the costs of advanced meters will decrease the counterfactual costs, reducing the net benefit of the scheme.

For electric smart meters, Stark provided Oxera with recent quotes from four different manufacturers. The price offered by each manufacturer depends on the technical specification of meter, as well as on the purchase volume—this is summarised in Figure 4.1.

Figure 4.1 Benchmarking of BEIS's electricity smart meter cost assumptions (£ 2011)



Source: Oxera analysis, based on data from Stark and the Office of National Statistics.

[28] BEIS (2019), 'SMART METER ROLL-OUT: Cost-Benefit Analysis (2019)' CBA, September, p. 21.
[29] In 2011 prices. See BEIS (2019), 'SMART METER ROLL-OUT: Cost-Benefit Analysis (2019)' CBA, September, p. 22.

As can be seen from the figure, in light of the information provided by Stark, BEIS's assumption on the cost of electric smart meters appears aggressive. Amending this assumption will increase the costs of the policy, reducing the net benefit of the scheme. BEIS appears to have overestimated the cost for the counterfactual scenario (no smart meter roll-out) and underestimated the costs of the policy scenario (smart meter roll-out). Using more up-to-date figures would decrease the net benefit of the scheme. BEIS's assumption on the cost of electric smart meters also doesn't appear to consider the price differential of meter variants – for instance pre-payment meters, which are more expensive. Including these variables would also decrease the net benefits of the scheme.

4.2 Capital costs

In its CBA, BEIS 'assume[s] a 6% cost of capital across all market participants'.[30] It is, however, unclear whether this assumption fully captures the costs levied on the consumers. While MAPs earn their cost of capital through the rental charges, the suppliers also charge a margin over and above their costs, of which rental charge is a part. It is therefore possible that the effective return that the supply side is recovering from consumers exceeds the headline assumption of 6%. BEIS's CBA does not elaborate on this point, so it is unclear to what extent this issue was considered. In addition, it is unclear to what extent BEIS considered the effect that marketing expenses, such as rebates for the roll-out of smart meters, would have on consumers.

4.3 Costs not included

As discussed in section 3.2, further costs are likely to need to be incurred by consumers to enable the demand-shifting benefits as claimed. For example, consumers may need to invest in energy-saving equipment. These costs do not appear to be included in BEIS's CBA.

It is not clear to what extent early replacement costs are included. In relation to SMETS1 meters that revert to dumb mode, Oxera understands that some suppliers offer consumers replacements if they have switched from a different supplier while on an incompatible SMETS1 meter. It is not clear whether these replacements are included in BEIS's cost contingencies.

[30] BEIS (2019), 'SMART METER ROLL-OUT: Cost-Benefit Analysis (2019)' CBA, September, p. 21.

5 Treatment of risk and uncertainty within the framework

5.1 Optimism bias

In their assessment of BEIS's 2016 CBA, the NAO found evidence that cost estimates were over-optimistic.[31] The NAO urged BEIS to 'not become defensive, and resistant to inconvenient truths'.[32]
BEIS's 2019 CBA shows evidence of over-optimism as well. In estimating the cost of the equipment, BEIS includes a '5% optimism bias to account for potential exchange rate fluctuations and economic risk'.[33] However, in the face of historical uncertainty of exchange rate alone, the magnitude of optimism bias appears insufficient.

To illustrate, over the course of last year alone,[34] the maximum drawdown (maximum percentage fall relative to the peak) on the USD–GBP exchange rate amounted to nearly 10%—twice the amount budgeted for by BEIS.[35] Moreover, over the past five and ten years, this value amounts to nearly 25% and 43% respectively. Increasing the optimism bias to account for possible exchange rate fluctuations will decrease the overall net benefit of the scheme.

BEIS's assumption of a 5% allowance for optimism bias appears low relative to guidance from HM Treasury. Supplementary Green Book Guidance on optimism bias suggests that for CAPEX and equipment related projects, the likely range is 10% to 200%.[36] Contributory factors relevant to this bias include design complexity, the degree of innovation, and external technology factors. While the roll-out is underway, this level is likely to be too low. An optimism bias of more than 5% would increase the cost and reduce the value-for-money of the project.

5.2 Installation costs

In its CBA, BEIS assumes that installation costs decrease over time, due to productivity gains. However, according to the analysis conducted by the NAO, assuming that productivity remains unchanged relative to 2017 levels implies an additional £1.8bn of costs for the scheme.[37] This implies that under constant productivity, the net benefit of the scheme decreases by 30%, relative to the level reported by BEIS.[38]

5.3 Roll-out profile

BEIS forecasts that by 2021, the penetration of smart meters will be just below 70%.[39]

[31] NAO (2019), 'Rolling out smart meters', Report by the Comptroller and Auditor General, 20 November, para 2.40
[32] NAO (2019), 'Rolling out smart meters', Report by the Comptroller and Auditor General, 20 November, para 26.
[33] BEIS (2019), 'SMART METER ROLL-OUT: Cost-Benefit Analysis (2019)' CBA, September, p. 21.
[34] 1 November 2018–1 November 2019.
[35] We are using USD as an example, since in the information provided by Stark, some producers link their quotes to USD.
[36] HM Treasury (2013), 'Green Book supplementary guidance: optimism bias'. 21 April 2013.
[37] NAO (2019), 'Rolling out smart meters', Report by the Comptroller and Auditor General, 20 November, Figure 18.
[38] The amount is calculated as 1.8bn (see reference above), divided by net benefit of £5,977m. See BEIS (2019), 'SMART METER ROLL-OUT: Cost-Benefit Analysis (2019)' CBA, September, p. 63.
[39] BEIS (2019), 'SMART METER ROLL-OUT: Cost-Benefit Analysis (2019)' CBA, September, p. 15, Figure 1.

However, according to BEIS's Q2 2019 outturn data, current penetration of smart and advanced meters amounts to less than 30%.[40] Therefore, BEIS effectively assumes that the penetration of smart meters will more than double over the course of two years. To the extent that the speed of the roll-out affects the timing (and therefore, magnitude) of benefits, it would be reasonable to consider alternative scenarios in which the roll-out is carried out at a slower rate.

According to BEIS, if the roll-out slows for the first two years alone (2019–21), the net benefit of the scheme decreases by 'approximately £1.0bn'. However, even under that downside scenario, the penetration is assumed to increase by 10% every year between 2021 and 2026. This is twice the historically observed rate.[41] This programme has suffered several delays, as highlighted in Figure 2.1. The overall roll-out profile has been shifted back in previous assessments.[42] In its assessment of the roll-out profile, the NAO stated:

> There is no realistic prospect of installing smart meters in all eligible premises covered by the roll-out obligation by 2020.[43]

It is unclear whether BEIS has fully accounted for the risks posed by a potentially slower rate of smart meter uptake.

One of the reasons for the slow uptake of smart meters could be heterogeneous preferences of customers, i.e. the fact that not all properties, especially micro-businesses, will find SMETS-1 meters to be the best solution. To illustrate, according to Q2 2019 statistics from BEIS, large suppliers have installed 733,608 advanced meters to non-domestic properties. In contrast, the same figure for smart meters amounts to only 87,489.[44] This may be an indicator that non-domestic properties find it more optimal to utilise advanced meters, rather than smart meters. If so, it appears that imposing a one-size-fits-all forced roll-out of smart meters may be value-destroying, rather than value-enhancing.

5.4 Programme dependencies

As indicated in the NAO report, the potential risks of premature termination of the 2G network, which underpins some of the DCC's infrastructure, are mitigated by the fact that the underlying contract is valid until 2028 and could be further extended until 2033. However, BEIS's CBA does not consider to what extent the cost of maintaining that contract could increase over time. It is reasonable to assume that under unfavourable circumstances, the provider would require an increased payment for the maintenance of the 2G network, which would, in turn, increase the costs of the scheme.

The full costs of continuing to operate the 2G network in order to support smart meters could be substantial. A significant component of this is the opportunity cost of the 900MHz and 1800MHz radio spectrum that these networks use. Shutting down 2G networks could free this resource so that it could be re-used by other more valuable services such as 4G and 5G mobile services. Ofcom,

[40] Out of 53,864,700 meters in operation, 14,942,418 are classified as 'smart and advanced'. BEIS (2019), 'Smart meter statistics: Quarter 2, 2019', tab 'Table 5 Annual Operating'.
[41] Penetration as of 2021 equals c. 40%, while penetration as of 2026 equals 90%. In contrast, according to the same figure, penetration as of 2012 (2018) amounted to 0% (30%) respectively. See BEIS (2019), 'SMART METER ROLL-OUT: Cost-Benefit Analysis (2019)' CBA, September, p. 15, Figure 1.
[42] BEIS (2016), 'SMART METER ROLL-OUT COST-BENEFIT ANALYSIS Part I' CBA, November 8, p.19 Figure 3.
[43] NAO (2018), 'Rolling out smart meters', Report by the Comptroller and Auditor General, 20 November, para. 1.36.
[44] BEIS (2019), 'Smart meter statistics: Quarter 2, 2019', tab 'Table 4 ND Installed -Large'.

the telecoms regulator in the UK, has attempted to capture this opportunity cost via its mechanism to set license fees that mobile operators pay for spectrum. It uses a methodology that values 2G spectrum in reference to comparable prices paid at auction for 4G spectrum—specifically acknowledging the opportunity cost 2G incurs.[45] It proposed that Telefónica (a service provider to DCC) pay £48.7m annually for its 2G spectrum holdings.[46]

A report by Realwireless suggests that of all the 2G use cases that still remain, telematics and smart meters face the biggest implications in the context of phasing out the network.[47] There are large numbers of connections, complex value chains and the risk of disruption is real. Most of the other use cases (domestic voice and text, roaming users, eCall) have low volumes and or methods to mitigate the disruption. On this basis, it is reasonable to assume that a significant portion of the costs of keeping the 2G network would be attributable to the smart meters programme.

An alternative to maintaining the 2G network would involve upgrading the infrastructure to migrate to a different network. This, in turn, would lead to further costs to the scheme.

5.5 Cyber security and resilience

Low-probability, high-impact events such as cyber-attacks are not discussed as potential risks in the assessment. The additional connectivity and functionality of smart meters do offer real benefits, but they also lower the costs for those who might seek to disrupt supply.

While the overall impact of such events may be small and difficult to quantify, they should be included—at least qualitatively. Further evidence on these risks may help with consumer engagement. Other risks, such as the possibility of unintended disconnection (as identified in section 3.5 of this report), are not discussed.

5.6 Risks to specific or vulnerable user groups

Recent data suggests that consumers are being switched to pre-payment mode more readily. Consumer group Which? highlights that there has been a threefold increase in suppliers switching to pre-payment mode from 2017 to 2018.[48] Smart meters eliminate a friction associated with billing and altering the service types. While this is likely to deliver benefits, it could be used to the detriment of consumer welfare.

Assumptions on the demand-shifting benefits assume uptake of time-of-use tariffs. Evidence from Citizens Advice suggests that some vulnerable users won't be able to take advantage of these.[49] Citizens Advice suggests that some users may not select these types of tariffs and may not be able to purchase equipment that supports these features. This could also imply that vulnerable user groups could be worse off under a regime that introduces time-of-use tariffs. Furthermore, Citizens Advice identifies a risk to vulnerable users from

[45] Ofcom (2015), 'Annual licence fees for 900MHz and 1800 MHz spectrum', consultation document, September 24
[46] Ofcom (2015), 'Annual licence fees for 900MHz and 1800 MHz spectrum', consultation document, September 24, Table 7.2
[47] Realwireless (2019), 'The Potential Impact of Switching Off 2G in the UK', Spectrum Policy Forum report, October 7.
[48] See Which?, 'Smart meter problems and how to solve them', https://www.which.co.uk/reviews/smart meters/article/smart meters-explained/smart meter-problems-and-solutions, accessed 6 November 2019.
[49] See Citizens Advice, 'The value of time of use tariffs', https://www.citizensadvice.org.uk/Global/CitizensAdvice/Energy/Citizens%20Advice%20summary%20of%20the%20value%20of%20time%20of%20use%20tariffs.pdf, accessed 6 November 2019.

the roll-out—specifically, that users could end up with heating or cooking appliances that are condemned as a result of the site visit.[50] These issues are not addressed in the assessment or distributional analysis. Rather, BEIS asserts that vulnerable users will be able to realise the full benefits of the programme:

> In light of the provisions put in place, we expect vulnerable consumers to be able to realise the full benefits of smart metering.[51]

[50] Citizens Advice (2018), 'Early consumer experience of smart meters', July, p. 5, https://www.citizensadvice.org.uk/Global/CitizensAdvice/Consumer%20publications/Early%20consumer%20experiences%20of%20smart%20meters%20-%202018%20.pdf, accessed 7 November 2019.
[51] BEIS (2019), 'SMART METER ROLL-OUT: Cost-Benefit Analysis (2019)' CBA, 25 October, p. 72.

6 Value for money

6.1 Value for money as modelled by BEIS

BEIS's CBA presents three value-for-money metrics.[52]

1. A net present value of £5.9bn, derived from the present value of the costs (£13.5bn) and benefits (£19.5bn) assessed for the programme.
2. A benefit–cost ratio (BCR) of 1.44, derived from the present value costs and benefits above. In addition, BEIS presents an ongoing BCR that excludes setup costs associated with the IT and system costs. This adjustment increases the BCR to 2.86.
3. Lifetime marginal costs and benefits. These are the costs and benefits of connecting a single additional meter. These exclude fixed setup and common costs.

Under BEIS's own assessment, the overall programme does not deliver a compelling value-for-money case. A figure of 1.44 for the BCR appears low in the context of precedents for other large projects. Elsewhere in programme appraisals for the Department for Transport (DfT), BCRs between 1 and 1.5 correspond to 'low' value for money, whereas 'high-value' projects are those with a BCR of 2.0 or above.[53] This weakness could motivate the presentation of the higher ongoing BCR, which by definition does not include all of the programme costs, nor does it capture the increased uncertainty associated with costs and benefits in the future.

Oxera also note that the NAO reviewed BEIS's CBA as conducted in 2016.[54] This report highlighted several weaknesses in the value for money case as presented by BEIS in 2016. These included:

- an overoptimistic assessment of costs;
- uncertainty surrounding the scale of benefits;
- challenges with the engagement of consumers in accepting installations and the provision of energy-saving advice, which were possibly the cause of delays in the roll-out;
- the pursuit of a technologically complex roll-out that carries more implementation risk (relative to an alternative suggested by the NAO).

As highlighted in sections 3, 4 and 5 above, BEIS's 2019 CBA still faces these broad challenges, despite the changes to the methodology following the NAO report.

6.2 Value for money under revised assumptions

It is not within Oxera's remit to quantitatively re-assess the BEIS CBA model with alternative inputs. However, based on the issues highlighted in sections 3, 4 and 5, we can comment on the expected directional impact.

[52] BEIS (2019), 'SMART METER ROLL-OUT: Cost-Benefit Analysis (2019)' CBA, 25 October, p. 63.
[53] DfT (2013), 'Value for Money Assessment: Advice Note for Local Transport Decision Makers', Department whitepaper, December, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/267296/vfm-advice-local-decision-makers.pdf, accessed 7 November.
[54] NAO (2018), 'Rolling out smart meters', Report by the Comptroller and Auditor General, 20 November.

- Real-world costs for smart meters could be higher than those assumed by BEIS. This would further escalate costs and lower the BCRs (both overall and ongoing).
- The benefits from energy savings will also depend on consumers making sustained choices over time. If the effect of the behavioural nudge provided by smart meters is transitory (rather than sustained permanently) the total quantum of benefits realised out to 2034 would be far lower than the £6.2bn that BEIS claims.[55] We have not yet seen evidence that the savings are permanent.
- The £1.4bn attributed to demand-shifting benefits will depend on other policies being delivered and may require further investment. For instance, the approach to settlement in the electricity market may need to reformed, and consumers may need to purchase additional equipment to enable demand shifting. This could entail further costs and lower benefits, both of which would weaken the value-for-money case.
- The roll-out is likely to face further delay given consumers' unwillingness to adopt the current proposition. Under BEIS's framework, delaying the installation will discount the marginal benefit of each meter in present value terms.[56] In addition, delay to the roll-out could increase cost overruns (such as supplier operating costs), and increase the exposure of the programme to other risks. All of these events would further lower the value-for-money case.
- Unmodelled risk factors could add further costs to be mitigated or jeopardise the benefits realisation plan. For example, the costs of connectivity via the 2G network that supports SMETS1 meters may increase in the future.

Moreover, BEIS has not presented a scenario analysis in its sensitivities that combines more than one modification from their central scenario at a time. If the outturn combines multiple adverse factors such as those listed above, BEIS's value-for-money case would be substantially weakened.

6.3 Review of factors that contribute to low value for money

The finding that this programme is set to deliver low value for money, at face value, appears counterintuitive.

Relative to traditional metering, smart metering should improve billing timing and accuracy and provide transparency on intensity of domestic and non-domestic consumption. Providing consumers with cost-effective tools to control their energy consumption should lead to more responsiveness to price signals and more efficient resource allocation.

There are several policy design factors that appear to limit the effectiveness of the programme.

- **Supplier-led roll-out**. The supplier-led approach adopted in Great Britain differs to the network-led approach in other countries. According to the NAO, this choice may make project execution more complex as it has to accommodate the design input and business strategies of multiple energy

[55] In its sensitivity analysis, BEIS only models changes in the steady-state level of energy savings.
[56] BEIS has estimated that each year of delay reduces the NPV of the programme by £0.5bn.

suppliers.[57] Furthermore, competition law limits the ability of firms to co-ordinate rollout activity.

- **The success of the programme is dependent on consumer engagement**. To deliver benefits, the policy requires that consumers are informed of the benefits in order to accept a meter and equipped with the information and incentive to adjust consumption habits. As with the roll-out itself, the consumer-engagement effort is being led by suppliers.
- **A one-size-fits-all solution is being applied to a heterogenous market, to address a wide range of issues**. A single specification (initially SMETS1 meters and now SMETS2 meters) is expected to deliver more frequent billing, in-house displays and load control while also supporting supplier switching. SMETS1 meters do not yet fully support switching, while even SMETS2 meters may have relatively limited electric vehicle and load control support. At the same time, the chosen solution is expected to serve a very wide user base, ranging from households with relatively little engagement to sophisticated users with additional requirements (e.g. those that require small-scale renewables support). Also included are pre-payment users and non-domestic users, each with potentially divergent requirements and priorities. This could mean that high-specification users may not get all the benefits they expect, while those users who see little additional benefit from a smart meter have additional costs forced upon them.

There may be ways that BEIS could improve and protect the programme to ensure that consumer benefits are delivered. We would suggest the following.

1. **exploring areas to reduce the programme scope and complexity**. BEIS and Ofgem can limit their interventions and address only the market failures that remain (i.e. those people who want a smart meter and do not have one). Interventions should avoid parts of the metering market that are well served by competition and ensure that the funding of monopoly activities is limited to the licence conditions and permitted activity of operators. For example, Oxera understand that DCC has recently opened a new innovation and testing facility.[59] BEIS and Ofgem should monitor such developments and ensure that regulated revenue is not distorting the adjacent markets.
2. **supporting choice**. The homogenous smart metering solution chosen by BEIS might not suit all consumers, in particular those in the smaller non-domestic sector and domestic consumers who are unlikely to see a benefit. Given that Advanced metering can be cost effective, supports the same policy objectives and addresses a variety of technical issues inherent to SMETS, BEIS should consider allowing discretion in the metering they can offer consumers.[60] In particular, in the non-domestic sector this could accelerate a more efficient roll-out and in the domestic sector this could avoid large amounts of money being spent on marketing smart meters to those who are unlikely to see benefits.

[57] NAO (2018), 'Rolling out smart meters', Report by the Comptroller and Auditor General, 20 November, para. 1.11.
[59] See Grundy, A. (2019), 'Ofgem ready to take 'tough action' if suppliers fail to meet smart meter targets, Current±, 30 October, https://www.current-news.co.uk/news/ofgem-ready-to-take-tough-action-if-suppliers-fail-smart meter-targets, accessed 6 November 2019.
[60] In supporting further meter choice, it may be necessary to adjust suppliers' targets and/or penalties to ensure that there is not an inefficient allocation of risk between retailers and consumers. Otherwise, suppliers may face all the risk of non-compliance, while customers have no obligation to accept a meter.

3. **obtaining better evidence on energy savings**. A robust difference-in-difference study should be possible on household level data both pre and post smart meter installation. BEIS should also explore whether data retained in SMETS1 that have reverted to 'dumb' mode (i.e. at the point of switching) present an opportunity to conduct a natural experiment to explore consumption habits. Sufficient time should now be available to ascertain whether energy savings are credible and sustained. This should be conducted on a wide sample, and reflect the different user groups, including non-domestic users.

4. **using improved evidence** as part of a concerted engagement campaign, alongside improved evidence of the effect on bills. This will need to address the differing capabilities and capacity of the suppliers operating in the market.

5. **identifying, modelling and containing risks** to eliminate further hostages to fortune. The programme has had several rounds of assessment that have revealed cost overruns and the over-estimation of benefits. The original plan may have been over-optimistic, while subsequent decisions have added complexity. BEIS should include more detailed cost modelling in relation to meter assets, a benchmarked approach to optimism bias and more detailed scenario analysis.

6. **apply a rigorous monitoring of realisation plan.** A benefits realisation plan is a critical part of project management. It should ensure that common problems are solved and the measurable improvement actually occurs. In this regard, BEIS could be more ambitious in monitoring and assessing the benefits. BEIS's benefits realisation plan does not appear to systematically define the programme's key performance indicators, or how these should be gathered and assessed.[61] Given that smart meters unlock such a rich set of data, more could be done to ensure that consumption data is leveraged in order to demonstrate the benefits in energy savings, demand shifting and resilience. The current plan appears to devolve the responsibility for analysing domestic data to the Smart Energy Research Lab (SERL).[62] The plan is unclear on how it intends to measure success in the non-domestic sector. Similarly, BEIS could also set out more clearly how it intends to monitor quality-of-service and competition indicators, and how it will assess them.

7. **give consumers transparent information on the costs and benefits of smart meters including the full impact on their bill.** Consumers, both domestic and non-domestic, have not yet been given the information on the costs and benefits of the program from their perspective, rather than society's. It is unclear what assumptions are used to construct the bill impact as presented in the analysis.[63] Using standard appraisal methods, transfers (such as a supplier's margin) are excluded, however when presenting an analysis on household bills, these factors need to be included. The other relevant factors also include the ongoing costs of the meter, such as meter rental. Consumers should also be presented with evidence on the magnitude and permanence of likely savings, as discussed above.

[61] BEIS (2019), 'SMART METERING IMPLEMENTATION PROGRAMME: A report on progress of the realisation of smart meter consumer benefits', September.
[62] BEIS (2019), 'SMART METERING IMPLEMENTATION PROGRAMME: A report on progress of the realisation of smart meter consumer benefits', September, p. 66.
[63] BEIS (2019), 'SMART METER ROLL-OUT: Cost-Benefit Analysis (2019)' CBA, September, p. 66.

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