UK Government

# Smart Meter Enabled Thermal Efficiency Ratings (SMETER)

## Case studies and evidence base

Department for Energy Security and Net Zero (2026)

**Acknowledgements**

We gratefully acknowledge the permissions which owners of case studies have given as well as the investments they have made in the various contributing projects and reports. We are also grateful to Professor Cliff Elwell of UCL for reviewing Section 3.

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# Contents

# 1. Introduction

## Purpose of this report

As described in the accompanying strategic user guide[1], SMETER (Smart Meter Enabled Thermal Efficiency Ratings) is an umbrella term that is used for technologies that measure the overall thermal performance of buildings whilst they are occupied.

DESNZ is working to support the introduction of SMETER measurements as part of the Warm Homes Plan. Part of this work is focussed on evidence, including both pilots and trials which provide case studies, and evidence from science.

This report aims to increase awareness of SMETER amongst potential users by publishing practical examples of the types of benefits and results that are accruing from their use by housing providers. The case studies are set out in Section 2 together with links to further material.

Section 3 of the report deals with science-based evidence, such as on accuracy, with links to further detail published elsewhere.  We have developed and populated an evidence framework to identify the different types of evidence of value; some new research is being published in parallel, with links in this report.

This section is primarily aimed at a more technical audience, such as researchers and professionals interested in building performance evaluation and innovators across the range of SMETER applications, but is presented here alongside the case studies, which it supports.

## Future updates to this report

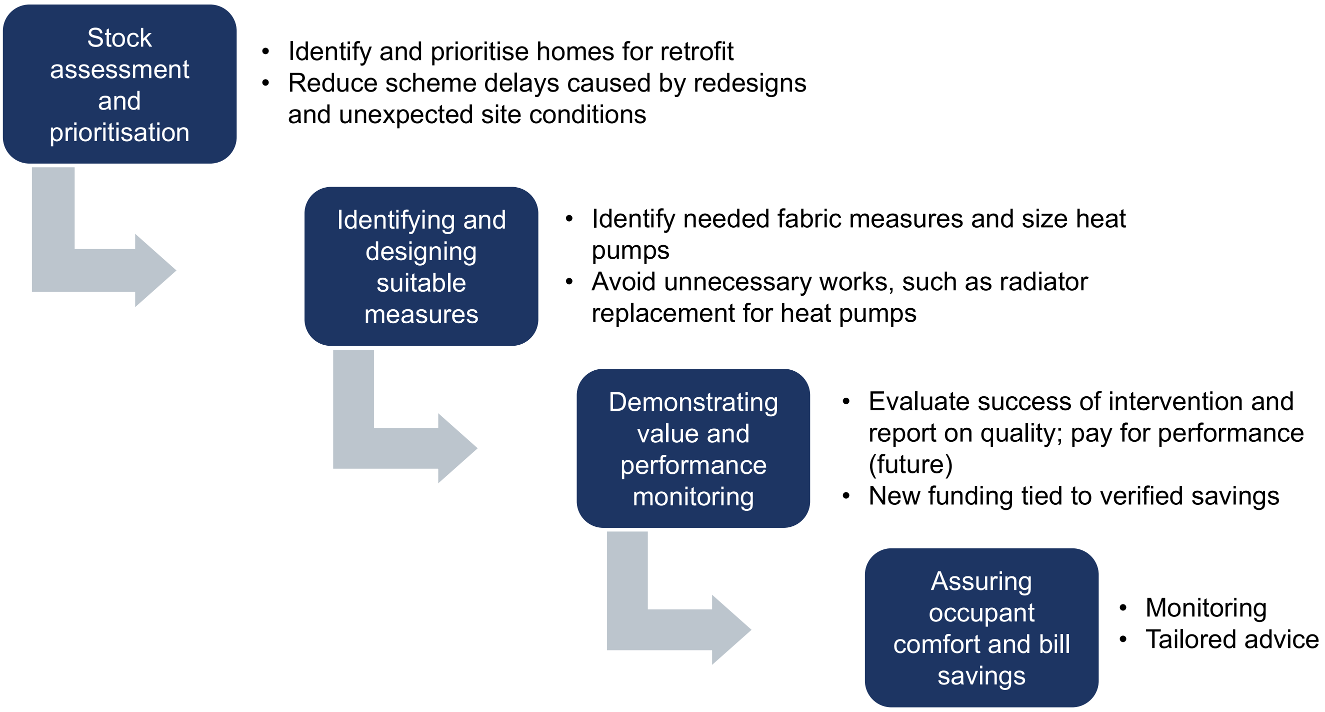
This is a rapidly developing area with multiple organisations actively conducting and evaluating pilots and other forms of research. We will therefore update this document in the first half of 2027 with new information; we welcome contributions of further case studies and other evidence for inclusion.

[1] DESNZ (2026) 'Smart Meter Enabled Thermal Efficiency Ratings (SMETER): An introduction to SMETER and its applications'

# 2. Case studies

## Scope and structure

The case studies detailed later in this section are focussed on the applications of SMETER HTC measurement at different stages of home improvement programmes. As described in Figure 2 of the separate strategic guide to SMETER, reproduced below, these follow a number of stages. The case studies address different sub-sets of these.




The next sub-section provides an overview of which application(s) each case study covers, together with selected findings.

# Summary of case study applications and selected findings

| Title of study and partners | Stock assessment | Selecting measures | Demonstrating value | Occupant benefits | Summary of study and selected findings |
|---|---|---|---|---|---|
| **Intelligent Measured Data. Smarter retrofit. Better outcomes.**<br>(Lloyds Bank with partners) | X | X | | | Lloyds Bank worked with housing association Bromford Flagship and tech provider Senze in a pilot that used in home sensors across 121 properties to measure real thermal performance and compare it with modelled Energy Performance Certificate (EPC) data. The pilot found that different sets of properties and measures would be selected for retrofit if decisions were based on real performance, with significant compliance cost savings. |
| **Retrofit programme monitoring and evaluation**<br>(Cambridge City Council and Purrmetrix) | | X | X | X | Cambridge City Council used pre- and post-retrofit monitoring of their social housing retrofit programmes. Monitoring, including heat transfer coefficient (HTC) measurement in at least 10% of homes each winter, enabled comparison across similar housing archetypes to assess performance, cost effectiveness, and inform future delivery. Results show improvements in efficiency, reveal performance variation between similar homes, and have helped identify underperforming systems and ventilation issues. |
| **Measured**<br>(Build Test Solutions (BTS), Veritherm UK, Elmhurst Energy Services) | | X | | | This DESNZ-funded project compared SMETER measured heat loss with the established survey-based method to determine whether measurements could help optimise heat pump sizing. A field trial in 56 homes showed that measured heat loss differed from calculations in 70% of cases. Most homes performed better than expected, suggesting potential to downsize heat pumps and significantly reduce costs. |

| Title of study and partners | Stock assessment | Selecting measures | Demonstrating value | Occupant benefits | Summary of study and selected findings |
|---|---|---|---|---|---|
| **Great Places Smart Retrofit**<br>(Knauf Energy Solutions (KES)) | | X | X | | This project demonstrated the value of SMETER measurement in addressing homes with defects. An estate in Old Trafford with failing insulation underwent targeted and bespoke retrofit, with pre- and post-retrofit energy performance monitoring and airtightness testing. There was a 31% measured reduction in space heating demand, quantifying the benefits to the housing provider of the programme, although these were not visible from EPC ratings. |
| **Delivering Energy Performance Insights in Burnley**<br>(Knauf Energy Solutions (KES)) | | X | X | | This project, similar in intent to the Old Trafford one above, involved 23 recently built homes in Burnley with poorly installed loft insulation. SMETER measurement showed a 14% average heating demand reduction from undertaking a quality assured, high-standard loft insulation replacement programme. This would not have been recognised by EPC assessments. |
| **Smart Retrofit, Aarschot, Belgium**<br>(Knauf Energy Solutions (KES)) | | | X | X | A large scale social housing retrofit programme achieved an average 37% reduction in energy demand and measurable improvements in indoor conditions. This demonstrated a new approach to contracting for retrofit programmes, based on results achieved rather than works completed and involving an integrated, end to end process underpinned by measurement, design and quality assurance processes. |

| Title of study and partners | Stock assessment | Selecting measures | Demonstrating value | Occupant benefits | Summary of study and selected findings |
|---|---|---|---|---|---|
| **Benchmarking Housing Performance**<br>(London Borough of Havering, Purrmetrix, Baily Garner) | | | X | X | Havering monitored homes retrofitted under the Warm Homes: Social Housing Fund (then SHDF) using Purrmetrix sensors to assess changes in heat loss, comfort and ventilation, finding substantial post retrofit reductions in heat loss alongside warmer homes and/or lower energy bills. The work also showed SAP calculations often overestimated pre-retrofit heat loss, indicating that measured HTC – though not used for measure selection in this programme – could help target future retrofits more effectively. |
| **Sheltered Energy Sensors in Barrhead Housing Association**<br>(AICO) | | | | X | Environmental sensors installed in sheltered housing, combined with smart metering and a tenant app to provide tenants with feedback. Real-time data empowered tenants to reduce energy waste and improve living conditions, with significant increases in tenant confidence and monitoring behaviour. |

# Detailed descriptions of case studies

These descriptions are based on project reports. Independent review has been noted where this occurred.

## Intelligent Measured Data. Smarter Retrofit. Better Outcomes. – Lloyds Bank, Bromford Flagship and Senze

Lloyds Bank worked with housing association Bromford Flagship and tech provider Senze in a pilot that used in home sensors across 121 properties to measure real thermal performance and compare it with modelled Energy Performance Certificate (EPC) data. The project was overseen by Birmingham City University who reviewed the robustness of Senze's method used to collect the property level data, and verified the data collected.

The goal was to see whether sensor data can produce better, property specific retrofit decisions. The sample was deliberately selected to over-represent older (pre-1967) properties which are more likely to be indicated for retrofit by their EPC ratings, and also detached and semi-detached properties; the EPC rating distribution of the sample was therefore more even, and flats were under-represented, compared to the Bromford and national social housing stock.

Key findings are that EPCs could mis-estimate thermal performance: the average ‘performance gap’ between modelled and measured results was 25%, and 11% of homes lost more than double the heat predicted. Older properties in the sample tended to match or outperform modelled expectations compared with newer homes. Using measured data enabled more precise retrofit scoping, avoiding unnecessary or potentially harmful measures (for example, over insulation or oversized heating systems; most homes did not need a 10kW heat pump based on measured peak heat load).

Economically, measured data suggested major potential savings for houses like this in future: for 59% of homes that needed retrofit under both approaches, more targeted works could save c.£12,500 per home. For another 7%, measured performance indicated no interventions were needed to achieve the desired thermal performance, despite being planned for retrofit, implying that around >£41,000 per home could be better targeted at worse-performing properties. The pilot also found that 13% of homes already rated EPC C+ still underperformed and appeared to need further interventions, despite average prior retrofit spend of ~£27,000.

The pilot report[2] concluded that sensor based measurement could improve social outcomes (comfort, damp/mould risk), reduce retrofit risk, and enable a low risk, incremental rollout with potentially profound sector wide impacts if replicated at scale, accelerating decarbonisation, strengthening the investment case for lenders, and improving resident outcomes, while noting trade offs between cost based EPC compliance and maximising carbon reduction. Following the success of the pilot, Bromford Flagship are expanding the trial to a further 250 homes.

[2] Lloyds (2025) ‘Intelligent Measured Data. Smarter Retrofit. Better Outcomes.’

## Cambridge City Council retrofit programme monitoring and evaluation

Since 2022 the Council has been using pre- and post-retrofit monitoring to assess the effectiveness of its two key social housing retrofit programmes: a fabric-first EPC C programme and net zero retrofit pilot featuring a more extensive package of fabric and energy upgrades at a higher cost per property. Extensive monitoring, including HTC measurement, is being undertaken in a minimum of 10% of programmed properties each winter. This helps to evaluate retrofit performance and drive continual improvement. Comparisons are being made across the same housing archetypes of different levels of retrofit under the two programmes, enabling evaluation of the benefits and relative cost-effectiveness of each programme, with lessons for future delivery.

The monitoring process involves installation of Purrmetrix combined temperature and humidity sensors and a $CO_2$ sensor in each selected home, both before and after retrofit. Meter readings are taken to calculate HTC values and review energy consumption, while residents complete a survey of their lived experience of their home. This combined evidence allows the Council to assess thermal performance through the HTC, condensation risk and ventilation effectiveness while validating the findings against resident feedback.

Although the majority of comparative results will be available next winter, HTC results from the past two winters have already demonstrated improvements through the EPC C programme. It has also shown that pre- and post-retrofit HTCs can vary across the same archetype, with some homes achieving greater improvements than others. In addition, anomalies in the data obtained have helped to highlight issues requiring further investigation, such as an underperforming heating system in one property and elevated humidity and $CO_2$ levels in others which prompted ventilation checks. Many participating households have been interested to see the data related to their home and have been motivated to engage throughout the monitoring process as a result.

The Council regards HTC and its associated monitoring as essential in evidencing outcomes, troubleshooting, refining specifications and building confidence in its retrofit programmes. The HTC and associated data and insights provided convincing evidence of whether retrofit measures had delivered intended outcomes, and also highlighted the benefits of testing and verifying improvements before scaling a programme.

## MEASURED – Build Test Solutions, Veritherm UK, Elmhurst Energy Services

The MEASURED project[3] set out to demonstrate how in-situ measurement of whole-house heat loss can support heat pump surveys and system design. Its objectives were to (1) show that measured heat loss improves the accuracy of calculations, (2) integrate measured data into existing Domestic Energy Assessor (DEA) tools, and (3) support wider industry acceptance through standardised measurement approaches.

The project funded a field trial across 56 homes, comparing traditional heat loss calculations with measured building performance. In parallel, it developed new software tools enabling measured heat transfer coefficients (HTCs) to be incorporated into DEA survey workflows, and produced standardised, technology-agnostic measurement protocols supported by guidance and public resources.

Survey-based heat loss calculations are based on a visual survey of the property and an established methodology (BS-EN 12831) for calculating heat loss according to typical U-values and air permeability for different building elements and materials. These were found to be different to measured data in 70% of cases. Traditional methods overestimated heat loss in 59% of homes and underestimated it in 11%, indicating a risk of systematically over-sizing heat pumps using standard approaches. The evidence shows measured heat loss can substantially improve sizing accuracy, with potential to reduce costs and improve performance. Based on the buildings in the sample, optimising the design and installations with measurements could create an average capital cost saving of around £450 (10%), with additional potential savings from reduced radiator replacements.

Measured HTCs were successfully incorporated into new BS EN 12831 aligned calculation tools within Elmhurst Energy software, enabling DEAs to use measured data in property surveys.

## Great Places Smart Retrofit – Knauf Energy Solutions

This project[4] focused on a 34-home estate in Old Trafford whose pre-existing insulation measures were failing. The aim was to understand, using KES's in-use SMETER energy performance assessment technology, the actual energy efficiency impact of renewing the insulation with high quality measures.

Targeted retrofits were carried out, with existing deteriorated insulation upgraded with new insulation. Bespoke solutions were applied to address unique building challenges, including staggered party walls with tailored insulation solutions, step details at roof level to protect exposed areas of gable end walls, insulated and draught-stripped existing loft hatches.

A custom extraction protocol was developed to safely remove degraded urea formaldehyde cavity insulation, and high-performance insulation solutions were re-installed. Pre-retrofit air pressure tests were conducted on 12 properties to benchmark performance, and post-retrofit testing and monitoring was carried out.

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[3] Build Test Solutions, Veritherm UK and Elmhurst Energy Services Ltd (2025) 'Improving the survey and design process: MEASURED'
[4] Knauf Energy Solutions, 'Great Places Smart Retrofit project in Old Trafford'

The findings were:

- a 31% improvement in Space Heating Demand (SHD) across the estate was measured with KES's in-situ energy performance technology, even though the EPC hardly changed. This translated to an average energy saving of 2,071 kWh per home annually
- the in-situ energy performance assessment was able to provide Great Places with a clear view of the benefits of renewing insulation in these homes, something that the current EPC approach was unable to support
- by also measuring indoor temperatures and humidity levels, it was possible to understand the impact of these measures, in real-time, on tenants' ability to keep homes warm and maintain appropriate humidity levels

## Delivering Energy Performance Insights in Burnley – Knauf Energy Solutions

In 2022 and 2023, Knauf Energy Solutions carried out a thermal retrofit project on 23 homes in Burnley, UK. The goal was to show how measured energy performance data can identify and deliver savings, over and above those facilitated by EPC assessments. The project involved using SMETER technology to calculate the space heating demands before retrofit, undertaking a quality assured, high-standard loft insulation replacement programme tailored to the demands of the properties, and then using SMETER to calculate the space heating demands after retrofit.

The analysis[5] revealed an average space heating demand reduction of 14% post-retrofit which, importantly, would not have been recognised by EPC assessments, demonstrating the tangible value to residents of high-standard fabric installations, informed by SMETER measurement.

## Smart Retrofit in Aarschot, Belgium – Knauf Energy Solutions

This was a 166-home social housing retrofit in Tienen (Belgium), commissioned by social housing company CNUZ, and evaluated by Knauf Energy Solutions (KES) using the International Performance Measurement and Verification Protocol (IPMVP).[6] KES oversaw the retrofit including resident engagement, assessment and design and quality assurance and handover as well as providing a pre and post real performance measurement using their SMETER technology.

This was a large-scale test of an outcome-based approach to contracting for retrofit programmes, based on results achieved rather than works completed and involving an integrated, end to end process underpinned by real performance in-situ measurement, design and quality assurance processes. The contractual target was a 25% improvement in energy performance relative to pre retrofit baselines.

Retrofit measures included cavity wall insulation, roof insulation, window and door replacement, and thermal junction improvements, ventilation upgrades and boiler replacements in a subset of homes.

[5] Knauf Energy Solutions, 'Delivering Energy Performance Insights in Burnley'
[6] Knauf Energy Solutions, 'Renovation of 166 social houses achieves 37% energy savings'

KES analysis showed that energy demand modelled, in particular space heating demand, under the Energy Performance of Buildings system substantially overestimated real space heating demand, attributing this to input assumptions of low fabric thermal performance. KES measured baseline and improved performance using an energy demand indicator (EDI) representing measured whole house energy performance.

The project achieved an average EDI reduction of 37%. Indicative improvements in environmental conditions included:

- Humidity: The proportion of homes frequently above 60% relative humidity fell from 17% to 3% post retrofit
- $CO_2$: Homes frequently exceeding 1500 ppm reduced from 22% to 18%, and above 2000 ppm from 8% to 5%
- Temperature: The share of homes frequently below 18°C during daytime winter hours dropped from 34% to 18%

The project demonstrated that a combination of the correct incentives, in this case being held to a real performance-based outcome, as well as strong on-site quality assurance, are able to deliver significant energy efficiency improvements and better indoor comfort conditions.

## Benchmarking Housing Performance in the London Borough of Havering

In 2022 and 2023, the London Borough of Havering (LBH)[7] conducted a comprehensive monitoring and testing programme on the fabric of homes undergoing retrofit works through the Warm Homes: Social Housing Fund (then Social Housing Decarbonisation Fund). The project aimed to measure the impact of these works on energy performance, comfort, and ventilation. Using Purrmetrix 'Warmscore' equipment, data on temperature, humidity, $CO_2$, and energy consumption was collected to create benchmarks for fabric performance, including heat loss, condensation risk, and ventilation rate. Archetypes were used to structure the sampling process; results suggested that there can be significant variability within an archetype, as well as between them.

The testing revealed substantial reductions in heat loss across the homes following retrofit, providing reassurance of the quality of the retrofit works. The data gathered showed residents enjoying much warmer homes and/or lower energy bills. Some residents had further opportunities to reduce energy bills by reducing their heating, hence might benefit from some follow-up to review heating controls and habits if they have concerns about heating bills.

The results of the HTC measurements also showed that there was wide variance between the rate of heat loss given by the SAP models and the measured HTC in the properties pre-retrofit, with a tendency for SAP to overestimate the rate of heat loss. While SMETER HTC was not used to select homes for retrofit in this case, this finding suggests that using measured HTC in future retrofit programmes can support housing providers to make better-informed decisions about which homes will benefit the most from retrofit, maximising positive outcomes for tenants and delivering value for the money invested in the retrofit.

[7] Purrmetrix (2025) 'Monitoring for retrofit at London Borough of Havering'

## Sheltered Energy Sensors in Barrhead Housing Association

236 sensors were installed to monitor energy usage, heat loss, and environmental conditions alongside smart metering in 50 properties, with 28 of these being sheltered accommodation.[8] Key aims include monitoring energy usage and environmental conditions in the properties, enabling tenant access to real-time data, identifying at-risk tenants, and using data to guide net zero carbon investments. The data was made accessible via a user-friendly tenant app. The project was designed to empower tenants to make informed energy decisions, identify those at risk of fuel poverty for targeted support, and to improve indoor health by reducing risks such as damp and high levels of carbon dioxide.

Success was measured quantitatively by reductions in energy bills and data accuracy, and qualitatively by tenant satisfaction and improved indoor conditions such as reduced mould risk. Findings included: real-time data empowered tenants to reduce energy waste and improve living conditions, with significant increases in tenant confidence and monitoring behaviour. Challenges included digital literacy and lack of smart devices among some tenants required additional support, and limited data collection time constrained long-term impact assessment. In the future Barrhead Housing plans to scale the project across its portfolio, providing baseline data for future energy efficiency and tenant support activities.

[8] Barrhead Housing and Glasgow City Region (2025) ‘SCSP Innovation Fund Case Study: Barrhead Housing’

# 3. SMETER evidence base

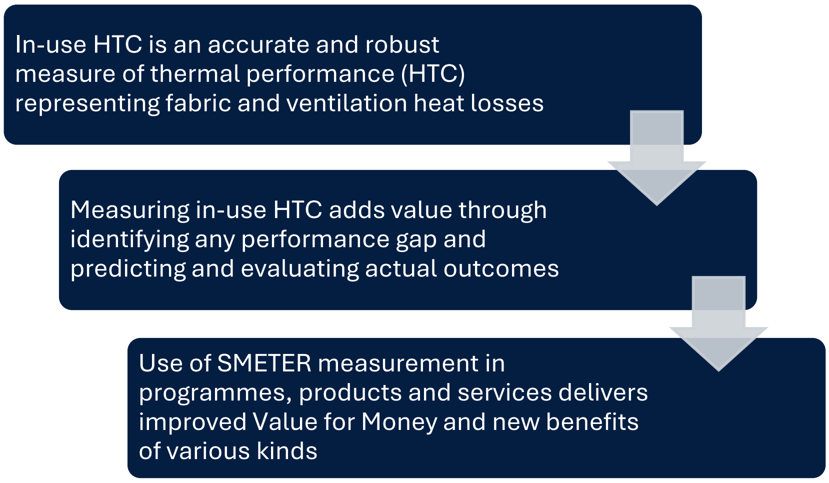
## The SMETER evidence framework

This section addresses a top-level question: why does measuring performance, in particular using SMETER HTC, provide information of value over and above data available from model and survey approaches such as EPCs? The section is aimed primarily at researchers and professionals in building performance evaluation.

The DESNZ SMETER implementation project has been working to develop evidence on the value of measuring in-use HTC to inform activities to decarbonise the housing stock. This has included new strategic work: on the role and value of performance measurement as part of the information system supporting decarbonisation, the range of opportunities it creates, and priorities for further development.[9] However, this section deals with the empirical and analytical evidence we have developed over the last few years, which we are also putting in the public domain. It focuses primarily on the use of SMETER methods which use internal temperature measurements.

We have developed a framework to structure the different types of such evidence, as outlined in Figure 1 below. Each element supports the element below: for example, evidence that in-use HTC can be measured accurately and consistently is needed so that comparisons can be reliably made with HTC generated by model calculations and the fabric performance gap quantified. Evidence on the elements is summarised and referenced in the following sub-sections.

**Figure 1: SMETER evidence framework schematic**




[9] Joint DESNZ and University College London workshop: 'Measuring the energy performance of homes to drive Net Zero: mobilising science and evidence'; Paper for European Council for an Energy Efficient Economy (ECEEE) Summer Study

Developing the evidence framework is an ongoing endeavour, and results will continue to be developed and published by the project and elsewhere, with an update intended in the first half of 2027; as with the case studies, we welcome industry and other contributions to the SMETER evidence base.

# Evidence within each framework element

## 1. What is the evidence on the accuracy and robustness of SMETER methods for measuring thermal performance (HTC)?

The in-use HTC is derived[10] from the relationship between dwelling heat loss and indoor-outdoor temperature differentials, from which SMETER methods establish how quickly heat leaves the dwelling envelope on average[11]. The average rate of heat loss cannot be measured directly, but by conservation of energy the average rate of heat loss is equal to the average rate that heat is added to the dwelling. Most of the heat added to the dwelling can be measured using smart meters. SMETER methods also account for the heat from the sun (using weather station data) and any other significant sources of heat.

The HTC may vary, for example due to differences in windspeed during the measurement period, and may be influenced by the occupants' use of mechanical and natural ventilation. Therefore, SMETER methods are best validated against in-use HTC measurements based on data collected from occupied homes (CIBSE TM 71[12]). However, it is still useful to compare the in-use HTC with the results of quasi-steady-state tests, such as the 'co-heating' test. The co-heating test has previously been established in building and energy research as the standard means of empirically measuring fabric heat losses in unoccupied homes, and the test results can be modified to account for ventilation.[13]

### Comparisons with quasi-steady-state tests in unoccupied homes

DESNZ funded the SMETER innovation competition[14] in which eight companies developed and tested SMETER methods in occupied homes. This included an evaluation[15] of their accuracy in 30 occupied homes, by a consortium led by Loughborough University. Participating organisations were asked to measure the in-use HTC in a blind trial against HTC as measured using a co-heating test carried out before the home was occupied and adjusted for ventilation.

[10] Heat transfer coefficients are defined in BSE EN ISO 13789:2017 (British Standards Institution, 2017) as the "heat flow rate divided by the temperature difference between two environments".
[11] Heat loss rates vary minute by minute, but the HTC provides an average value on the time scale of days or weeks.
[12] CIBSE (2026) 'TM71 Measuring heat transfer coefficients in buildings (2026)'
[13] Ventilation openings are normally sealed during a 'co-heating' test and so the result is not directly comparable with SMETER and SAP HTC without adjustment. For more information see CIBSE TM 71.
[14] DESNZ, Smart Meter Enabled Thermal Efficiency Ratings (SMETER) Innovation Programme
[15] BEIS (2022) 'Smart meter enabled thermal efficiency ratings (SMETER) technologies project: technical evaluation'

Results showed that three out of the eight SMETER methods had very little bias and relatively high precision[16] compared to the HTC measured by the quasi-steady-state test. A late joining SMETER method also successfully predicted the HTC of two separate homes; this method has also been successfully tested in further comparisons with quasi-steady-state tests[17]. The most accurate SMETER methods used internal temperature data (two of the eight SMETER solutions used only remote monitoring of external temperature and energy consumption). The best methods were more accurate than an expert using the RdSAP method to calculate the HTC, as used for EPCs.

### Factors that affect the measurement of HTC

Since SMETER HTC values will be derived from data collected by different methods, in different homes, and under a range of occupancy and weather conditions, we need to understand the degree to which any of these factors could affect the in-use HTC output value (causing it to vary) or the accuracy of its measurement (introducing uncertainty). Any significant factors would need to be controlled.

To address this, we have conducted new analysis[18] and undertaken a review[19] of evidence from published literature, on the impact of a range of factors. These can either affect the measured in-use HTC value or the accuracy of its measurement, and come under the following four categories:

- dwelling characteristics
- how households use their homes
- the external environment, such as weather
- measurement methods

The review concluded that many factors are not significant and therefore do not need to be controlled. However around 10 factors were identified as needing some controls: either within the SMETER method (i.e. the algorithm) itself; or by application of process controls applied to how SMETER measurement should be conducted.

The preferred approach is ensuring that SMETER methods are robust to these factors. Validation tests can be used to check that the methods are robust for periods with, for example, sunny weather and underheated homes, and based on how many temperature sensors are used.

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[16] Bias was quantified using the normalised mean bias error (NMBE) which is a measure of the trueness, or systematic agreement, of the measurement and would ideally be zero. The NMBE ranged from -0.7% (best) to -26.9% (worst). Precision was quantified using the coefficient of variation of the root mean square error (CVRMSE). A lower CVRMSE is better and the CVRMSE ranged from 13.4% to 38.9%.

[17] Leeds Beckett University / Leeds Sustainability Institute (LSI) (2025) 'Knauf Energy Solutions SMETER verification study: Interim summary report'

[18] Sonia Fogeh, Dan Cooke, David Allinson and David Ross (2026) 'To what extent can occupants' actions change the in-use SMETER HTC value?', (presentation), Loughborough University; Dan Cooke, David Allinson and David Ross (2026) 'What impact does the number and location of temperature sensors have on the accuracy of the in-use SMETER HTC measurement?', (presentation), Loughborough University

[19] David Allinson and Max Eastwood (2026) 'Factors that affect the measurement of the in-use HTC of dwellings: evidence review – July 2026', Loughborough University

Certain low carbon technologies could affect SMETER algorithms if not controlled for, for example unmetered PV or EV charging would affect the smart meter data. SMETER providers may demonstrate that they have an effective means of accounting for this, and this can be tested as part of the validation. Any remaining factors would be controlled through application of process controls which are currently being designed in SMETER QA work.

### Evidence on SMETER HTC measurement uncertainty

Measurement uncertainty (expressed in terms of confidence intervals) of HTC values is relevant to the use of SMETER methods. For example, it may make it hard to detect the impact of certain forms of retrofit for individual homes. It may also sometimes entail analysing impacts for clusters of homes together (not individually) for policy and delivery purposes[20].

Initial evidence on measurement uncertainty of SMETER methods was collected in the TEST project, as described above. Further evidence on uncertainty will be developed through the SMETER validation process. A guiding principle for validation is that the measurement uncertainty of SMETER methods should be less than the error in the current calculation methods used for EPCs, which are based on a short visual survey and modelling assumptions.

In addition, we are exploring a novel method for routinely verifying HTC measurements through the estimation of the energy consumption for a period without access to energy input data, and subsequent comparison with real data[21]: if proven effective, this could also offer in the future a routine method of validating SMETER HTC values.

## 2. What is the evidence that measuring in-use HTC adds value through identifying any performance gap and predicting and evaluating actual outcomes?

### Measuring the fabric (thermal) performance gap

The difference between the real thermal performance (HTC) of a dwelling, as measured either in an unoccupied house (e.g. quasi-steady-state test) or using an accurate in-use HTC, and the current calculation methods used for EPCs, is usually termed the fabric performance gap. This has multiple causes, including construction defects versus design and the use of standard modelling assumptions in the calculation (fabric components and ventilation).

The size of the fabric performance gap varies both systematically (e.g. between construction types) and indiscriminately (e.g. between adjacent houses of the same pattern). The latter might be regarded as noise but is practically important when deciding what actions to take in individual homes.

Some causes of the fabric performance gap may be correctable with administrative data, such as correctly identifying energy efficiency measures present in the home[22]. However, others, such as construction defects, are hidden and can only be identified through physical measurement. SMETER HTC methods quantify the overall fabric performance gap.

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[20] DESNZ (2025) 'Green Homes Grant (GHG) SMETER project evaluation: final report', page 82
[21] David Allinson (2026) 'SMETER: Expert meeting to discuss Energy Estimation for HTC validation', Loughborough University
[22] DESNZ (2026) 'Energy Performance Certificate (EPC) accuracy research'

The current evidence base includes small-scale academic studies of newer, energy-efficient homes that are, on average, 17% worse than design prediction (see CIBSE TM 71). Conversely, work funded by DESNZ through the Energy Saving Trust and Build Test Solutions[23] with hundreds of measured homes indicated that the thermal performance of many older and therefore worse-rated homes was significantly better than predicted by EPCs (of ~500 homes, 30% performed better than predicted, with one in six differing by more than 50%). This positive performance gap result occurs consistently in other studies such as the DESNZ DEEP project[24] and pilots such as the Lloyds Bank study[25] summarised in Section 2. Its practical consequences include lower than expected savings from retrofit and smaller heat pump size requirements.

### The difference to predicted outcomes, for example heating demand, from measuring in-use HTC rather than calculating it using modelling assumptions

Extensive studies have shown that EPC metrics of heating demand are poorly correlated with real heat demand and that this is due to multiple causes[26]. One source of potential value from SMETER in-use measurement comes from the ability to provide more accurate predictions of heat demand, for example to assess the future running costs of heat pumps.

DESNZ commissioned Loughborough University to assess the impact of using in-use HTC, as well as other measured input values (e.g. indoor air temperatures, electricity consumption and weather) as inputs to the calculation model (RdSAP) that underpins EPC ratings to predict the heating energy (gas) consumption in homes. This was carried out with a sample of 72 gas-heated homes ranging from EPC band B-E[27].

This research found that introducing measured data into the RdSAP model improved its ability to predict gas consumption[28]; using the measured HTC value alone had a greater impact than the combination of all the other measured data, demonstrating the significance of the in-use HTC in building an accurate picture of the energy performance of homes.

## 3. Evidence that use of measured metrics in programmes, products and services delivers value for money and new benefits of various kinds

### Evidence of delivery benefits from trials and pilots

There is growing evidence on the benefits of SMETER measurement in areas such as retrofit delivery and heat pump sizing, as provided by the case studies in Section 2. We welcome further studies.

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[23] Ben Whittle and others (2026) 'The value of in-use building performance metrics on the route to net zero', Energy Saving Trust

[24] BEIS (2019) 'Demonstration of Energy Efficiency Potential (DEEP)': Comparison of co-heating tests with RdSAP calculations for 43 homes found that measured performance was 42% better on average. A significant gap remained after measuring elements, including U-values, thermal bridges and ventilation (17%).

[25] Lloyds (2025) 'Intelligent Measured Data. Smarter Retrofit. Better Outcomes.'

[26] Jessica Few and others (2023) 'The over-prediction of energy use by EPCs in Great Britain: A comparison of EPC-modelled and metered primary energy use intensity' Energy and Buildings, Volume 288

[27] Publication under peer review.

[28] The correlation (R2) of gas consumption predicted by RdSAP with actual gas consumption increased from 42% to 62% when measured HTC was introduced to the model.

## Value to householders of information derived from SMETER measurements

Alongside the improvement in outcomes which could be enabled by in-use measurement within retrofit schemes and heat pump and other delivery supply chains, information from SMETER measurements could also be of direct value to householders. DESNZ commissioned some exploratory research to investigate this possibility[29].

The research examined whether in-use data from homes could improve diagnosis, product selection and validation of performance, and whether it might encourage greater confidence in energy efficiency upgrades. It drew on interviews with householders who had recently installed insulation or heat pumps, alongside interviews with installers of these technologies.

Most consumers had not actively sought quantified evidence to validate the effect of installing insulation or heat pumps, and some found it difficult to see how they would use such data in practice. Even so, consumers and installers generally regarded the concept positively in principle. Many felt that, if credible and easy to understand, performance measurement could support more informed choices, strengthen confidence in retrofit outcomes, improve heat pump sizing, and potentially enhance or complement existing approaches such as EPCs. Performance measurement is most likely to add value where it is translated into simple, outcome-focused information and incorporated into the services offered by installers or other trusted intermediaries.

[29] DESNZ (2026) 'Qualitative research into the consumer value of in-use home energy performance metrics'

This publication is available from: www.gov.uk/government/publications/smart-meter-enabled-thermal-efficiency-ratings-smeter-strategic-guide

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