Department for Energy Security & Net Zero

# Monitoring smart meter energy savings using the National Energy Efficiency Data-Framework

November 2024 Research report

This report presents the findings from an experimental use of the 2021 version of the National Energy Efficiency Data-Framework (NEED) to analyse energy savings from smart meter installations that took place between 2015 and 2018 in Great Britain.

**Report highlights**

- The project successfully demonstrated that the data currently available in NEED can be used to provide meaningful insights into smart meter energy savings for installations between 2015 and 2018. Future analysis will depend on the availability and quality of meter installation information beyond 2018 and confirmation that our methodology can be applied to consumption years beyond 2019.
- Installations were grouped into annual cohorts and by the energy supplier that installed the meters. Energy savings were analysed for 20 electricity smart meter installation cohorts and 22 gas smart meter installation cohorts between 2015 and 2018. These included 1.7m electricity smart meter installations and 1.5m gas smart meter installations, approximately a quarter of all installations during that time. To preserve supplier anonymity, the results in this report are based on a representative sample of 10,000 from each cohort.
- A statistically significant first-year electricity saving was observed following the installation of a smart meter for all electricity installation cohorts. Savings ranged from a low of 1.0% to a high of 3.4%. The median saving estimate was 2.5%.
- A statistically significant first-year gas saving was also observed following the installation of a smart meter for all gas installation cohorts. Savings ranged from a low of 1.0% to a high of 2.8%. The median saving estimate was 2.0%.
- A longitudinal analysis covering the three years post-installation indicated that electricity savings were sustained over time. The lowest annual electricity saving recorded in the third year was 2.4% and the highest was 2.9%.
- Gas savings were also sustained for most cohorts, but with evidence of a decline for some. The lowest annual gas saving recorded in the third year was 0.9% and the highest was 2.2%.

**What you need to know about these statistics:**

- Savings are estimated using a quasi-experimental evaluation method called matched difference-in-differences. The analysis compares the consumption of smart metered dwellings before-and-after the smart meter installation with the consumption of similar traditionally metered dwellings over the same period. The smart meter savings estimate is the difference in the two consumption trends.
- The samples include and combine credit and prepay customers, and installations are included regardless of whether the smart meter is operating in smart mode (though the impact of this should be limited by the exclusion of dwellings where there had been a switch in electricity supplier during the observation periods).
- Several types of dwelling and consumer are excluded for methodological reasons:
  a) Not supplied by both electricity and mains gas (i.e. must be dual-fuel)
  b) Not an Electricity Profile Class 1 customer, e.g. those on a time-of-use tariff (electricity analysis only)
  c) Invalid or unreliable data in NEED, which is also likely to exclude customers who did not regularly submit meter reads before their smart meter installation
  d) Dwellings where there had been a switch in electricity supplier during the pre-installation, installation or post-installation years (around 20% of dwellings)
- As NEED tracks dwellings not occupants, occupancy changes are possible over time and the effects of this are incorporated into the results.
- Around a quarter of smart meter installations between 2015 and 2018 are included in the final sample for the analysis. This includes around 1.7m electricity smart meter installations and 1.5m gas smart meter installations.
- To preserve the anonymity of the energy suppliers, the reported results are based on a random sub-sample of 10,000 installations per energy supplier in each year. Results are only reported where a supplier had at least 10,000 installations for that fuel in the year, and more than 70% of the smart meter installations could be matched to similar traditionally metered dwelling.
- The results should be interpreted as estimates of the savings for the specific dwellings and installations included in the final samples. No weighting or other methods are applied to represent excluded dwellings, wider supplier customer bases or the GB housing stock.

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# Introduction

## Background

Smart meters are replacing traditional gas and electricity meters across Great Britain, with the goal of making the energy system more efficient and flexible, helping Great Britain use more renewable energy, and delivering net zero greenhouse gas emissions by 2050. At the end of 2023, there were almost 35 million smart and advanced meters[2] in Great Britain in homes and small businesses, representing 61% of all meters.

A key principle of the roll-out is for consumers to be able to use smart meter data to gain a better understanding of their energy consumption and, where desirable, reduce it to save money and minimise carbon emissions. The Government's 2019 cost benefit analysis anticipated that the roll-out would result in average energy consumption reductions of 3.0% for electricity and 2.2% for gas (0.5% for gas prepay), driven by multiple behavioural mechanisms:

- Direct feedback – real-time consumption data through In-Home Displays (that are offered to all domestic smart metered households), smart phone applications, online services or other platforms and products
- Indirect feedback – aggregated or non-real-time feedback, e.g. accurate billing and historic or comparative information bills
- Advice and guidance – on energy use and energy reduction, including advice that installers are required to offer during installations, or applications and services that can help interpret data and point towards better choices
- Motivational campaigns – designed to raise energy literacy and motivation to reduce energy consumption. Smart Energy GB, the national communications campaign supporting the roll-out, has an objective to this effect. Engagement and advice provided before the installation, during (e.g. on how to use the IHD and how to save energy) and after (e.g. Smart Energy GB's communication campaigns and post-install communications from energy suppliers).

## Monitoring and evaluating energy savings

Since its inception in 2011, the Smart Metering Implementation Programme (SMIP) in the Department for Energy Security and Net Zero (DESNZ) has been monitoring and evaluating its impacts on household energy consumption. During the foundation stage of the roll-out, SMIP focused on learning from early installations to understand how best to deliver the anticipated consumer benefits. This was the aim of the Smart Metering Early Learning Project (ELP), a programme of social research that also included statistical analysis of consumption reductions

[2] Advanced meters are only installed in non-domestic premises.

from early installations. That analysis found that compared to traditional meters, smart-type meters enabled an average annual reduction of 2.3% of domestic customers' electricity consumption and 1.5% for their gas consumption. Based on these findings, international evidence on the efficacy of consumption feedback in driving energy savings, and the fact that several of the consumer engagement policies had not yet been introduced, the ELP concluded that it would be reasonable to expect durable average savings of 3%.

As the roll-out has progressed to the main installation stage, monitoring of energy savings has continued, including via analysis conducted by energy suppliers on the impacts of smart metering on their customers' energy consumption. In January 2022, SMIP commissioned the Behavioural Insights Team (BIT), to complete an independent and comprehensive review of energy supplier evidence, gathering the latest analyses from the ten largest domestic energy suppliers[3] to understand what conclusions could be drawn from their studies about the scale of energy savings from the roll-out.

Published in June 2023, BIT's report used a meta-analysis method to synthesise seven studies from four energy suppliers, estimating the first-year energy savings from smart meters to be 3.4% for electricity and 3.0% for gas, on average, for the households included in the studies. These estimates are higher than the savings anticipated in the roll-out cost benefit analysis (3% for electricity, 2.2% for gas credit, 0.5% for gas prepay).

BIT's evidence review is a substantial addition to the evidence base on the impacts of the GB smart meter roll-out, providing the first large-scale analysis of household energy savings from smart metering. Their final analysis includes almost 200,000 smart metered households that had installations between 2015 and 2018, by which point smart meter coverage was almost 30%. BIT also noted, however, several limitations in the evidence available from energy suppliers, most notably that only four of the ten largest energy suppliers had evidence of sufficient quality to be included in the review.[4]

# Monitoring energy savings using NEED

Acknowledging these gaps, SMIP conducted a parallel project to assess whether DESNZ's National Energy Efficiency Data-Framework (NEED) could be used as an additional source for monitoring energy savings in the future. NEED links together existing data sources to provide insights on the electricity and gas consumption of dwellings in Great Britain by property attributes and household characteristics, and enables analysis of the real-world impact of energy efficiency measures on energy consumption.

As NEED covers all dwellings in GB, it could offer wider coverage of smart meter installations than the evidence currently available from energy suppliers, include some key segments not well-represented to-date (e.g. prepay customers), and also allow for analysis of savings

[3] As of Autumn 2022.
[4] As an indication of the coverage of this evidence, according to the data available in NEED these four energy suppliers had a combined share of 44% of all electricity meters at the beginning of 2018.

beyond the first-year post-installation. There is also already a pathway to follow in implementing such analysis in NEED, as similar analysis is regularly performed of the savings from installing various energy efficiency measures such as cavity wall insulation.[5]

However, whilst information on meter types and installation dates has been gathered in NEED in the past, it has typically been used only as an exclusion criterion in analysis of other energy efficiency measures to remove any confounding savings from the installation of smart meters. The impact of smart meters themselves has not been analysed and the data has not been collected, cleaned or structured with this aim in mind.

The project's first objective was therefore to use the meter data already in NEED to test whether it is possible to complete high-quality analysis of smart meter impacts on household energy consumption. The project showed that it was possible to use NEED for this, demonstrating that there was sufficient quality meter data available in NEED. A robust difference-in-difference analysis was completed, aligning with best practice methods for this type of evaluation and meeting a standard similar to that set out in BIT's guidance for energy suppliers on conducting energy consumption analysis for smart meter installations.[6]

The project's second objective was then to produce an energy savings analysis using the available data to add to the existing evidence base on energy savings and enable stronger conclusions to be drawn. Savings were estimated for different installation cohorts between 2015 and 2018, grouped by the installing energy supplier. The analysis was segmented in this way for two main reasons:

1. Most existing evidence in this area is energy supplier-level studies with different cohorts over time, such as those in BIT's 2023 report. Estimating savings for supplier installation cohorts therefore makes it easier to compare the findings from NEED with the supplier studies.

2. This analysis covers a period of time in the roll-out when suppliers were at differing stages of maturity in their roll-out strategies, which includes consumer engagement and targeting. Supplier-level analysis captures the diversity of outcomes associated with this.

However, the NEED findings should not be directly compared with the evidence from energy suppliers. NEED is a different data source to that used by suppliers, with different coverage, advantages, and constraints. The analysis balances an application of the typical methods used by suppliers whilst also leveraging several advantages offered by NEED, such as greater market coverage, the inclusion of prepay customers, and the availability of high-quality information on the characteristics of properties that enables more robust analysis. The analysis therefore provides a useful set of additional findings to be considered alongside the evidence from energy suppliers.

[5] See the 'Impact of Measures' analysis in the annual summary of NEED analysis reports: https://www.gov.uk/government/statistics/national-energy-efficiency-data-framework-need-report-summary-of-analysis-2023
[6] SMIP commissioned BIT to produce this guidance for energy suppliers, tailored to helping them produce high quality analysis of smart meter impacts on their customers' energy consumption.

This report details the findings from the project, including a detailed description of the methodology and findings from this initial set of monitoring.

For more information on NEED, the data contained within it and how it is produced, see Annex A of the Domestic NEED 2023 Report.

# Analysis Method

*This section details how we conducted this analysis, including the data used and how the estimates of energy savings attributable to the installation of a smart meter were produced.*

## Overview of the method

Our methodology for analysing smart meter energy savings using NEED was designed to emulate the methods typically used by energy suppliers. It should be noted that the data available in NEED is different to that available to energy suppliers, so this is considered a 'best effort' at providing comparable evidence. Strict comparisons of the results with the energy supplier evidence are not advised. The method is nonetheless similar to methods used by energy suppliers and advised by BIT in their guidance, as well as the method used in DESNZ's regular NEED analysis of savings from energy efficiency measures. See Appendix E for an overview of the key differences in methods necessitated by these different sources.

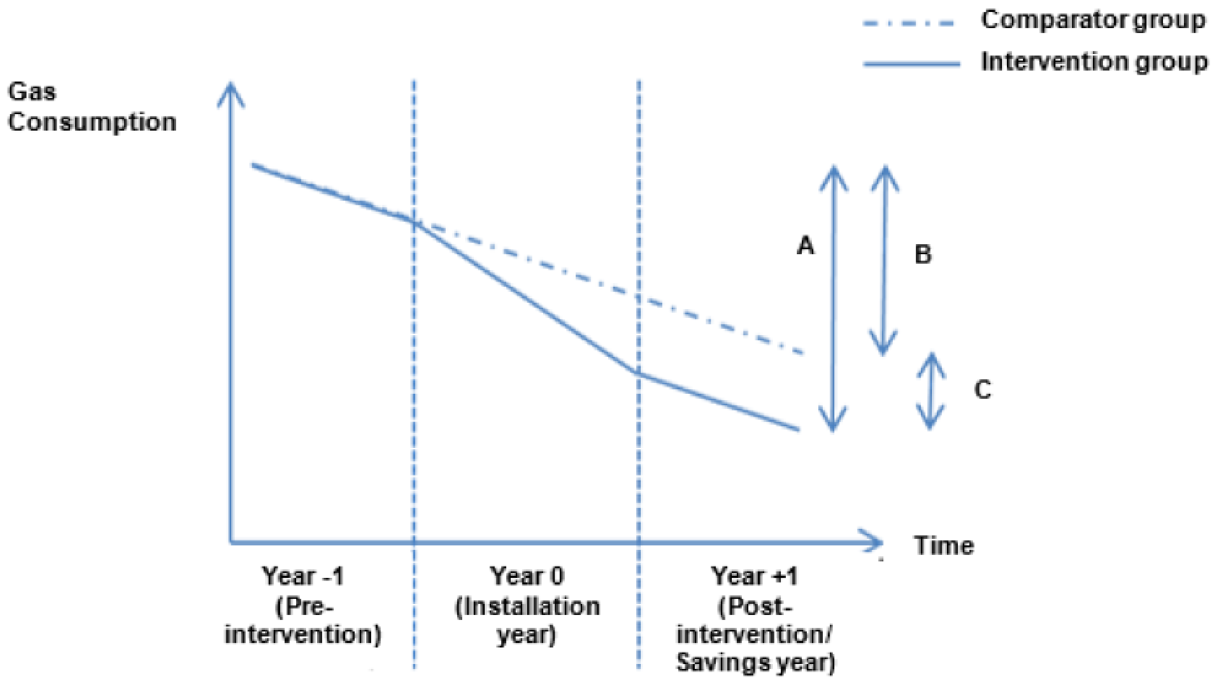
A 'matched difference-in-difference' approach is used to estimate the impact of smart meters on domestic energy consumption. In this analysis, this worked by comparing the energy consumption in dwellings after a smart meter installation with consumption before the installation. The change in consumption for dwellings that have had a smart meter installed (the intervention group) is compared with a 'matched' group of similar dwellings that did not have a smart meter installed (the control group). The impact of the smart meter is taken as the difference in the consumption trends of the two groups after the smart meter installations took place.

## Installation cohorts and temporal coverage

The analysis uses a cohort approach in which dwellings that have had smart meter installations are grouped into annual cohorts referred to in this report as the 'installation year'.

The savings are estimated by comparing consumption in the years after the installation year with consumption in the year before the installation year, using a group of similar but traditionally metered dwellings as a baseline (see Figure 3 for an illustration).

**Figure 1 - Difference-in-difference approach (using gas consumption as an example)**




**On the diagram, 'C' is taken as the difference in consumption attributable to the intervention.**

Source: DESNZ (2023), Domestic NEED 2023 Annex D: Methodology Note.

The installation cohorts and the precise time periods in which they had their installations are shown in Table 1.

**Table 1 - Smart meter installation cohorts**

| Installation cohort | Electricity installation period | Gas installation period |
|---|---|---|
| 2015 | February 2015 to January 2016 | September 2015 to Mid-July 2016 |
| 2016 | February 2016 to January 2017 | Mid-July 2016 to Mid-June 2017 |
| 2017 | February 2017 to January 2018 | Mid-July 2017 to Mid-May 2018 |
| 2018 | February 2018 to January 2019 | Mid-June 2018 to Mid-May 2019 |

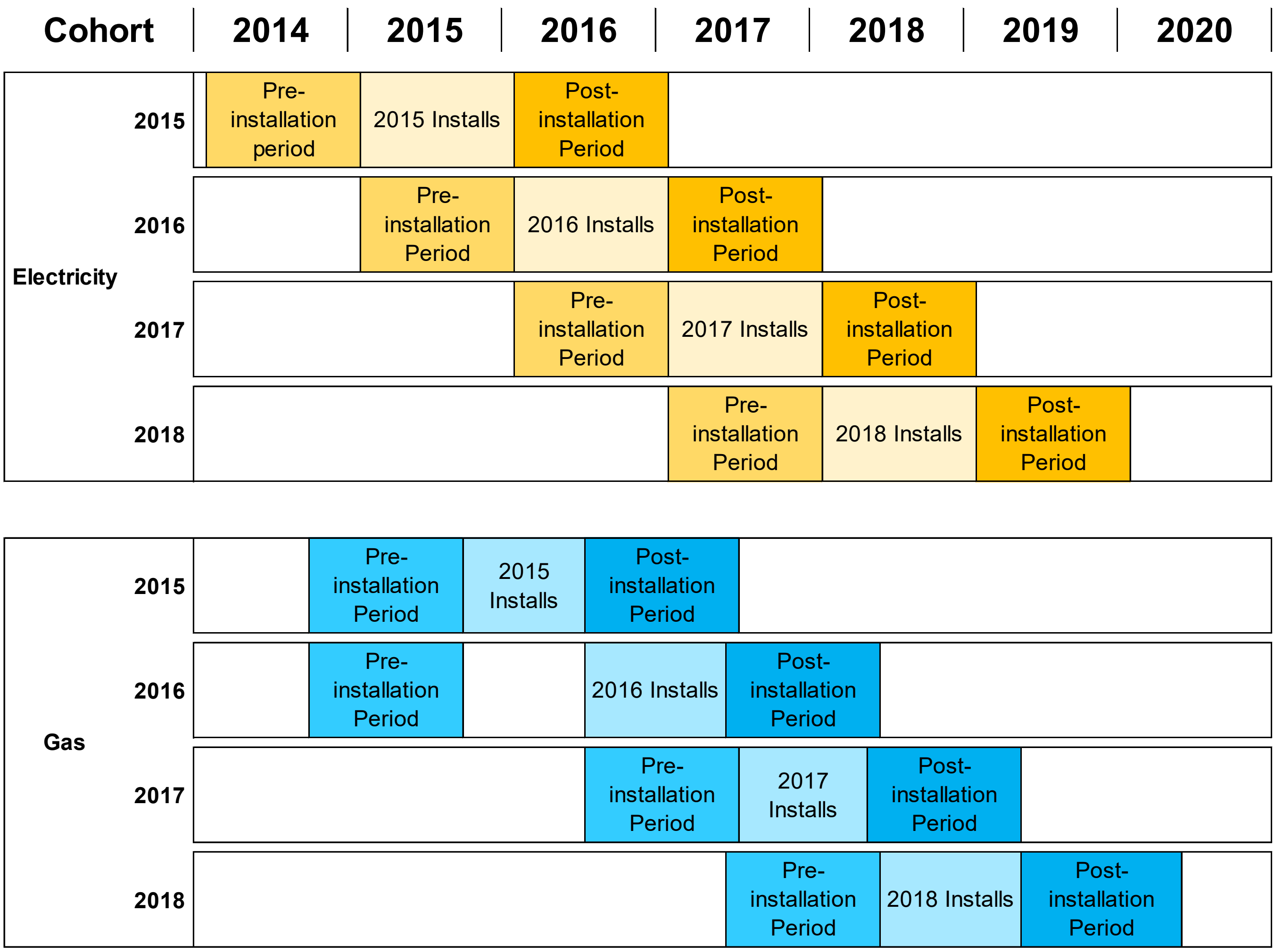
For ease of reporting, the year in which the installation year began is used as the label for each cohort. However, the installation cohorts for electricity and gas installations do not completely overlap and results for each fuel should be considered distinct. For example, the 2016 gas savings are not an estimate of the gas savings for the 2016 electricity smart meter installation cohort, and vice versa. This is because the consumption time periods in NEED differ for each fuel.

As the most recent consumption data available in NEED at the time of this analysis was for 2019 and consumption must be observed for at least a year after the installations, the most recent installations that could be included are the 2018 cohorts.

Some gas installation periods do not cover a full 12 months. This is because the time periods for gas consumption in NEED are shorter in some years and there is sometimes a one month overlap between the time periods. Installations in the overlapping periods have been excluded to prevent contamination (e.g. a smart meter installed in the pre-installation consumption period would undermine a pre and post-installation comparison of consumption). Beyond that, this has no effect on the analysis because the time period is the same for the smart and traditionally metered dwellings, and it compares the consumption trends over time, rather than absolute consumption.

Figure 4 shows the periods of energy consumption used for the analysis around the installation years for the first-year saving analysis. For the three-year analysis described later in this report, the post-installation consumption periods were the three NEED consumption years after the installation.

**Figure 2 - Smart meter installation cohorts and observation periods**




Note that the 2015 and 2016 gas smart meter installation cohorts use the same pre-installation period. This is because there is a gap between the 2015 and 2016 gas consumption years in NEED. The 2015 gas cohort is taken as installations in that gap, using the '2015 gas consumption year' as the pre-installation year.

Full details of the consumption years used in this analysis can be found in Annex A to the 2021 NEED report (page 8).

# NEED data used in this analysis

The NEED data used in this analysis is summarised in Table 2. The dataset underpinning the 2021 NEED analysis (which reported on energy consumption in 2019) was used as the base for the analysis, with the additional data required for an analysis of smart meter energy savings appended.

**Table 2 - NEED data sources used in the smart meter energy savings analysis**

| Data | Source | Purpose |
|---|---|---|
| **Meters and consumption** | | |
| Gas meters and gas consumption | Xoserve | To signify gas supply and provide consumption data.<br>Note that gas consumption is weather corrected in line with regular NEED analysis. |
| Electric meters | Gemserv | To signify electricity supply, enabling data linking and identifying meter profile classes |
| Electricity consumption | Electricity data aggregators | To provide consumption data for analysis |
| **Geographical information** | | |
| Geographies and area classifications | Office for National Statistics (ONS) | For matching smart metered and traditional metered dwellings to enable a comparison of energy consumption trends around a smart meter installation |
| **Property characteristics** | | |
| Domestic properties in England and Wales | Valuation Office Agency (VOA) | For matching smart metered and traditional metered dwellings to enable a comparison of energy consumption trends around a smart meter installation |
| Domestic properties in Scotland | Scottish Assessors Association (SAA) | For matching smart metered and traditional metered dwellings to enable a comparison of energy consumption trends around a smart meter installation |
| **Additional NEED data appended to the 2021 dataset** | | |
| Gas meter type and installation date | Xoserve | For identifying smart meter installations and installation dates |
| Electricity meter type and installation date | Elexon | For identifying smart meter installations and installation dates |
| Electricity supplier | Electricity data aggregators | To assign installations to energy suppliers and for matching smart metered and traditional metered dwellings |

The source and construction of the consumption, geographical and property characteristic information is detailed in full in Annex A to the 2021 NEED report. As there is significant overlap with the 2021 NEED Impact of Measures (IoM) analysis, only the additional data are described in this report. Any other deviations from the data used in the NEED IoM analysis method are explained in the step-by-step explanation of the methodology or in Appendix E.

## Meter type and installation dates

As explained in the introduction, information on a dwelling's meter type and installation date has been gathered in NEED but has usually been applied to ensure the integrity of other analysis. It has never been the primary subject of any analysis, and the data has not been collected, cleaned, and structured with this purpose in mind. The first part of this project therefore involved confirming the provenance of this data and assessing its suitability for an analysis of savings from smart meter installations.

### Gas meter data

The gas meter information in NEED has been provided by Xoserve. For the data provided to DESNZ, Xoserve uses information from gas shippers (the Meter Mechanism Code) to designate whether the installed meter is a smart meter. This designation represents the type of meter installed, regardless of current operational status. The remainder are assumed to be traditional meters. Xoserve provide this data as a 'snapshot', capturing the type of smart meter at the time of the data request.

Installation dates are also available alongside the type of meter (for the smart meters only) representing the date that the current meter was installed. It is important to note that this does not necessarily represent the date a smart meter was first installed, and some installation dates are likely to be for replacements. This could introduce some error deflating any observed smart meter energy savings, as some smart metered dwellings will have had a smart meter in their designated 'pre-installation' consumption period. However, as replacements are uncommon and were especially rare when the installations included in this analysis took place (relatively early in the roll-out), this should have little impact on the results.

The data on meter type and installation dates is provided at the meter level and linked by the NEED team to dwellings using a process similar to that used for linking consumption data to dwellings (i.e. linking Meter Point Reference Numbers (MPRNs) to Unique Property Reference Numbers (UPRNs)).

The 'snapshot' of gas meter status and installation dates used in this analysis was taken in Autumn 2020. As detailed earlier, only gas smart meter installations up to mid-2019 were analysed in this study as consumption data was not yet available for later installations.

### Electricity meter data

The electricity meter data used in this analysis was provided by Elexon and derived from the meter exchange database. The data provided to DESNZ included a designation for the meter type for all electricity meters in Great Britain as well as an installation date. Like the gas data, this data was provided as a 'snapshot' at the time of the request. The snapshot used in this analysis was taken in January 2019, aligning with the end of the time period for the 2018 electricity consumption data. This was a one-off data request from Elexon and is not routinely gathered.

Like the gas meter data, the electricity meter installation dates are also assumed to represent the date the current meter was installed, rather than the first smart meter installation. The electricity meter data is also linked to dwellings (Meter Point Administration Numbers (MPANs) to UPRNs) in the same way as the gas meter data.

Quality assurance of the electricity and gas meter data against similar sources[7] confirmed its reliability. See Appendix A for the results of the quality assurance.

## Information on energy (electricity) supplier

The analysis uses information on the dwelling's energy supplier to assign smart meter installations to energy suppliers.

It is also used in the matching of smart metered dwellings and traditional metered dwellings to ensure they had the same electricity supplier as each other across the installation and consumption periods. Dwellings were also only included where the electricity supplier remained the same across those periods. This was for several reasons:

- The characteristics of energy customers vary across suppliers and particularly newer energy suppliers. Matching on electricity supplier enables a more like-for-like comparison of smart and traditional meter customers, avoiding bias from unobservable attitudinal or behavioural factors.
- NEED does not track occupancy changes in dwellings. As changes in energy supplier are likely to correlate with occupancy changes, ensuring a consistent energy supplier reduces any bias this could introduce. This also aligns with energy supplier studies, which evaluate the savings at the customer-level.
- NEED does not track tariff rates which could result in different consumption patterns if there is imbalance on rates between the two groups. For example, if the smart meter group are more likely to have switched to a cheaper tariff, they might increase their consumption, masking any savings occurring in response to the smart meter. Research suggests that the difference in switching rates between smart and traditionally metered consumers at the time of these installations was relatively small.[8] However, as it is not possible to confirm balance on the exact tariff rates, ensuring a consistent energy supplier helps minimise any bias introduced by unobserved tariff changes.
- It replicates the approach used by energy suppliers (and reviewed by BIT), who necessarily can only include customers who remain with them for the entire analysis period. They can also only match their smart metered customers with their own traditional metered customers.

The implications of this matching criterion for interpreting the findings of the analysis are discussed in the Findings chapter.

[7] This included including checks against DESNZ' official statistics on installation progress, which are based on data returns from energy suppliers, and cross-checking the gas and electricity meter data in NEED (which are provided from different source and data processes).
[8] For example, an Ofgem survey in 2018 reported that 37% of smart metered households had switched gas or electricity tariff in the previous 12 months, and 29% of traditional metered households had done the same. See Ofgem (2018), Consumer Engagement Survey Report 2018: Data Tables: https://www.ofgem.gov.uk/publications/consumer-engagement-survey-2018

The data on electricity supplier is provided yearly alongside the annual electricity consumption data and represents the electricity supplier for that meter at that time (the end of January in each year).[9] As this data is not regularly used by the NEED team, it was quality assured through comparisons with SMIP's roll-out monitoring data from energy suppliers.

As information on the gas supplier was not available, dwellings in the gas analysis were matched based on their electricity supplier. As some customers have a different electricity and gas supplier, this will mean that some installations have not been attributed to the correct energy supplier and some will not have been matched to dwellings that are truly with the same supplier for the given fuel. However, given the scale of this analysis and that it is rare to have a different electricity and gas supplier, any error introduced is unlikely to have a material impact on the results.[10]

# Step by step method

The next section explains how the analysis was performed for each installation cohort.

## Step 1 – Append meter type, installation date and other required data to the 2021 NEED dataset

The starting point for the analysis is the dataset created in Step 2 of the 'Consumption Estimates Methodology' described in Annex D to the 2021 NEED report.

This step links the meter-level energy consumption data to the 28.2 million dwellings in Great Britain. After Step 2, there are 26.2 million dwellings in the electricity sample and 22 million dwellings in the gas sample (England, Wales and Scotland combined).

The data on the type of energy meter, installation date (if a smart meter has been installed) and electricity supplier are appended to this dataset using the same address linking procedure as the consumption data. The only exception is that any properties with more than one meter for the given fuel are discarded from our dataset. This is because of uncertainty that having two meters can introduce to the analysis (e.g. multiple installation dates, mixed metering where a smart meter and traditional meter are both present, and having multiple electricity suppliers).

An additional variable from the VOA and SAA databases representing the floor area of the dwelling is also appended at this stage (this is used in Step 4).

## Step 2 – Determine the smart and traditional metered groups

The sample is split into the smart metered and traditionally metered groups to be considered for the analysis for the installation year in question.

[9] Note that the because the electricity supplier must remain the same across the observation periods, there is little risk that the electricity smart meter installation has been assigned to the wrong supplier due to a supplier switch during the installation year.
[10] See Ofgem (2018), Consumer Engagement Survey Report 2018 for example. In 2018, 92% of electricity and gas supplied households said they had the same energy supplier for both fuels. The proportions were similar for smart and traditional metered customers (94% and 91% respectively).

The smart meter group includes any dwellings that had an installation during the set installation period (see Table 1 on page 10). The traditional meter group includes any dwellings that have not had a smart meter installed or have had a smart meter installed since the post-installation observation period.

## Step 3 – Apply exclusion criteria

Several exclusion criteria are applied in line with typical practice in the energy supplier studies and BIT's guidance:

1. Dwellings must have an electricity supply and a gas supply, i.e. a dual-fuel energy customer
2. For the electricity sample, dwellings must be a Profile Class 1 customer for the duration of the analysis periods (from the start of the pre-installation year to the end of the post-installation year).[11] This criterion limits the sample to customers on single rate tariffs.
3. Dwellings must have had the same electricity supplier for the duration of the analysis periods. As explained previously, this is also applied to the gas dwellings as a proxy for the gas supplier.

These criteria are applied to ensure a like-for-like comparison in the analysis. The vast majority of dwellings remain in the samples after 1 and 2; almost all gas dwellings and more than 80% of smart metered electricity dwellings. The third criterion has a more notable impact, with an average of 22% excluded from each installation cohort. The implications of these exclusions are discussed in the findings section.

Another exclusion criterion was considered for any dwellings that had an energy efficiency measure installed during the analysis time periods. This was not applied as the proportion of homes having installed a measure was small (less than 10%) and the proportions were similar across the smart and traditionally metered dwellings, so this was unlikely to influence the results. A sensitivity analysis confirmed this and is presented in Appendix D.

Unlike the NEED IoM analysis, flats are included in the analysis despite their lower representation in NEED due to lower address matching rates.[12] This is for several reasons:

- Energy suppliers do not exclude flats in their studies (and are usually unable to do so).
- Flats are an important segment of interest in the evaluation of the roll-out due to additional logistical and technical challenges of installing smart meters in them.
- Flats form a small proportion of the overall sample, so any bias in the sample of flats is unlikely to influence the aggregated energy savings estimates.
- The analysis aims only to estimate the savings achieved for specific installation cohorts included in the final analysis sample, which is the approach typically used by energy suppliers. No attempt is made to estimate the savings for excluded dwellings (e.g. via

[11] Further information on the electricity profile classes can be found here: https://bscdocs.elexon.co.uk/guidance-notes/load-profiles-and-their-use-in-electricity-settlement
[12] Note that rare property types (e.g. cluster houses and caravans) are excluded in this analysis.

weighting). The bias in the sample of flats does not undermine the conclusions of the study and is instead accepted as a limitation in the coverage of the findings.

## Step 4 – Remove dwellings with invalid or missing data

We exclude any dwellings from the analysis if any of the following conditions hold for the consumption figures for either the pre-installation year or post-installation year(s):

- The consumption estimates are not within a plausible range. For gas, the plausible range adopted is 1,000 kWh – 40,000 kWh. For electricity, it is 500 kWh – 12,000 kWh.
- The consumption figure is an extreme change on the previous year's figure at the same dwelling (an increase or decrease of more than 50%).
- The consumption figure is suspected to be imputed or estimated. This is the case if:
    a) The figure is identical to the figures for either of the previous two years at the dwelling.
    b) The figure corresponds to a spike in the distribution of the consumption values for the year in question. Such spike values in the distribution are identified by rounding the consumption values for all properties to the nearest kWh, counting the number of properties by each kWh and ordering the counts by the rounded kWh. Values that are more than 300% higher than the two values either side are considered to be spike values.

Dwellings are also excluded if there is missing information for any of the following attributes:

- Property type
- Property age
- Floor area
- Region (formerly known as Government Office Region)
- Electricity supplier

## Step 5 – Match each smart metered dwelling to a traditionally metered dwelling

We attempt to match each dwelling in the smart metered group to a comparable dwelling in the traditionally metered group using a simple 1:1 matched pair methodology. For each smart metered dwelling, a traditionally metered dwelling is selected from the pool of traditionally metered dwellings that meet the matching criteria:

- Property type group
- Property age group
- Region
- Floor area (within $10m^2$)
- Pre-installation consumption (± 50kWh for electricity and ± 200kWh for gas)

- Same electricity supplier across all observation years

Exact matching is used for the categorical criteria and calliper matching is used for pre-installation energy consumption and floor area.[13] The matching is conducted without replacement, meaning that each traditionally metered dwelling can only be matched to one smart metered dwelling.

On average, 84% of the electricity smart meter installations and 89% of the gas smart meter installations were successfully matched to a traditionally metered dwelling (see Appendix C for detailed attrition tables).[14]

A 'parallel trend test' was also conducted to evaluate the success of the matching methodology in creating a valid consumption baseline for the estimation of smart meter energy savings. This suggested that the matching was successful in this regard. See Appendix B for the findings of the test.

## Step 6 – For each supplier, select 10,000 pairs for inclusion in the final savings estimate

This analysis reports findings at the energy supplier-level. Having created the dataset of matched pairs of smart and traditionally metered dwellings, Step 6 segments the dataset in preparation for the supplier-level analysis.

To ensure anonymity in the results, the results in this report are based on a selection of 10,000 random pairs of smart metered and traditionally metered dwellings from each supplier's set of installations in the given year. 10,000 was chosen to correspond with BIT's guidance on the minimum sample sizes required for a reasonably precise energy savings analysis.

Also in line with BIT's guidance, suppliers were excluded if either of the following was true:

- They had less than 10,000 smart meter installations in the final sample for the given year
- Less than 70% of their smart meter installations could be matched to a similar traditionally metered dwelling

One of the 2016 electricity installation cohorts was also excluded due to anomalous consumption data for dwellings with that supplier in 2017.

Across the four installation years (2015 to 2018), the final analysis included 20 supplier-level electricity smart meter installation cohorts, and 22 gas smart meter installation cohorts. Descriptive statistics for each year's installations can be found in Appendix C.

[13] This avoids a problem with exact matching where dwellings cannot be matched despite having near-identical consumption levels and floor areas due to the arbitrary nature of category boundaries (e.g. a cut off of 1,500 kWh/year means that a dwelling with 1,499 kWh/year pre-installation consumption cannot be matched with a dwelling with 1,501 kWh/year pre-installation consumption). See page 14 of BIT's guidance for more information: BIT (2020), Guidance on conducting energy consumption analysis: https://www.bi.team/publications/guidance-on-conducting-energy-consumption-analysis/.

[14] The match success rates for the samples remaining after Step 6 (which removes installations for any supplier cohort where the match rate was lower than 70%) were typically above 90% for each fuel.

## Step 7 – Use bootstrapping to produce final energy saving estimates and 95% confidence intervals

The first step in estimating the energy savings was to calculate the **percentage consumption change** for the smart metered group and the traditionally metered group separately:

$$\frac{\text{(Total post-installation consumption – Total pre-installation consumption)}}{\text{Total pre-installation consumption}}$$

The second step is to calculate the **difference between those two consumption changes**:

(Smart percentage consumption change) – (Traditional percentage consumption change)

This gives the savings estimate for the installation cohort. A negative value represents a saving (a % decrease), so for ease of interpretation the estimates are transformed by multiplying the estimate by -1. A positive value represents a reduction/saving and a negative value represents an increase in consumption.

To account for statistical uncertainty in the estimates (e.g. due to sampling error and heterogeneity in energy consumption over time), bootstrapping was used to calculate final energy saving estimates and 95% confidence intervals.

Bootstrapping is a statistical procedure that uses random resampling from a sample dataset as a way of estimating uncertainty. It creates many simulated samples, each of which produce a different savings estimate that form a distribution of potential results. That distribution can then be used to communicate uncertainty.

In this analysis, 100 bootstrap samples were generated for each supplier installation cohort. The 10,000 pairs were resampled (with replacement) from the original 10,000 pairs to create a 'new' set of 10,000 pairs.[15] The savings estimate was calculated for each bootstrapped sample and the process repeated 100 times. The final energy savings estimate is the average (mean) of the 100 savings estimates. 95% confidence intervals are taken as the 2.5$^{th}$ percentile and the 97.5$^{th}$ percentile of the 100 savings estimates. Note that because a sub-sample is used the reported confidence intervals are conservative and are substantially smaller in the full installation samples (reaching approximately ± 0.3% when the number of installations is above 30,000).

## Final sample sizes

The tables below show the final sample sizes for the analysis. These sample sizes represent the sample before the 10,000 pairs are taken (i.e. after Step 5), excluding any installations

[15] This bootstrapping approach is known as a paired or block bootstrap. It is often used for estimating uncertainty when using matching without replacement. See: Austin, P.C., Small, D.S. (2014) 'The use of bootstrapping when using propensity-score matching without replacement: a simulation study'. Stat Med. 2014 Oct 30;33(24). 4306-19: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4260115/

from suppliers that are not included in the final analysis due to small sample sizes or low match rates.

To demonstrate the coverage of the final NEED samples used in this analysis, the sample sizes are also shown as a proportion of the smart meter installations recorded in the official statistics for that year.

**Table 3 - Final cohort sample sizes**

| Installation cohort | NEED final electricity installation sample | % of recorded electricity installations[1] | NEED final gas installation sample | % of recorded gas installations[2] |
|---|---|---|---|---|
| 2015 | 243,783 | 28% | 250,019 | 37% |
| 2016 | 457,158 | 28% | 471,717 | 28% |
| 2017 | 641,188 | 24% | 417,689 | 20% |
| 2018 | 402,680 | 15% | 328,465 | 16% |
| **Totals** | **1,744,809** | **22%** | **1,467,890** | **23%** |

[1] The annual time periods covered by the recorded official statistics are January to December. The electricity smart meter installation periods in NEED are February to January, and do not align completely.

[2] The time periods covered by the recorded official statistics are July to June. The gas smart meter installation periods in NEED are typically June to May, and so do not align completely.

Detailed attrition tables demonstrating the effect of each step in the methodology on the sample are provided in Appendix C.

## What 'treatment effect' do the savings represent?

The results produced by this method should be interpreted as estimates of the savings for the specific dwellings included in the final samples. No weighting is applied to represent excluded dwellings, wider supplier customer bases or the GB housing stock.[16]

[16] To use formal evaluation terminology, the treatment effect estimated in this analysis is most closely aligned with an Average Treatment Effect on the Treated (ATT) for the installations in each cohort (with the exception of the excluded installations). This aligns with the energy supplier studies in BIT's review but contrasts with the regular NEED IoM analysis which is more comparable to an Average Treatment Effect (ATE) due to the weighting applied.

# Findings

*This chapter presents estimates of the impact of smart meter installations that took place between 2015 and 2018 on electricity and gas consumption for dwellings in England, Wales and Scotland. It also outlines important considerations for interpreting the results.*

The first analysis estimates savings for the first full year post-installation. The second is a longitudinal analysis, estimating savings for three years post-installation.

Note that whilst the installations are grouped into annual cohorts in this analysis, in reality they are distributed throughout the year. This means the first-year savings observation period will take place within the two years post-installation (and the three-year savings period will be within the four years post-installation).

All findings are reported at the level of the energy supplier that installed the smart meter. To ensure anonymity, the results in this report are based on random and representative samples of 10,000 installations per year for each supplier. Electricity and gas impacts are analysed separately. The installation cohort for one fuel may not be the same as the installation cohort for the other fuel.

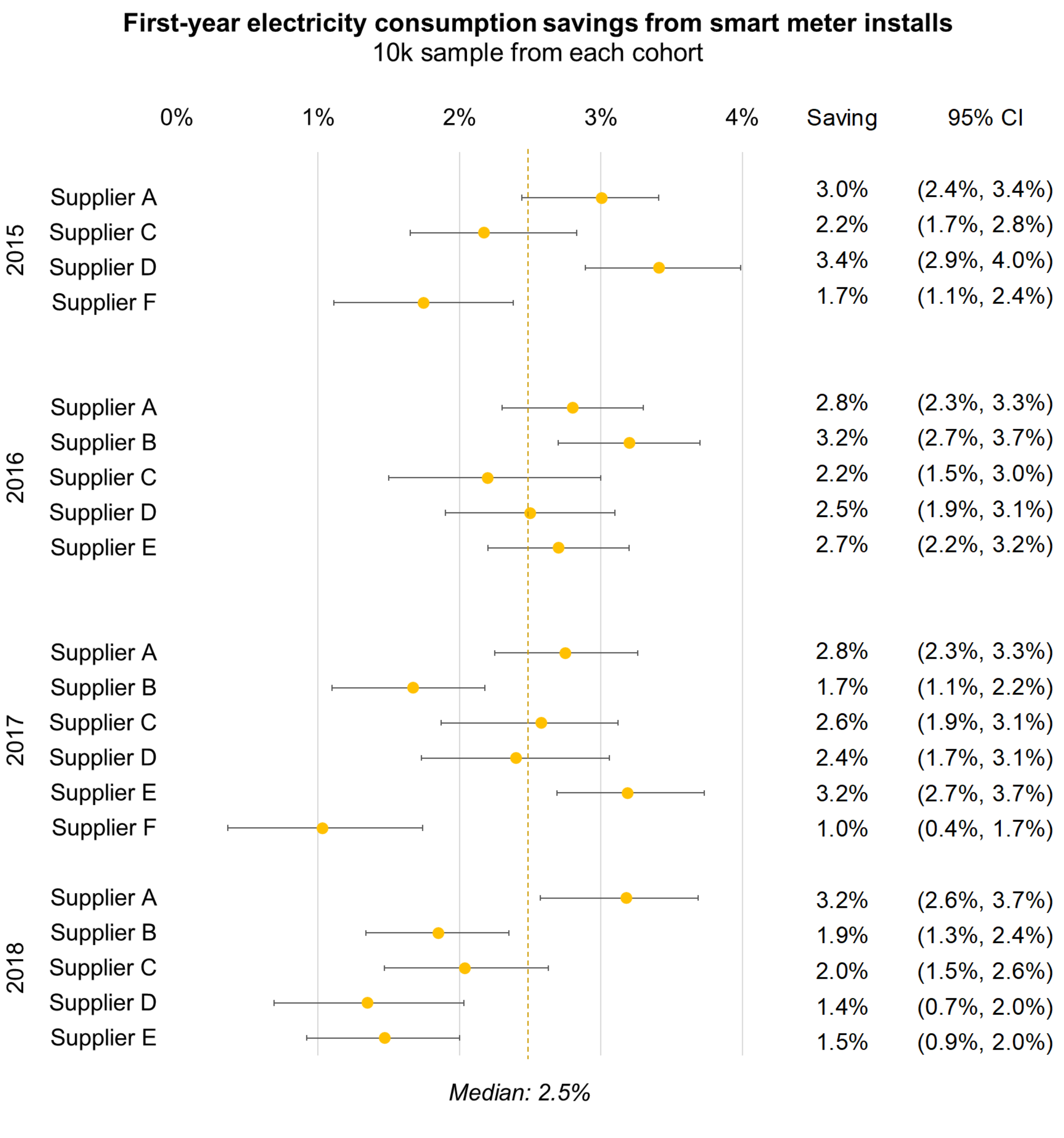
## First-year savings

### Electricity

Figure 5 shows the results for the electricity smart meter installations first-year savings analysis. The vertical axis lists the supplier installation cohorts across the years. The horizontal axis is the energy consumption saving or reduction. The dots on the chart are the first-year saving estimates for each installation cohort and the error bars demonstrate the uncertainty around the estimate (a 95% confidence interval).

A significant first-year electricity saving was observed for all 20 installation cohorts. Savings ranged from a low of 1.0% to a high of 3.4%. The median cohort electricity saving was 2.5%.

**Figure 3 - First-year electricity consumption savings from smart meter installations (2015 – 2018)**

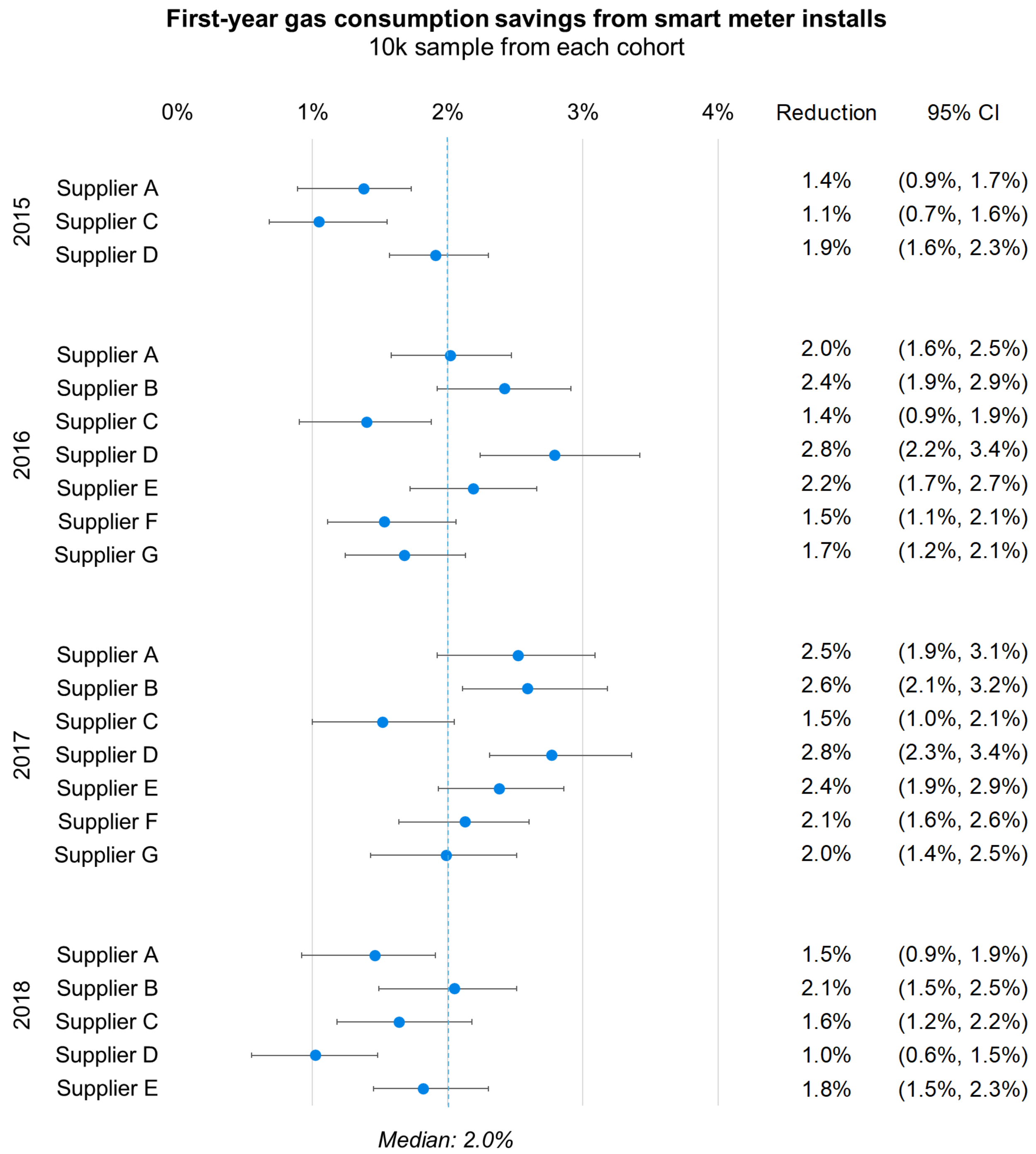



## Gas

As with the electricity results, a significant first-year gas saving was observed for all 22 installation cohorts. Savings ranged from 1.0% to a high of 2.8%. The median gas saving was 2.0%.[17]

[17] When comparing with the gas saving assumptions in the smart meter roll-out cost-benefit analysis, readers should note that there are different assumptions for credit and prepay customers (2.2% and 0.5% respectively) but the samples in this analysis combine credit and prepay customers. The results cannot be directly compared

**Figure 4 - First-year gas consumption savings from smart meter installations (2015 – 2018)**

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with those assumptions. A more appropriate comparison figure is 1.95%, which would be the aggregate gas saving, assuming that 14% of gas customers are prepay (based on the [2017-18 English Housing Survey]).

# Three-year savings analysis (longitudinal analysis)

A secondary analysis was conducted to examine longer-term savings and whether the savings observed in the first-year are sustained beyond that year.

The analysis looked at the energy savings across the three years post-installation. It is a longitudinal analysis, meaning that the same dwellings are included across all the observation periods. As the most recent consumption data available was for 2019, the analysis could only be completed for installations in 2015 and 2016. The same method is used as for the first-year analysis, except that the dwellings must also have had valid consumption data across the additional observation years and remained with the same electricity supplier over those years too. The savings are again estimated by baselining against consumption in the year before the installation.

Approximately 65-70% of the dwellings included in the first-year savings analysis are eligible for the three-year savings analysis (see Appendix C for full information on attrition and sample sizes). This equates to around 18% of actual electricity smart meter installations and 25% of actual gas smart meter installations recorded in official statistics for 2015 and 2016.

## 2015 installations

Figures 7 and 8 show the results of the three-year savings analysis for electricity and gas smart meter installations, respectively. The savings estimates for the first-year will differ slightly from the main analysis because this uses a subsample of those dwellings, but these are not the focus here. We are interested in the consistency of the savings across the 3 years post-installation.

Whilst the confidence intervals in this analysis are relatively wide (max. ± 0.7%)[18], the first-year savings appear sustained across the 3 years after the installations for all cohorts and for both fuels. The savings for the Supplier C gas installation cohort are a possible exception. Supplier C's remain within the first-year estimate confidence interval but fluctuate more substantially than the other cohorts. Nonetheless, a statistically significant saving remains in the third year (0.9%).

[18] As explained in the methods chapter, these are conservative due to the use of a sub-sample of 10,000 installations for each supplier.

**Figure 5 – Three-year electricity consumption savings from 2015 smart meter installations**

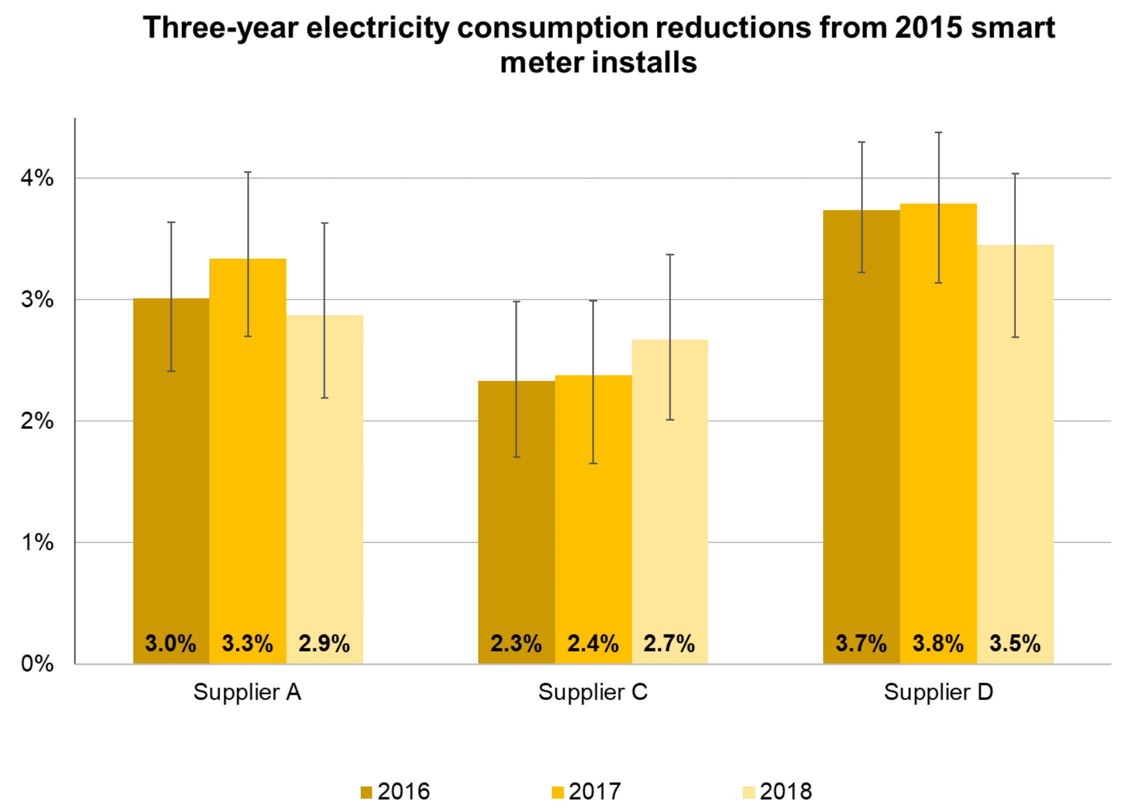
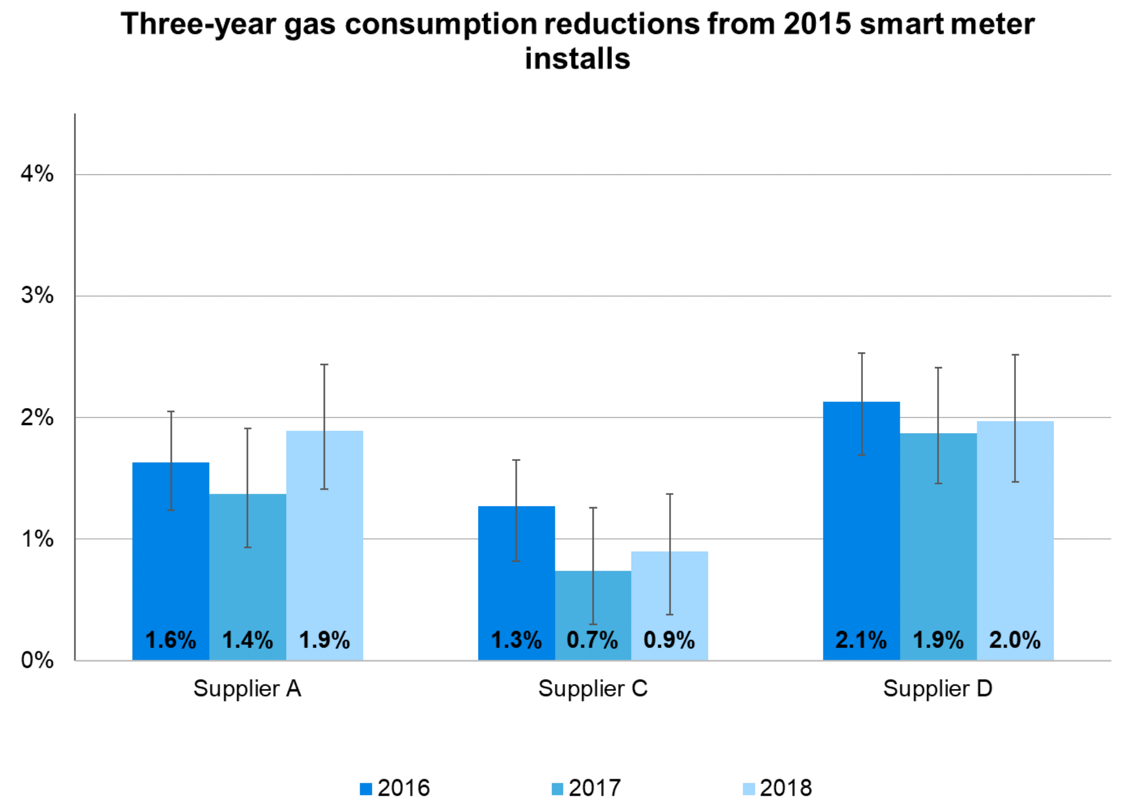



**Figure 6 – Three-year gas consumption savings from 2015 smart meter installations**



## 2016 installations

The trend for the 2016 electricity installation cohorts is similar to 2015, with savings appearing sustained across all three years for all five cohorts. Gas savings appear sustained for two of the four gas installation cohorts but appear to decrease in the third year for the other two cohorts. The savings nonetheless remain statistically significant by the end of the third year (0.9% and 1.5%)

**Figure 7 – Three-year electricity consumption savings from 2016 smart meter installations**

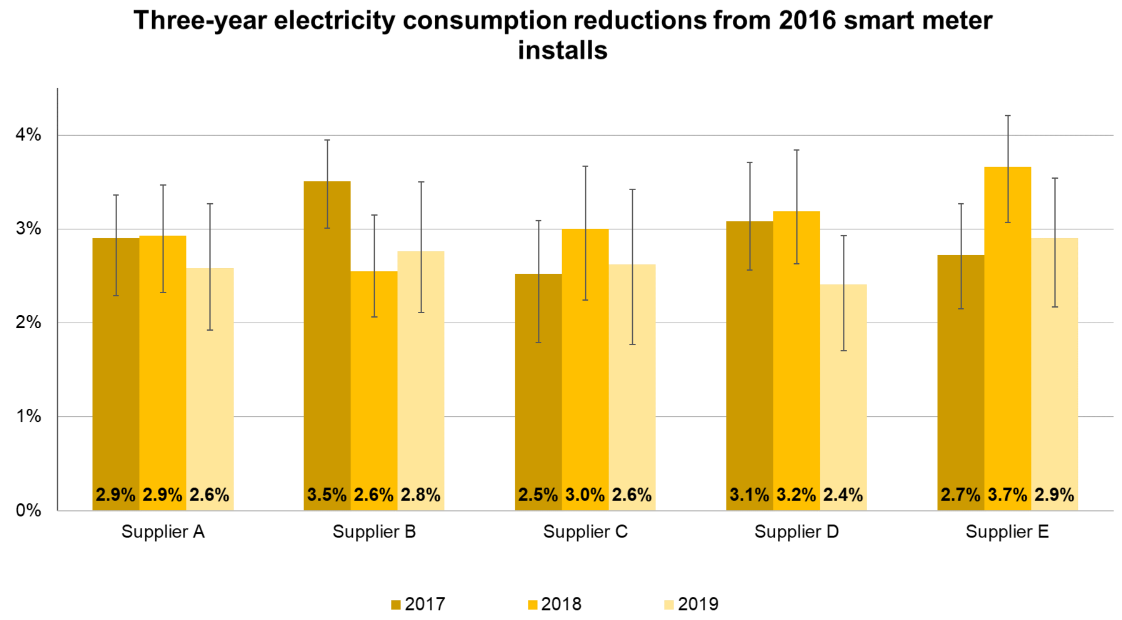
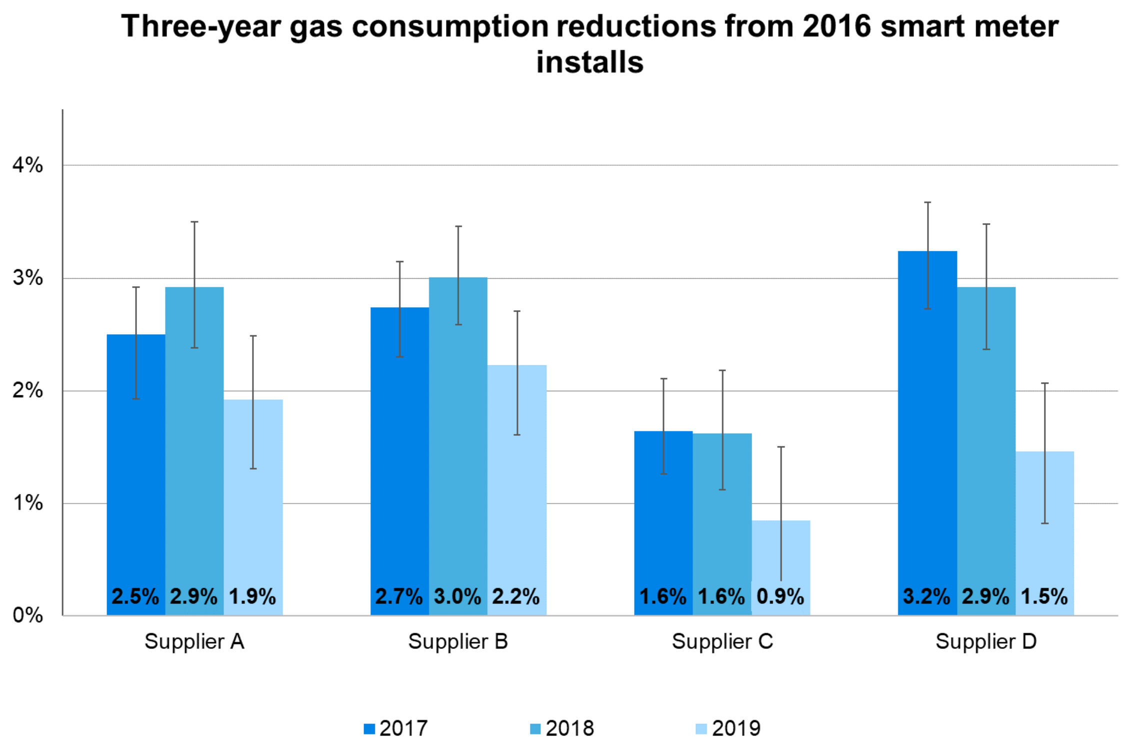



**Figure 8 – Three-year gas consumption savings from 2016 smart meter installations**



## Considerations when interpreting this analysis

- Savings are analysed for electricity and gas smart meter installations independently. The first-year savings are based on the first full consumption year after the installation as defined in NEED. This means, for example, that if an electricity installation took place in March 2016, the saving estimate is based on consumption in 2017 (compared with consumption in 2015). Depending on when the installation occurred, the first-year savings observation period can be anytime in the first two years post-installation (and the three-year savings period can be up to four years).
- Dwellings are included where a smart meter has been installed. Some smart meters can temporarily operate in traditional mode for several reasons, including customers switching to an energy supplier who is currently unable to operate the meter. In some cases, this can affect In-Home Displays and customers may temporarily be unable to access feedback on their energy consumption. As dwellings are excluded where there has been a switch of electricity supplier, the impact of switching will be limited in the results. The results will however include the impact of operational issues from other causes.
- The analysis population is dual-fuel dwellings in Great Britain. The electricity analysis is also limited to dwellings not on a time-of-use tariff. This means that almost all gas-supplied dwellings and more than 80% of electricity-supplied dwellings are in scope. As electricity-only dwellings are not included and a significant proportion of these use electric heating systems (and therefore have higher electricity demand), the analysis may underestimate the electricity savings in the full smart meter installation cohorts.
- Households that did not regularly submit meter readings before having a smart meter installed are likely to be excluded. This is because accurate consumption data is needed. It is unclear whether we would expect different savings for these households. It could be theorised that those who do not submit meter readings are less engaged with energy and less likely to save energy in response to a smart meter installation (though there is no empirical evidence to suggest this). However, this could mean the smart meter group is being compared with a ‘more engaged’ set of traditionally metered households, because the latter are households that submitted meter readings in the post-installation period. Following the same logic, this would result in an underestimate of the smart meter energy saving.
- NEED is a dwelling-level database and there is no visibility of occupancy changes. This enables analysis of long-term savings but also means occupancy changes are possible. Whilst some controls are applied for this (e.g. exclusion of dwellings with extreme consumption changes and where there has been a switch in energy supplier), the savings estimates likely include effects from some occupancy changes.
- Installations for credit and prepay dwellings are analysed together. This has several important implications:
    a) The energy supplier studies in BIT’s review were restricted to credit customers only and this difference should be borne in mind in any comparison of results.

b) There are different gas savings anticipated for credit and prepay customers (2.2% and 0.5% respectively in the [2019 smart meter roll-out cost benefit analysis](#)). This is why an aggregated assumption is used throughout the report to provide a baseline for interpretation (1.95%), based on an assumption that 15% of households pay by prepay.[19]

c) At the time of the installation, prepay households were more likely to have had a smart meter installed and may be disproportionately represented in the smart meter group.[20] If gas savings are indeed lower for prepay households, the gas savings in this study would be an underestimate of what would be found in a fully smart metered GB population.

- Even after the exclusions, the final sample from which the results in this report are drawn cover a substantial proportion of the roll-out - almost a quarter of the smart meter installations between 2015 and 2018: 1.7 million electricity meter installations and 1.5 million gas meter installations.
- The results should be interpreted as estimates of the savings for the specific installations included in the final samples. No weighting or other methods are applied to represent excluded installations, dwellings, wider supplier customer bases or the GB housing stock.

[19] This is a simple weighted average of the two assumptions: (2.2% * 85%) + (0.5% * 15%).

[20] For example, in Ofgem's 2018 Consumer Engagement Survey, 25% of prepay bill-payers said they had a smart meter compared with only 17% of credit bill-payers: Ofgem (2018), Consumer Engagement Survey 2018: https://www.ofgem.gov.uk/publications/consumer-engagement-survey-2018

# Appendix A: Quality assurance of meter information in NEED

## Comparison of NEED smart meter installation dates with official statistics

The first test used to quality assure the information on meter type and installation dates was a comparison with the Department's official statistics on smart meter roll-out progress. These are produced using monitoring data gathered from energy suppliers, a different source to the NEED data. It reports the number of smart meters installed in domestic and non-domestic premises each quarter, as well as the number operating in smart mode as of each quarter.

As the NEED analysis defines a smart meter installation by the meter type, the smart meter installation numbers in NEED were compared with the installation figures in the official statistics (rather than the operating figures). Note that we would expect the NEED figures to track lower than the official statistics because it only includes installations where the meter can be accurately linked to a dwelling and excludes any installations in dwellings where there are multiple meters. We are therefore most interested in the similarity of the trends, which are closely aligned for both fuels.

For gas, the comparison could be extended to Q3 2020 to provide additional assurance. Most notably, the NEED data tracks the official statistics well in 2020 when installation activity was heavily curtailed in Q2 due to Covid-19, before scaling back up later in the year.

**Figure 9 - Comparison of quarterly electricity smart meter installation numbers in NEED with official statistics on the smart meter roll-out**

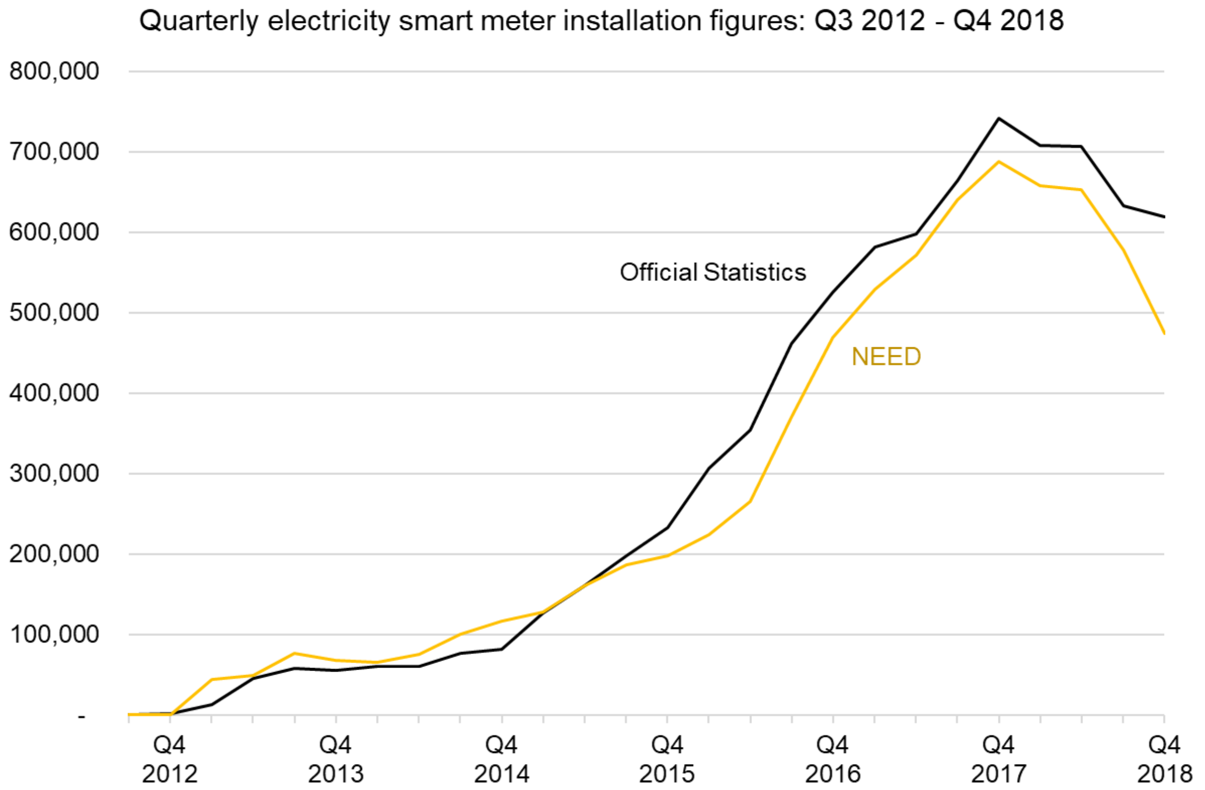
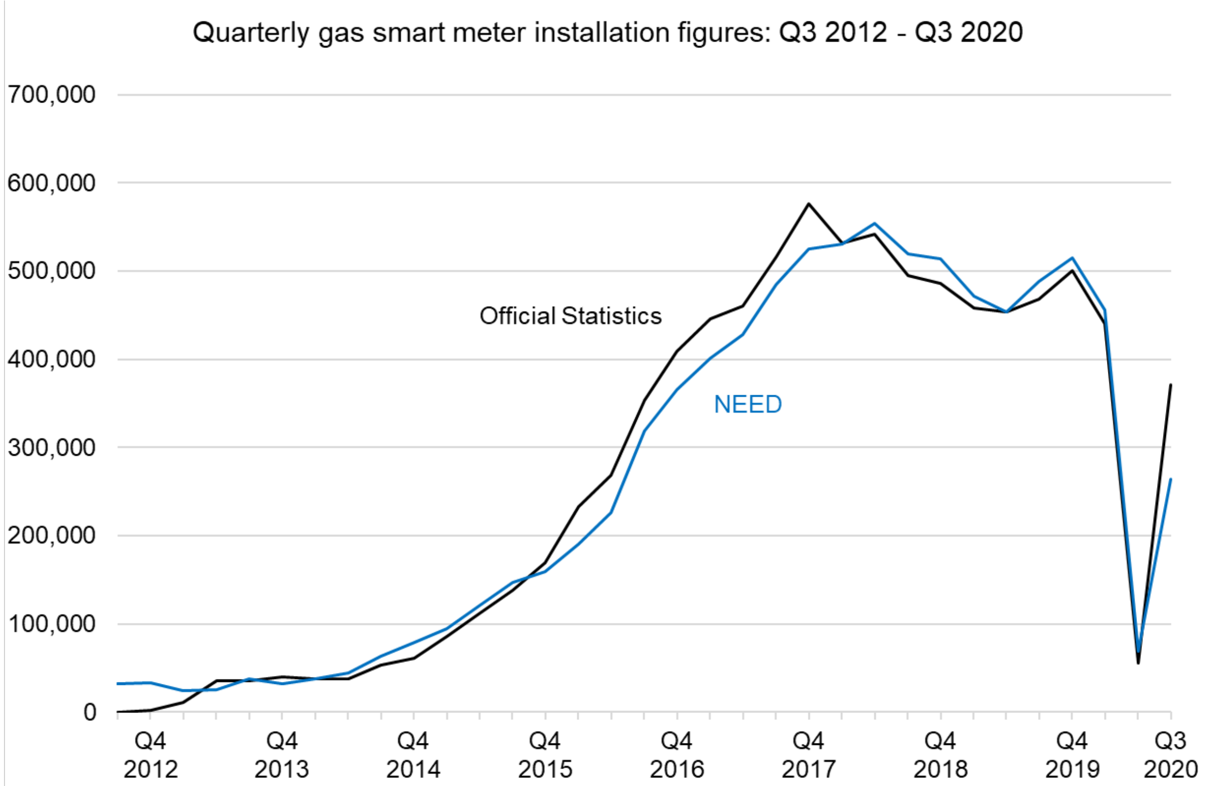



**Figure 10 - Comparison of quarterly gas smart meter installation numbers in NEED with official statistics on the smart meter roll-out**



# Comparison of installation dates for electricity and gas smart meters in NEED

The second test compared the installation dates for the electricity and gas smart meters in dual-fuel dwellings where a smart meter had been installed for both fuels. This test would provide assurance because the meter information in NEED for the two fuels is created using independent processes and gathered separately.

Due to the way smart meters work, the vast majority are expected to have the same installation date and if different, the gas installation date would be later.[21] There would be a small number where the electricity installation is recorded as later than the gas installation because there are rare cases where this happens in practice[22], and also where the electricity smart meter has been replaced but the gas smart meter has not (because NEED records the installation date for the current meter, not the first smart meter install).

The installation dates corresponded with this hypothesis. 89% of the electricity and gas smart meters had the same exact installation date. Most importantly for this analysis - which groups installations by their year of installation - 97% shared the same calendar year. Where the dates differed, the gas smart meter was almost always installed after the electricity smart meter (9%). Few had an electricity smart meter installation recorded after the gas smart meter (2%).

**Table 2 - Comparison of electricity and gas smart meter installation dates in NEED (where both electricity and gas smart meters have been installed)**

| | **Percentage** |
|---|---:|
| Same calendar year | 97% |
| Same calendar quarter | 95% |
| Same install date (exact) | 89% |
| Gas smart meter installed after the electricity smart meter install date | 9% |
| Electricity smart meter installed after gas smart meter install date | 2% |

[21] This is because the communications hub that allows for the communication between the smart meters and the central communications system (the Data Communications Company (DCC)) requires a constant power source and so is attached to the electricity smart meter. The gas smart meter is battery-operated. Therefore, the electricity meter will almost always be installed first.

[22] Sometimes referred to as ‘hot-shoe’ installations.

## Comparison of electricity and gas meter type in NEED

The third test looked at how many dwellings had a smart meter for one fuel but not the other. Following similar logic to the second test, it would be expected that almost all dwellings with a gas smart meter would also have an electricity smart meter.

The test result was in line with this hypothesis: 99% of dwellings recorded as having a gas smart meter were also recorded as having an electricity smart meter.

# Appendix B: Parallel trend test

## Parallel trend test – is the traditional meter group a valid counterfactual for the smart metered group's consumption?

The primary assumption underpinning an impact evaluation using a difference-in-difference methodology is that the smart and traditionally metered groups would have had **parallel trends** in consumption if the smart meters were not installed. The purpose of matching is to help ensure this is the case, on the basis that if similar dwellings and consumers had similar consumption in the past, they are likely to have had similar consumption in the future.

By definition, the parallel trend assumption cannot be proved. However, it is common practice to test this by checking whether the groups had parallel trends in the past. It is rarely possible to do this in evaluations using energy consumption analysis as data is required over lengthy periods of time before the intervention occurs.[23] But it is possible to do this in NEED because it includes a lengthy time series of consumption for each dwelling, and because of its market-wide and substantially sized sample.

We therefore conducted parallel trend tests to evaluate the success of the methodology in building a valid counterfactual for consumption in the absence of a smart meter. The figures below show the results of the test for the 2016 installation cohorts. The inclusion and matching criteria are the same as in the main analysis, except that any dwellings with invalid data in any of the additional pre-installation years are excluded.

The comparisons of pre-installation consumption between the smart metered group and the matched traditionally metered group show extremely similar average annual consumption (mean) in the years before the smart meter installations. Consumption is most similar in the years closest to 2016 (the installation year), which is expected given the two groups are matched based on their consumption in 2015 (pre-installation year) but not the years before that.

[23] Despite their large customer bases, energy suppliers have also been unable to do this in their studies of smart meter savings because of customer churn.

**Figure 11 - Comparison of average (mean) pre-installation electricity consumption for the 2016 installation cohort**

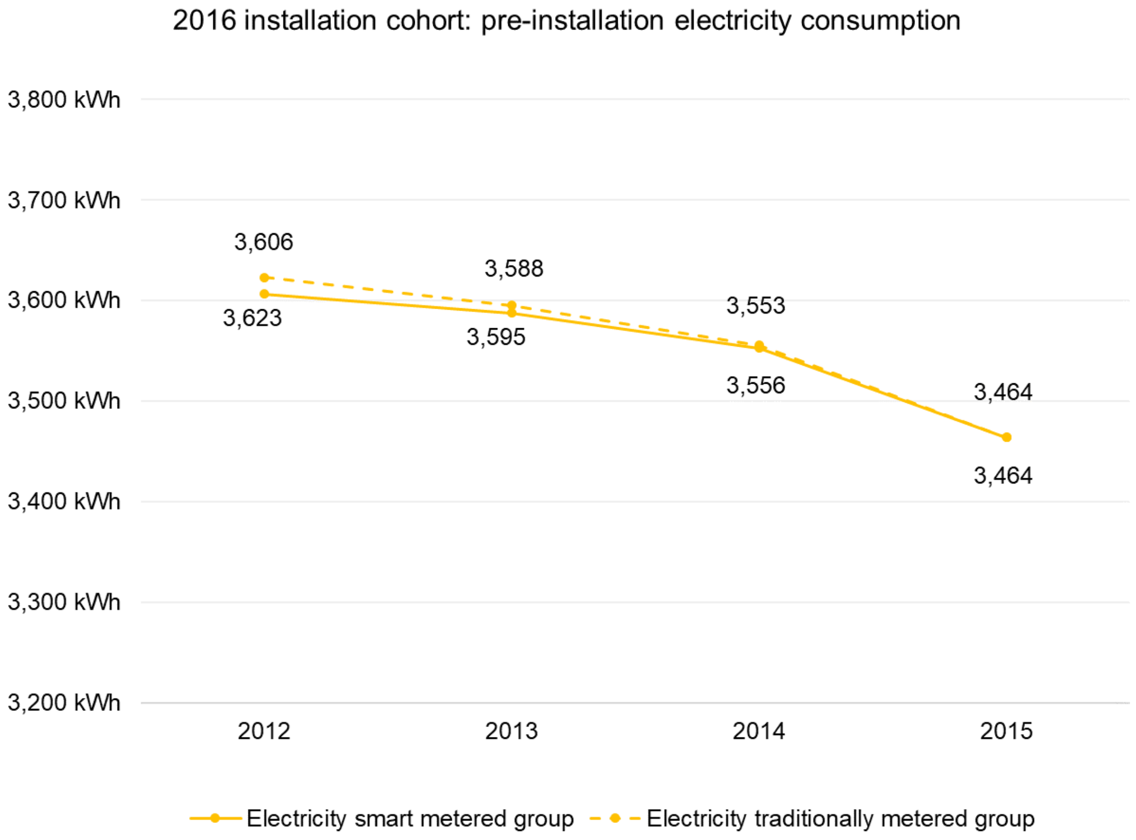
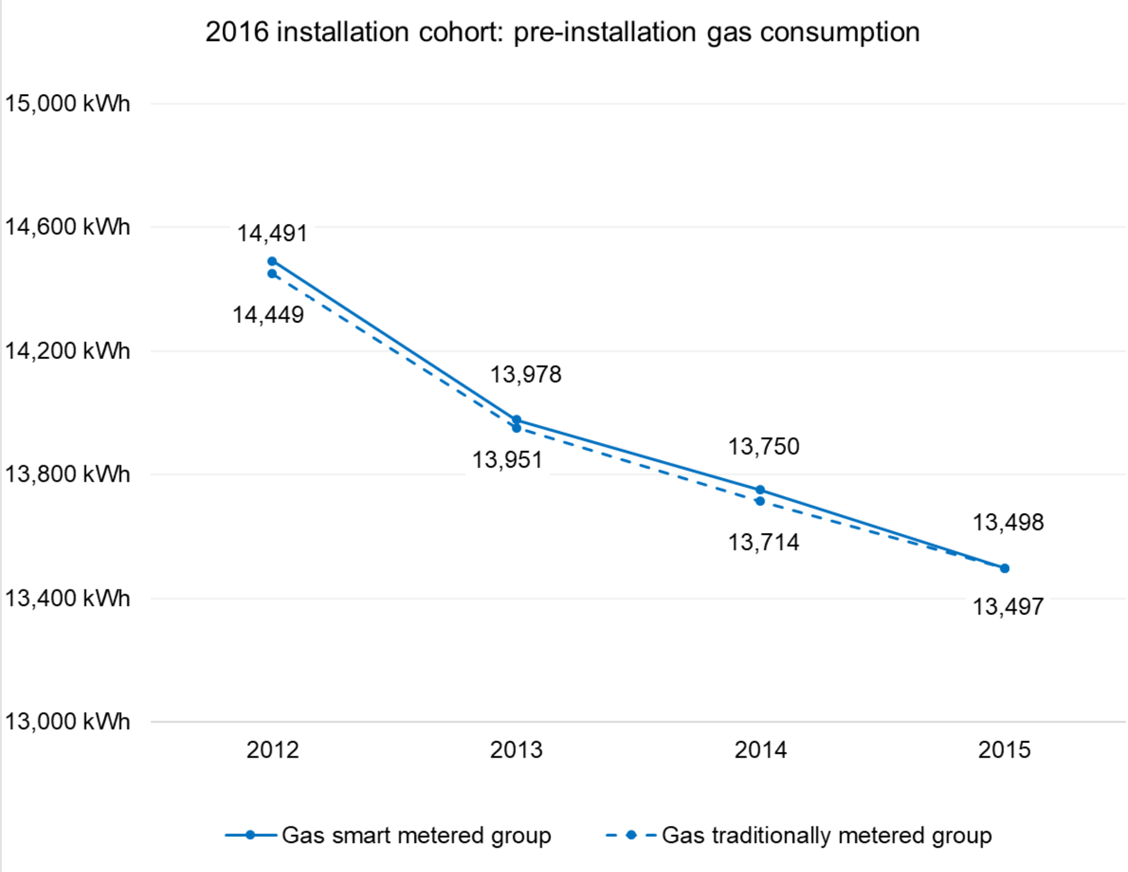


**Figure 12 - Comparison of average (mean) pre-installation gas consumption for the 2016 installation cohort**



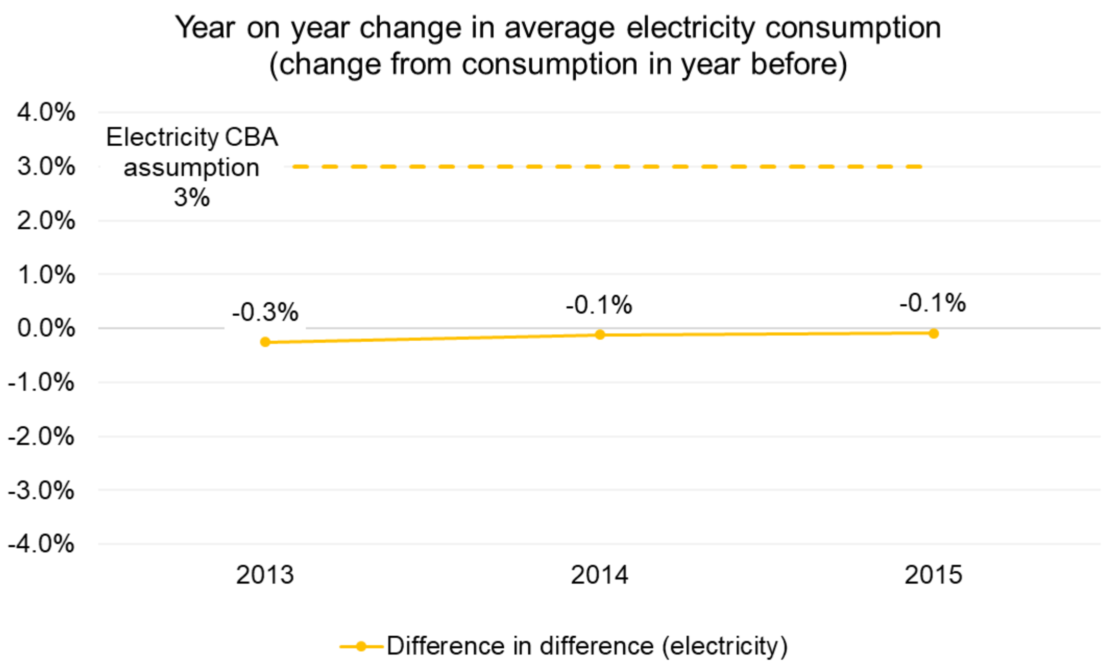

The key question for the parallel trend analysis, however, is not whether annual consumption is similar between the two groups – it is whether the consumption change gradient is similar for the two groups. The difference in the two gradients is what is used to estimate the impact of the smart meters (i.e. the difference-in-difference). Whether a trend can be considered 'similar' depends on the scale of the expected impact. If the pre-installation difference-in-difference is large, it may be a sign that the post-installation difference-in-difference is not really being driven by the smart meter.

Figures 15 and 16 show the difference in consumption trends between the two groups. The energy consumption saving assumptions from the [2019 smart meter roll-out cost benefit analysis]() (CBA) are also shown to contextualise the results. This works in a similar fashion to the calculation of energy consumption changes in the main analysis (step 7):

- Calculate the year-on-year percentage change – the average consumption (mean) in the year divided by the average consumption in the previous year
- Subtract the traditionally metered group's year-on-year change from the smart metered group's year-on-year change, and multiply by -1

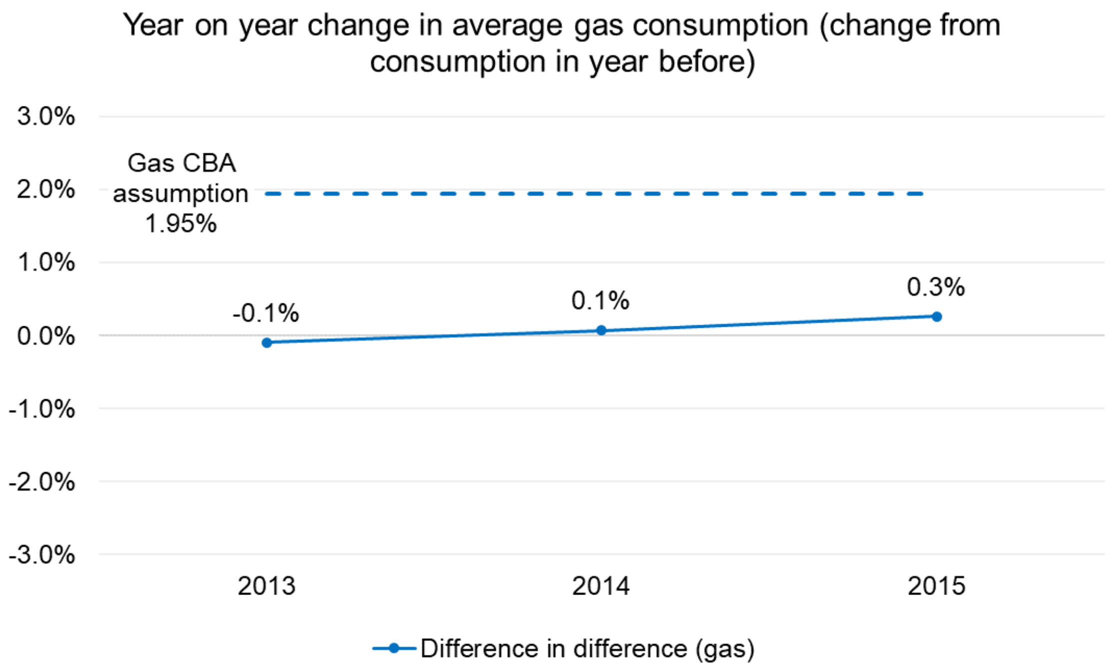
The parallel trend test finds that the pre-installation trends are extremely similar for both fuels. Relative to the CBA assumptions and the savings estimates reported in this analysis (2-3% for electricity, 2% for gas), the differences in the year-on-year trends are very small: 0.3% at most. The difference in long-term trends is similarly small. Between 2012 and 2015, the smart meter group trends deviated from the control group by only -0.5% for electricity and 0.3% for gas.

**Figure 13 - Difference in pre-installation year-on-year electricity consumption trends for the 2016 installation cohort**




*A positive value means the consumption in the smart metered group reduced more compared to the previous year. A negative value means the consumption in the control group reduced more.*

**Figure 14 - Difference in pre-installation year-on-year gas consumption trends for the 2016 installation cohort**




*A positive value means the consumption in the smart metered group reduced more compared to the previous year. A negative value means the consumption in the control group reduced more.*

The fact that the trends are similar over the 3 years before the installations despite only being matched on consumption level in 2015 also provides assurance that 'reversion to the mean' is unlikely to be a factor in the savings estimates. This can occur when the pre-intervention level of the outcome variable (consumption) is used for matching[24], especially when there are substantial differences in the level between the intervention population and the rest of the population. The match on pre-installation consumption can cause a 'rebound' in the control group's post-intervention outcome values as they return to their longer-term trend (i.e. reversion to the mean), biasing the impact estimate. Assuming any (unknowable) future divergence in consumption trends would be of a similar scale to the limited divergence in the historical trends, the parallel trend analysis suggests reversion to the mean is unlikely to have a noteworthy impact on this analysis.

Overall, the findings of the parallel tests suggest we can be confident that any differences in trends in this analysis are driven by the introduction of the smart meters.

[24] Daw, J. R., Hatfield, L. A (2018), 'Matching and Regression to the Mean in Difference-in-Differences Analysis. Health Serv Res. 2018 Dec;53(6): https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6232412/

# Appendix C: Attrition tables and sample sizes

## Electricity savings analysis

### Base sample for all electricity savings analysis

| # | Step | Number of dwellings (millions) | Percentage of starting population |
|---|---|---|---|
| 0.1 | All domestic properties in NEED - England, Wales & Scotland<br>*(Step 1 in NEED 2021 report)* | 28.3 | 100% |
| 0.2 | Linking electricity consumption<br>*(Step 2 in NEED 2021 report)* | 26.7 | 92% |
| 1.1 | Linking electricity supplier information | 23.8 | 84% |
| 1.2 | Linked meter type and installation date | 23.2 | 82% |
| 1.3 | Linking additional floor area information | 23.0 | 81% |

## First-year savings analysis

**Table 3 - Attrition table for 2015 electricity smart meter installation cohort (first-year savings)**

| # | Step | Number of dwellings | | Percentage of recorded installations/population in NEED | |
|---|---|---|---|---|---|
| | | Smart (intervention) | Traditional (control) | Smart (intervention) | Traditional (control) |
| 2 | Determine smart meter group (intervention) and traditional meter group (control) for 2015 installation analysis | 658,387 | 18,819,694 | 100% | 100% |
| 3.1 | Apply exclusion criteria - dual-fuel and profile class 1 | 561,458 | 13,846,834 | 85% | 74% |
| 4.1 | Remove dwellings with missing property characteristic data | 556,531 | 13,555,749 | 85% | 72% |
| 4.2 | Remove dwellings with invalid or extreme consumption values | 435,680 | 9,823,326 | 66% | 52% |
| 3.2 | Apply exclusion criteria – switched electricity supplier | 354,122 | 7,128,190 | 54% | 38% |
| 5 | Match smart metered dwellings to traditionally metered dwellings in pairs | 286,704 | 286,704 | 44% | 2% |
| 6 | Include pairs where:<br>• The installing supplier had more than 10,000 installations in the final sample for 2015<br>• At least 70% of the supplier's installs could be matched to a traditionally metered dwelling<br>10,000 pairs from each supplier used in the final analysis | 243,783 | 243,783 | 37% | 1% |

**Table 4 - Attrition table for 2016 electricity smart meter installation cohort (first-year savings)**

| # | Step | Number of dwellings | | Percentage of recorded installations/population in NEED | |
|---|---|---|---|---|---|
| | | Smart (intervention) | Traditional (control) | Smart (intervention) | Traditional (control) |
| 2 | Determine smart meter group (intervention) and traditional meter group (control) for 2016 installation analysis | 1,342,734 | 16,499,435 | 100% | 100% |
| 3.1 | Apply exclusion criteria - dual-fuel and profile class 1 | 1,159,090 | 12,027,230 | 86% | 73% |
| 4.1 | Remove dwellings with missing property characteristic data | 1,143,282 | 11,749,847 | 85% | 71% |
| 4.2 | Remove dwellings with invalid or extreme consumption values | 985,337 | 8,401,444 | 73% | 51% |
| 3.2 | Apply exclusion criteria – switched electricity supplier | 579,459 | 5,271,497 | 43% | 32% |
| 5 | Match smart metered dwellings to traditionally metered dwellings in pairs | 521,179 | 521,179 | 39% | 3% |
| 6 | Include pairs where:<br>• The installing supplier had more than 10,000 installations in the final sample for 2016<br>• At least 70% of the supplier's installs could be matched to a traditionally metered dwelling.<br>10,000 pairs from each supplier used in the final analysis | 457,158 | 457,158 | 34% | 3% |

**Table 5 - Attrition table for 2017 electricity smart meter installation cohort (first-year savings)**

| # | Step | Number of dwellings | | Percentage of recorded installations/population in NEED | |
|---|---|---|---|---|---|
| | | Smart (intervention) | Traditional (control) | Smart (intervention) | Traditional (control) |
| 2 | Determine smart meter group (intervention) and traditional meter group (control) for 2017 installation analysis | 2,317,990 | 14,553,598 | 100% | 100% |
| 3.1 | Apply exclusion criteria - dual-fuel and profile class 1 | 1,893,816 | 10,514,058 | 82% | 72% |
| 4.1 | Remove dwellings with missing property characteristic data | 1,856,367 | 10,258,925 | 80% | 70% |
| 4.2 | Remove dwellings with invalid or extreme consumption values | 1,407,477 | 7,235,090 | 61% | 50% |
| 3.2 | Apply exclusion criteria – switched electricity supplier | 844,640 | 4,237,692 | 36% | 29% |
| 5 | Match smart metered dwellings to traditionally metered dwellings in pairs | 710,212 | 710,213 | 31% | 5% |
| 6 | Include pairs where:<br>• The installing supplier had more than 10,000 installations in the final sample for 2017<br>• At least 70% of the supplier's installs could be matched to a traditionally metered dwelling.<br>10,000 pairs from each supplier used in the final analysis | 641,188 | 641,189 | 28% | 4% |

**Table 6 - Attrition table for 2018 electricity smart meter installation cohort (first-year savings)**

| # | Step | Number of dwellings | | Percentage of recorded installations/population in NEED | |
|---|---|---|---|---|---|
| | | Smart (intervention) | Traditional (control) | Smart (intervention) | Traditional (control) |
| 2 | Determine smart meter group (intervention) and traditional meter group (control) for 2018 installation analysis | 1,955,898 | 12,795,168 | 100% | 100% |
| 3.1 | Apply exclusion criteria - dual-fuel and profile class 1 | 1,662,715 | 9,296,554 | 85% | 73% |
| 4.1 | Remove dwellings with missing property characteristic data | 1,617,072 | 9,072,753 | 83% | 71% |
| 4.2 | Remove dwellings with invalid or extreme consumption values | 1,177,215 | 6,259,656 | 60% | 49% |
| 3.2 | Apply exclusion criteria – switched electricity supplier | 544,994 | 3,252,749 | 28% | 25% |
| 5 | Match smart metered dwellings to traditionally metered dwellings in pairs | 450,062 | 450,062 | 23% | 4% |
| 6 | Include pairs where:<br>• The installing supplier had more than 10,000 installations in the final sample for 2018<br>• At least 70% of the supplier's installs could be matched to a traditionally metered dwelling.<br>10,000 pairs from each supplier used in the final analysis | 402,680 | 402,680 | 21% | 3% |

## Three-year savings analysis

**Table 7 - Attrition table for 2015 electricity smart meter installation cohort (Three-year savings)**

| # | Step | Number of dwellings | | Percentage of recorded installations/population in NEED | |
|---|---|---|---|---|---|
| | | Smart (intervention) | Traditional (control) | Smart (intervention) | Traditional (control) |
| 2 | Determine smart meter group (intervention) and traditional meter group (control) for 2015 installation analysis | 658,387 | 14,553,598 | 100% | 100% |
| 3.1 | Apply exclusion criteria - dual-fuel and profile class 1 | 555,422 | 10,214,028 | 84% | 70% |
| 4.1 | Remove dwellings with missing property characteristic data | 550,292 | 10,019,848 | 84% | 69% |
| 4.2 | Remove dwellings with invalid or extreme consumption values | 364,711 | 5,850,879 | 55% | 40% |
| 3.2 | Apply exclusion criteria – switched electricity supplier | 243,081 | 3,269,496 | 37% | 22% |
| 5 | Match smart metered dwellings to traditionally metered dwellings in pairs | 183,372 | 183,372 | 28% | 1% |
| 6 | Include pairs where:<br>• The installing supplier had more than 10,000 installations in the final sample for 2015<br>• At least 70% of the supplier's installs could be matched to a traditionally metered dwelling<br>10,000 pairs from each supplier used in the final analysis | 154,295 | 154,295 | 23% | 1% |

**Table 8 - Attrition table for 2016 electricity smart meter installation cohort (Three-year savings)**

| # | Step | Number of dwellings | | Percentage of recorded installations/population in NEED | |
|---|---|---|---|---|---|
| | | Smart (intervention) | Traditional (control) | Smart (intervention) | Traditional (control) |
| 2 | Determine smart meter group (intervention) and traditional meter group (control) for 2016 installation analysis | 1,342,734 | 12,795,168 | 100% | 100% |
| 3.1 | Apply exclusion criteria - dual-fuel and profile class 1 | 1,154,551 | 9,138,541 | 86% | 71% |
| 4.1 | Remove dwellings with missing property characteristic data | 1,141,151 | 8,942,472 | 85% | 70% |
| 4.2 | Remove dwellings with invalid or extreme consumption values | 739,006 | 5,013,124 | 55% | 39% |
| 3.2 | Apply exclusion criteria – switched electricity supplier | 383,388 | 2,319,006 | 29% | 18% |
| 5 | Match smart metered dwellings to traditionally metered dwellings in pairs | 323,752 | 323,752 | 24% | 3% |
| 6 | Include pairs where:<br>• The installing supplier had more than 10,000 installations in the final sample for 2016<br>• At least 70% of the supplier's installs could be matched to a traditionally metered dwelling<br>10,000 pairs from each supplier used in the final analysis | 308,773 | 308,773 | 23% | 2% |

# Gas savings analysis

## Base sample for all gas savings analysis

| # | Step | Number of dwellings (millions) | Percentage of starting population |
|---|---|---|---|
| 0.1 | All domestic properties in NEED - England, Wales & Scotland *(Step 1 in NEED 2021 report)* | 28.3 | 100% |
| 0.2 | Linking gas consumption (excludes dwellings without a gas supply) *(Step 2 in NEED 2021 report)* | 22.3 | 78% |
| 1.1 | Linking electricity supplier information | 20.5 | 73% |
| 1.2 | Linked meter type and installation date | 20.2 | 71% |
| 1.3 | Linking additional floor area information | 20.1 | 71% |

## First-year savings analysis

**Table 9 - Attrition table for 2015 gas smart meter installation cohort (first-year savings)**

| # | Step | Number of dwellings | | Percentage of recorded installations/population in NEED | |
|---|---|---|---|---|---|
| | | Smart (intervention) | Traditional (control) | Smart (intervention) | Traditional (control) |
| 2 | Determine smart meter group (intervention) and traditional meter group (control) for 2015 installation analysis | 566,820 | 17,349,519 | 100% | 100% |
| 3.1 | Apply exclusion criteria - dual-fuel only | 566,820 | 17,349,519 | 100% | 100% |
| 4.1 | Remove dwellings with missing property characteristic data | 541,888 | 16,642,712 | 96% | 96% |
| 4.2 | Remove dwellings with invalid or extreme consumption values | 362,037 | 9,072,749 | 64% | 52% |
| 3.2 | Apply exclusion criteria – switched electricity supplier | 300,022 | 6,422,499 | 53% | 37% |
| 5 | Match smart metered dwellings to traditionally metered dwellings in pairs | 279,151 | 279,151 | 49% | 2% |
| 6 | Include pairs where:<br>• The installing supplier had more than 10,000 installations in the final sample for 2015<br>• At least 70% of the supplier's installs could be matched to a traditionally metered dwelling<br>10,000 pairs from each supplier used in the final analysis | 250,019 | 250,019 | 44% | 1% |

**Table 10 - Attrition table for 2016 gas smart meter installation cohort (first-year savings)**

| # | Step | Number of dwellings | | Percentage of recorded installations/population in NEED | |
|---|---|---|---|---|---|
| | | Smart (intervention) | Traditional (control) | Smart (intervention) | Traditional (control) |
| 2 | Determine smart meter group (intervention) and traditional meter group (control) for 2016 installation analysis | 1,355,783 | 15,413,568 | 100% | 100% |
| 3.1 | Apply exclusion criteria - dual-fuel | 1,355,783 | 15,413,568 | 100% | 100% |
| 4.1 | Remove dwellings with missing property characteristic data | 1,296,826 | 14,790,803 | 96% | 96% |
| 4.2 | Remove dwellings with invalid or extreme consumption values | 802,764 | 7,999,490 | 59% | 52% |
| 3.2 | Apply exclusion criteria – switched electricity supplier | 554,985 | 4,877,574 | 41% | 32% |
| 5 | Match smart metered dwellings to traditionally metered dwellings in pairs | 502,049 | 502,049 | 37% | 3% |
| 6 | Include pairs where:<br>• The installing supplier had more than 10,000 installations in the final sample for 2016<br>• At least 70% of the supplier's installs could be matched to a traditionally metered dwelling.<br>10,000 pairs from each supplier used in the final analysis | 471,717 | 471,717 | 35% | 3% |

**Table 11 - Attrition table for 2017 gas smart meter installation cohort (first-year savings)**

| # | Step | Number of dwellings | | Percentage of recorded installations/population in NEED | |
|---|---|---|---|---|---|
| | | Smart (intervention) | Traditional (control) | Smart (intervention) | Traditional (control) |
| 2 | Determine smart meter group (intervention) and traditional meter group (control) for 2017 installation analysis | 1,565,617 | 13,763,026 | 100% | 100% |
| 3.1 | Apply exclusion criteria - dual-fuel | 1,565,617 | 13,763,026 | 100% | 100% |
| 4.1 | Remove dwellings with missing property characteristic data | 1,478,373 | 13,249,001 | 94% | 96% |
| 4.2 | Remove dwellings with invalid or extreme consumption values | 884,394 | 7,086,257 | 56% | 51% |
| 3.2 | Apply exclusion criteria – switched electricity supplier | 508,017 | 4,001,501 | 32% | 29% |
| 5 | Match smart metered dwellings to traditionally metered dwellings in pairs | 442,802 | 442,802 | 28% | 3% |
| 6 | Include pairs where:<br>• The installing supplier had more than 10,000 installations in the final sample for 2017<br>• At least 70% of the supplier's installs could be matched to a traditionally metered dwelling.<br>10,000 pairs from each supplier used in the final analysis | 417,689 | 417,689 | 27% | 3% |

**Table 12 - Attrition table for 2018 gas smart meter installation cohort (first-year savings)**

| # | Step | Number of dwellings | | Percentage of recorded installations/population in NEED | |
|---|---|---|---|---|---|
| | | Smart (intervention) | Traditional (control) | Smart (intervention) | Traditional (control) |
| 2 | Determine smart meter group (intervention) and traditional meter group (control) for 2018 installation analysis | 1,616,150 | 12,290,346 | 100% | 100% |
| 3.1 | Apply exclusion criteria - dual-fuel | 1,616,150 | 12,290,346 | 100% | 100% |
| 4.1 | Remove dwellings with missing property characteristic data | 1,505,657 | 11,831,559 | 93% | 96% |
| 4.2 | Remove dwellings with invalid or extreme consumption values | 845,349 | 6,150,062 | 52% | 50% |
| 3.2 | Apply exclusion criteria – switched electricity supplier | 408,798 | 3,150,397 | 25% | 26% |
| 5 | Match smart metered dwellings to traditionally metered dwellings in pairs | 356,321 | 356,321 | 22% | 3% |
| 6 | Include pairs where:<br>• The installing supplier had more than 10,000 installations in the final sample for 2018<br>• At least 70% of the supplier's installs could be matched to a traditionally metered dwelling.<br>10,000 pairs from each supplier used in the final analysis | 328,465 | 328,465 | 20% | 3% |

## Three-year savings analysis

**Table 13 - Attrition table for 2015 gas smart meter installation cohort (Three-year savings)**

| # | Step | Number of dwellings | | Percentage of recorded installations/population in NEED | |
|---|---|---|---|---|---|
| | | Smart (intervention) | Traditional (control) | Smart (intervention) | Traditional (control) |
| 2 | Determine smart meter group (intervention) and traditional meter group (control) for 2015 installation analysis | 566,820 | 13,709,795 | 100% | 100% |
| 3.1 | Apply exclusion criteria - dual-fuel | 566,820 | 13,709,795 | 100% | 100% |
| 4.1 | Remove dwellings with missing property characteristic data | 539,418 | 13,199,456 | 95% | 96% |
| 4.2 | Remove dwellings with invalid or extreme consumption values | 325,040 | 5,987,031 | 57% | 44% |
| 3.2 | Apply exclusion criteria – switched electricity supplier | 227,513 | 3,189,972 | 40% | 23% |
| 5 | Match smart metered dwellings to traditionally metered dwellings in pairs | 175,943 | 175,943 | 31% | 1% |
| 6 | Include pairs where:<br>• The installing supplier had more than 10,000 installations in the final sample for 2015<br>• At least 70% of the supplier's installs could be matched to a traditionally metered dwelling<br>10,000 pairs from each supplier used in the final analysis | 165,133 | 165,133 | 29% | 1% |

**Table 14 - Attrition table for 2016 gas smart meter installation cohort (Three-year savings)**

| # | Step | Number of dwellings | | Percentage of recorded installations/population in NEED | |
|---|---|---|---|---|---|
| | | Smart (intervention) | Traditional (control) | Smart (intervention) | Traditional (control) |
| 2 | Determine smart meter group (intervention) and traditional meter group (control) for 2016 installation analysis | 1,355,783 | 12,286,013 | 100% | 100% |
| 3.1 | Apply exclusion criteria - dual-fuel | 1,355,783 | 12,286,013 | 100% | 100% |
| 4.1 | Remove dwellings with missing property characteristic data | 1,295,477 | 11,827,415 | 96% | 96% |
| 4.2 | Remove dwellings with invalid or extreme consumption values | 723,582 | 5,342,628 | 53% | 43% |
| 3.2 | Apply exclusion criteria – switched electricity supplier | 397,602 | 2,347,884 | 29% | 19% |
| 5 | Match smart metered dwellings to traditionally metered dwellings in pairs | 340,049 | 340,049 | 25% | 3% |
| 6 | Include pairs where:<br>• The installing supplier had more than 10,000 installations in the final sample for 2016<br>• At least 70% of the supplier's installs could be matched to a traditionally metered dwelling<br>10,000 pairs from each supplier used in the final analysis | 308,923 | 308,923 | 23% | 3% |

# Appendix D: sensitivity analysis: excluding homes with an energy efficiency installation

A sensitivity analysis was conducted to understand the role of energy efficiency measures installations in the savings estimates for smart meter installations.

A disproportionate number of energy efficiency measure installations in the smart metered groups would not necessarily invalidate the savings estimates because it is plausible that some smart meter installations could result in energy efficiency measures that would not have otherwise been installed. For example, if smart meter-based feedback on consumption prompted a householder to install insulation. Whilst there is some evidence of this, previous research has found that the installation of energy efficiency measures as a short-term response to smart metering is uncommon and behaviour changes are far more likely, and so we would not expect energy efficiency measures to be driving much of the initial population-level savings from smart meters.

The sensitivity analysis therefore sought to understand the role of energy efficiency measures in the smart meter savings estimates by excluding any dwellings where an energy efficiency measure had been recorded as installed in the pre-installation, installation or post-installation years.[25]

The sensitivity analysis was performed using the 2016 installation cohorts. Dwellings in the smart and traditionally metered groups were excluded at Step 3 of the analysis if an energy efficiency measure was recorded as installed in either 2015, 2016 or 2017 (see Annex A to the 2021 NEED report for the sources of information on energy efficiency measures). The list of possible measures installed is below and was kept the same for both the electricity and gas analysis:

- External and Internal Solid and Cavity Wall Insulation (including Party Wall Cavity Wall Insulation)
- Loft Insulation
- Flat Roof Insulation
- Park Home Insulation
- Room-in-Roof Insulation
- Underfloor Insulation
- Solid Floor Insulation
- Window Glazing
- Energy Efficient Doors
- Boilers (new and replacements)
- Electric Storage Heaters (new and replacements)

[25] Note that the installation data in NEED only captures installations under Government schemes.

- District Heating Systems
- Heating Controls (Conventional and Smart), Smart Thermostats and Thermostatic Radiator Valves
- Solar PV

The exclusion of these dwellings had relatively little impact on the composition of the sample as few were registered as having had an energy efficiency measure installed during the observation periods: the final samples were around 4% smaller in the electricity smart meter installation cohort (~20,000) and around 11% smaller in the gas smart meter installation cohort (~50,000).

The figures below compare the results of the sensitivity analysis against the results for the samples in the main analysis. This shows that excluding these dwellings had little effect on the results and there was no consistent direction in that effect, demonstrating savings are not being driven the installation of energy efficiency measures in a small proportion of the smart metered group, or disproportionate take-up of these measures in the smart metered group.

We note that this analysis should not be interpreted to reflect the energy savings arising from installing energy efficiency measures, since such properties only form a small minority of our analysis sample and measures were installed in similar proportions of the smart metered and traditionally metered dwellings. 'Impact of Measures' statistics on the consumption impacts of installing energy efficiency measures are published in the NEED report series.

**Figure 15 - Savings estimates for 2016 electricity smart meter installations when dwellings which had energy efficiency measures installed during the observation periods are excluded**

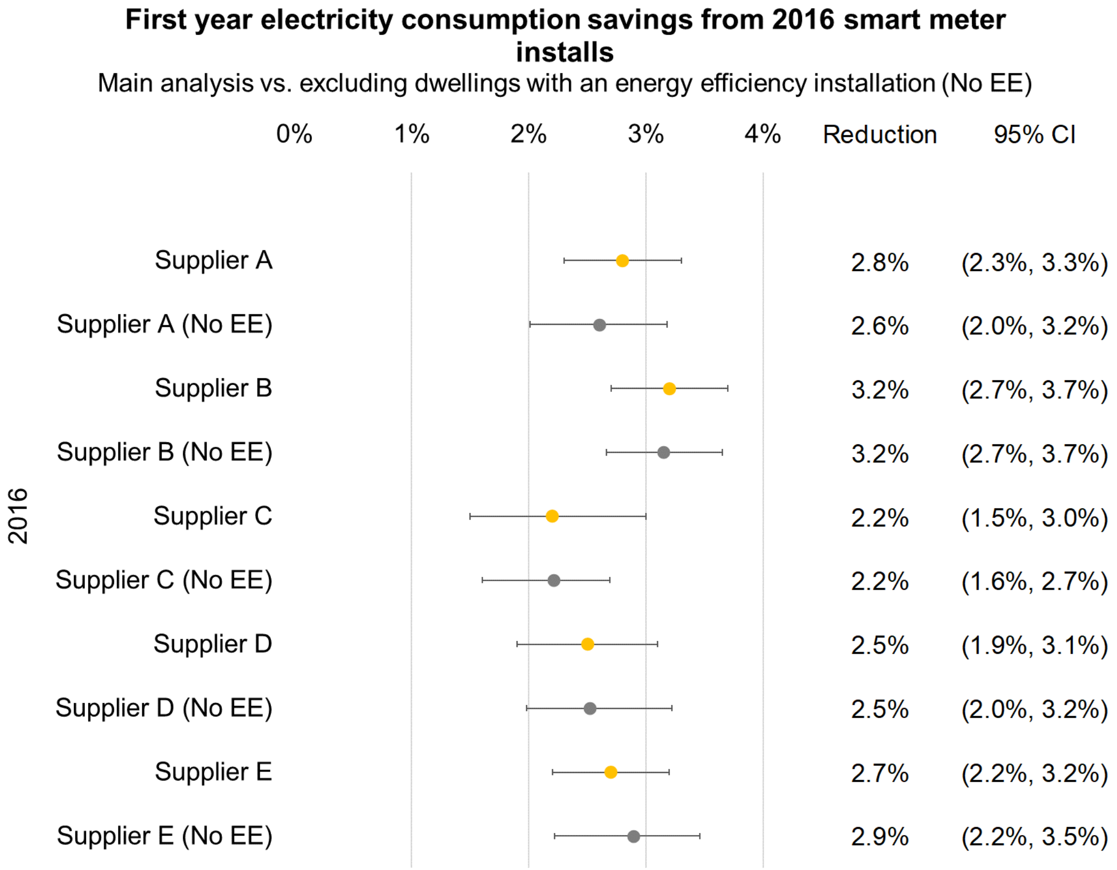
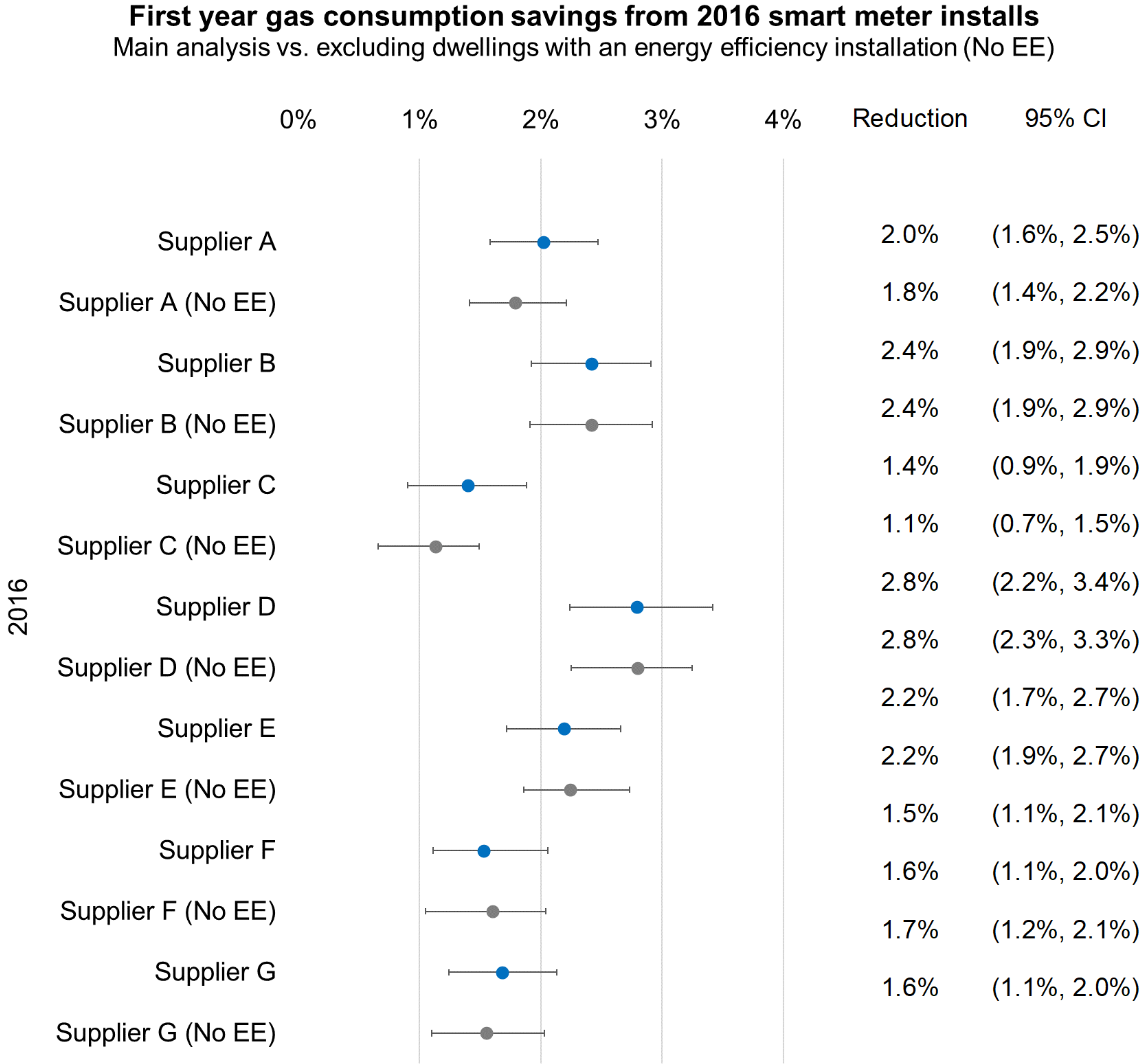


**Figure 16 - Savings estimates for 2016 gas smart meter installations when dwellings which had energy efficiency measures installed during the observation period are excluded**



# Appendix E: Notable differences in the method from NEED Impact of Measures, energy supplier studies and BIT's guidance

## NEED Impact of Measures

### No elastic matching

The NEED IoM analysis flexes the number of criteria used in the matching process to ensure 99.9% of dwellings can be matched. In this analysis, smart metered dwellings are only included if there is a match on all criteria. It was not deemed necessary to use elastic matching as fewer matching criteria are used and match rates above 90% were consistently achieved across the installation cohorts (see Appendix C).

### No weighting

In the NEED IoM analysis, the intervention group is weighted to reflect the total housing stock. This enables more like-for-like comparisons between analysis of different energy efficiency measures and between groups of installations across years because each intervention group is weighted to look similar in each year of analysis.

Weighting is not applied in the smart meter analysis. The results therefore estimate the savings for the specific installations included in the final sample and do not attempt to account for variation in the composition of installation cohorts over time.[26]

The choice to apply weighting is subjective and depends on the objectives of the research, as a weighted analysis will answer a slightly different question. No weighting was chosen given the objectives of this research, which included understanding differences in savings across cohorts, and also to align with the supplier studies which do not use weighting.

### Outcome measure

The energy saving estimate is calculated using changes in total consumption for the smart metered group over time. This aligns with the typical supplier method but it differs from the approach recommended in BIT's guidance (the difference in the mean or median consumption change over time between smart and traditional metered groups) and that used in the NEED IoM analysis (which calculates the change at the dwelling level, and compares the average change between the intervention and control groups).

The analysis pilot used all three methods for calculating energy savings and found the differences to be subtle with little impact on overall results.

[26] To use evaluation terminology, the NEED IoM analysis estimates the Average Treatment Effect (ATE), whereas the smart meter analysis estimates something closer to an Average Treatment Effect on the Treated (ATT).

#### Accounting for uncertainty in the control group

In the NEED IoM analysis, the matching procedure is repeated to create 50 different pairings of intervention and control groups. The savings estimates are calculated for each and the average is used as the final savings estimate. This accounts for any uncertainty introduced from using a 1:1 matching procedure that uses only a sample of the possible control group dwellings. BIT advocate an approach that achieves a similar effect in their guidance (one-to-many or many-to-many matching, page 17). In this analysis, the paired bootstrapping achieves a similar effect (see Step 7 in the Methods chapter).

#### England, Wales and Scotland combined

The NEED IoM analysis produces results separately for England and Wales, and for Scotland due to the different sources of data used for property characteristics in Scotland. This is not necessary for the smart meter analysis because the smart meter and traditional meter groups are matched on their region, avoiding any problems from matching across incompatible datasets.

## Energy supplier studies

### Consumption data

The only consumption data available in NEED is a single, annual consumption figure for both fuels. This is calculated by the data providers before being passed to NEED. This is calculated using meter reads in most cases. Where current meter reads are not available, it is estimated using historical consumption data and/or an assumed consumption profile.

Whilst it is possible in NEED to exclude consumption data that is not based on actual meter reads, energy suppliers have full access to meter read data. Energy suppliers can therefore exercise far more control over the calculation of consumption, and may be able to reduce the amount of attrition from invalid consumption data through more flexible consumption periods for each customer.

#### Credit and prepay customers

Whilst suppliers can segment their analysis by credit and prepay customers, it is not possible to distinguish credit and prepay smart metered dwellings in NEED. The NEED analysis therefore includes installations for both credit and prepay meter installations. This is an important difference because the energy supplier evidence in BIT's evidence review is entirely based on credit customers.

# Considerations and improvements for future analysis

- **Electricity meter installation dates for after 2018** – exact installation dates for smart meters are not available in the current NEED data for after 2018. The more recent electricity meter data instead has a flag indicating that the meter has become a smart meter in the previous 12 months (between February to January). Analysis for cohorts beyond 2018 will require quality assurance of this data and additional data may need to be gathered if this is not suitable.

- **Use of first smart meter installation date** – the installation dates in NEED represent the installation date for the current meter. If a dwelling has had a second smart meter installed, this will represent the date for the second meter installation. It may however be desirable to use the first smart meter installation date for these dwellings or analyse first and second installations separately, especially if most impacts are expected to accrue to the first smart meter installation. Whilst second installations will have been rare in this analysis, it may be more common in future analysis and so important to consider.
- **Inclusion of dwellings with multiple meters for a fuel** – dwellings for which there was more than one meter for the given fuel were excluded from the analysis due to uncertainty about the meter status and installation date. With further work it may be possible to develop a valid method for deconflicting meter status and reduce the number excluded for this reason.
- **Information on payment types** – this would make it possible to analyse savings separately for credit and prepay smart meter customers in NEED. This is more important for prepay than for credit, as only a minority pay by prepay and aggregate savings are likely to correlate closely with credit customer savings.
- **Analysis for electricity-only dwellings** – electricity-only dwellings are excluded from the analysis (and the energy supplier studies) as they are more likely to have electric heating, which means they cannot be meaningfully compared with the vast majority of homes which use gas for heating.[27] However, given their substantial electricity consumption, this may be an important segment to investigate (if feasible).
- **Validating the method for the years beyond 2019** – any future analysis using NEED will cover years affected by COVID-19 and the unprecedented rise in global energy prices during 2022 and 2023. Given the substantial impact these factors may have had on households and their consumption patterns, the method may require additional validation for those years.

[27] 78% of households in Great Britain say they use gas boiler central heating to heat their homes. DESNZ (2024), DESNZ Public Attitudes Tracker: Winter 2023: https://www.gov.uk/government/statistics/desnz-public-attitudes-tracker-winter-2023

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