DATA & TECHNOLOGY

STRENGTHENING OUR UNDERSTANDING FOR BETTER RETROFIT OUTCOMES

A NEW APPROACH TO ASSESSING PERFORMANCE OF HOMES

This report sits within the Measuring Outcomes and Impact Evaluation project, led by the National Retrofit Hub in collaboration with Arup, supported by Impact on Urban Health and TrustMark. The project asks "How can broader outcome measurement accelerate retrofit delivery and be designed to drive better policy, funding, and delivery decisions."

In **Measuring for Success?**, we describe how the majority of large-scale retrofit delivery programmes, for example ECO or Warm Homes: Local Grant, define success by a narrow range of predicted outcomes, often based on the number of measures installed and improvements in EPC ratings. Schemes require targeting, monitoring and reporting against metrics that do not directly create resident benefit and inaccurately predict performance improvements. One outlier is the Welsh Optimised Retrofit Programme, which collected robust post-installation performance data.

Many in the industry are calling for better real-world performance monitoring and testing to improve the quality and effectiveness of retrofit delivered. We support the need for better post-retrofit performance data. However, this report considers the value of performance data both pre- and post-retrofit. We look at how real-world data can better inform all stages of retrofit projects and tracking of our progress to net zero.

We argue that accurate knowledge of the performance of homes pre-retrofit is a valuable commodity. Used well, this knowledge can reduce the administrative burden of planning retrofit projects, reduce project risk, eliminate abortive works, help target the right homes with the right interventions, and minimise disruption wherever possible.

Creating more robust data baselines can also lead to more effective retrofit programmes across both fabric and systems and help us build a picture of how they work collectively. Implemented well, this baseline can better support locally-led retrofit delivery, facilitated by industry confidence in outcomes.

Those delivering retrofit schemes can already get started, and this report sets out the benefits to their programmes, stock and residents. However, if we are to enable widespread measurement of in-use performance data then retrofit funding and finance models need to change. Government grant-funded schemes often base eligibility and funding requirements on EPC ratings, without setting thermal performance targets or requirements to evidence performance. The supply chain and procurement structures are therefore under-developed in their ability to prove performance. Changing the criteria within grant funded schemes, utilising measured data, would influence wider systemic change throughout the sector.

This is a key time for building performance policy. The Warm Homes Plan, Future Homes Standard and EPC reform could all adopt real-world data within their methodologies to better reward true performance in homes, creating a systemic shift in the wider retrofit supply chain. This report highlights the benefits of using this real-world data at the planning stage, and explores one innovation, the SMETERS-HTC, in more detail. We consider how this, now low-cost intervention, can be utilised alongside other datasets, to create a more robust baseline of knowledge for decision makers.

AUDIENCES

This is not an academic paper, but a practical guide informed by emerging innovations and stakeholder perspectives. It sets a direction for future work by showing how measured performance data can improve investment decisions, capture lessons from implementation, design grants that drive better outcomes and strengthen delivery within a whole-system decarbonisation context.

WHO SHOULD USE THIS REPORT?

- **Central Government Departments (e.g., DESNZ, Cabinet Office) and Ofgem** to inform policy and funding frameworks.
- **Combined Authorities and Devolved Governments** for regional policy development and implementation.
- **Local Authorities and Housing Associations** for planning and prioritising retrofit programmes.
- **Delivery Partners and Grant Administrators** to design schemes that reward verified outcomes.
- **Private Landlords and Housing Providers** to improve investment confidence and reduce risk.
- **Financial Institutions and Investors** to support ESG objectives and create investable pathways.
- **Climate Change Committee** in gathering evidence-based recommendations for national decarbonisation pathways.
- **Consultants** in their advice to all of the above.

AUTHORS

Arup – Sarah Bousquet, Tara Clinton, Freddie Oxland, Helene Gosden, Chris Jofeh, Becci Taylor, Jacqueline Stables

NRH – Rachael Owens, Sara Edmonds

Thank you to our reviewers:

Daniel Archard – Clarion Housing Group

Steven Heath – Knauf

Richard Hauxwell-Baldwin – MCS Foundation

Sarah Kostense-Winterton – MIMA

Matt James - Smart DCC

Dr Ahsan Khan – xRI

George Martin – Building Performance Network

Kate de Selincourt - UK Passivhaus Trust

Dr Kate Simpson - Nottingham Trent University

Russell Smith - Cotality

Professor David Glew - Leeds Sustainability Institute

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UNDERSTANDING THE CHALLENGE

DEFINITIONS

HTC: Heat Transfer Coefficient – a measure of the rate of heat loss through a building's envelope per degree temperature difference between the internal and external environment. It is expressed in Watts per Kelvin or Celsius. A lower HTC corresponds to a lower rate of heat loss, and therefore better thermal performance. HTC specifically characterises the thermal performance of the building fabric, while other factors such as occupant behaviour, internal gains, and appliance use also contribute to the overall discrepancy between predicted and actual energy use.

EPC: Energy Performance Certificates - a document that provides an energy efficiency rating for a property. EPCs are based on the SAP or RdSAP and are legally required when selling or renting properties in the UK.

SAP: Standard Assessment Procedure, the UK government's methodology for assessing and comparing the energy performance of dwellings, forming the basis for Energy Performance Certificates (EPCs). A predictive analysis.

RdSAP: Reduced Data Standard Assessment Procedure, a simplified version of SAP used for existing dwellings, relying on fewer data inputs and assumptions to estimate energy performance.

Smart Meter: A digital energy meter that records real-time electricity and gas consumption and communicates this data to suppliers and consumers. In the context of SMETER, smart meter data can be used to infer heat loss characteristics and calculate HTCs without intrusive testing.

SMETER: Smart Meter Enabled Thermal Efficiency Rating - a technology and methodology that uses thermostats, smart meter data and algorithms to estimate a home's Heat Transfer Coefficient (HTC) in situ.

SMETERS-HTC: the Heat Transfer Coefficient calculated by SMETER technology.

RdSAP HTC: the Heat Transfer Coefficient predicted using the RdSAP method.

Measured HTC: the Heat Transfer Coefficient measured using a traditional coheating test to assess the fabric and infiltration heat loss, with an additional blower door test to account for air tightness.

Performance gap: The difference between the predicted energy performance of a building (based on models such as SAP or RdSAP) and its actual measured performance in use.

Classification: The process of categorising properties into groups or typologies, based on shared characteristics.

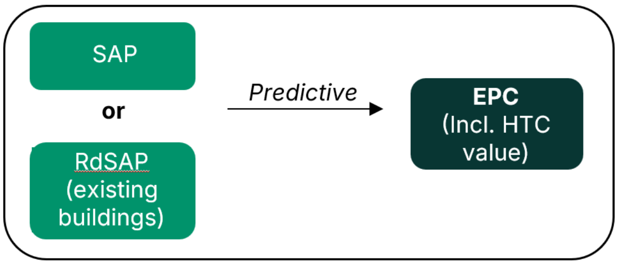
Archetyping: Creating representative models of homes.

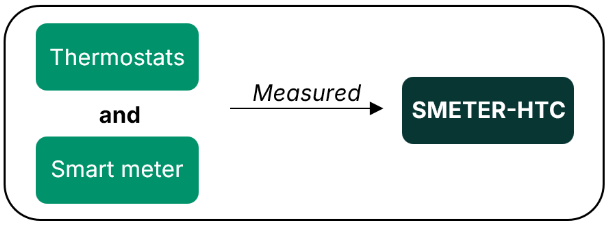
Baselining: Planning a large-scale retrofit programmes using building data, classified data and/or typal data.

QUB: The rapid test measures the heat transfer coefficient (HTC) in a single night. During the test the house is heated and then allowed to cool. External and internal temperatures are measured throughout heating and cooling phases, and the data is used to calculate the as-built HTC.

Thermal Imaging: Thermographic (or Infrared) surveys map the thermal efficiency of buildings using an infrared (IR) camera. The results can show where thermal bridging or thermal bypass is taking place, any areas of missing insulation, and poor window, door and junction sealing for example.

Figure 1 demonstrates the different heat gains and losses in a space, highlighting the variability and complexity in predictive modelling.





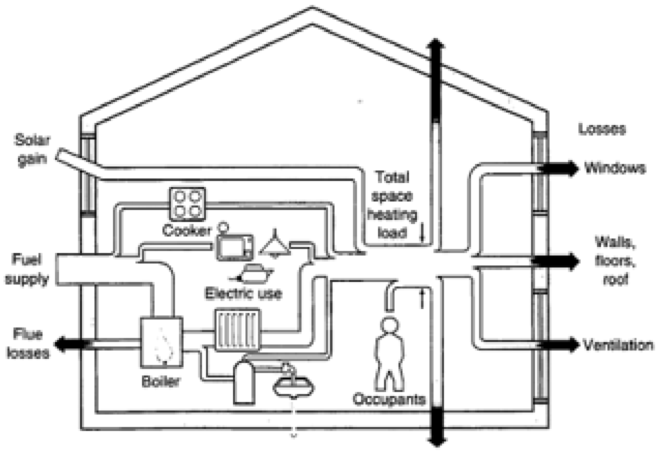


Figure 1: Illustration of heat gains and heat losses in a building[1]

1 Chambers, Developing a rapid, scalable method of thermal characterisation for UK dwellings using smart meter data (2017)

CAPTURING REALITY

Limitations of EPC modelling for real-world retrofit

Meeting the UK's statutory net zero target by 2050 requires significant improvements in housing energy performance, alongside large-scale transition from gas to low-carbon heating systems. Accurate baseline data is essential for identifying which properties need retrofit, what interventions are needed and capturing the impact of those interventions.

EPCs are the most widely used and reported dataset given their coverage, but they have well-documented limitations when it comes to retrofit. Studies comparing EPCs to measured performance have widely ranging results, which depends on many factors, but all demonstrate the unreliability of EPCs in lieu of measured performance. Even with planned improvements to EPC methodology, predicting thermal performance accurately will remain challenging. Underprediction is potentially more important as it hides the experience of fuel poverty, depriving disadvantaged residents of the help they need, and opens the risk of badly performing and potentially unaffordable decarbonised heat installation in homes that the EPC deemed 'heat pump ready'.

Case Study 1

UCL researchers[1] analysing data found EPCs overpredict energy use compared to metered consumption, with the gap widening for lower EPC ratings. Analysis of 1,374 gas-heated homes showed EPCs over-estimated primary energy use by 8% for band C and 48% for bands F and G (see Figure 2).

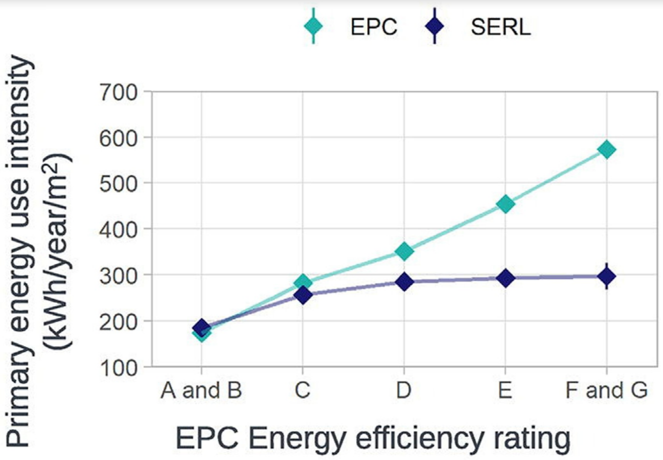


Figure 2: Comparison of EPC modelled energy use with metered energy use by the Sma\rt Energy Research Lab (SERL)

Case Study 2

The DEEP[2] project compared EPC-derived HTCs with those measured via coheating tests (measured HTC) and found EPCs overestimated HTC by an average of 42%, a phenomenon known as the "prebound effect," which was more pronounced before retrofit than after.

Case Study 3

Lloyds and the Good Economy Partnership[3], found the average thermal performance gap in the pilot study was 25%, with 11% of the pilot sample experiencing a level of heat loss which was more than double their modelled predictions.

1 Few et al, The over-prediction of energy use by EPCs in Great Britain: A comparison of EPC-modelled and metered primary energy use intensity (2023)
2 DESNZ, Deep Synthesis Report (2023)
3 Lloyds Bank, Smarter retrofit, better outcomes, (2025)

UNDERSTANDING THE CHALLENGE

MORE THAN SKIN DEEP

Homes that look the same do not perform the same

So why do these discrepancies between (predicted) EPCs and (measured) performance occur?

- **Physical:** Construction quality, repair effectiveness, thermal bridging, and air infiltration.
- **Behavioural:** Occupant habits such as heating patterns and ventilation practices.
- **Modelling assumptions:** Simplifications in SAP and RdSAP that cannot fully account for variability in real-world conditions.

An example of this can be seen in a case study of 20 new homes by Knauf. These new build homes had identical physical characteristics, such as age, construction type and design.

Despite these shared characteristics, when the energy use of each home was measured the results varied considerably from one home to the next. Then when the existing loft insulation was removed, service penetrations sealed, and new higher performing insulation fitted, the heating demand reduced - but in an inconsistent and unpredictable way. The accuracy and variability across measurement devices can also be a factor, but this result challenges assumptions of consistent impact across similar homes.

These discrepancies highlight two critical issues:

- **Data limitations:** Segmenting homes by physical characteristics does not always create groups with similar performance or build quality. This occurs in EPCs and models that use standard material assumptions, rather than actual performance data. The accuracy of the model is directly related to the accuracy and level of completeness of the data available.
- **Policy and incentive gaps:** Current retrofit policy and funding mechanisms (e.g., MEES, SHF, ECO) are tied to EPC targets rather than measured outcomes. As a result, measurement is often seen as an unnecessary cost yet given the weak correlation between EPC ratings and actual efficiency; this is a missed opportunity. There are no incentives for pre- or post-retrofit measurement, and procurement frameworks rarely specify performance-based targets such as guaranteed thermal performance improvements.

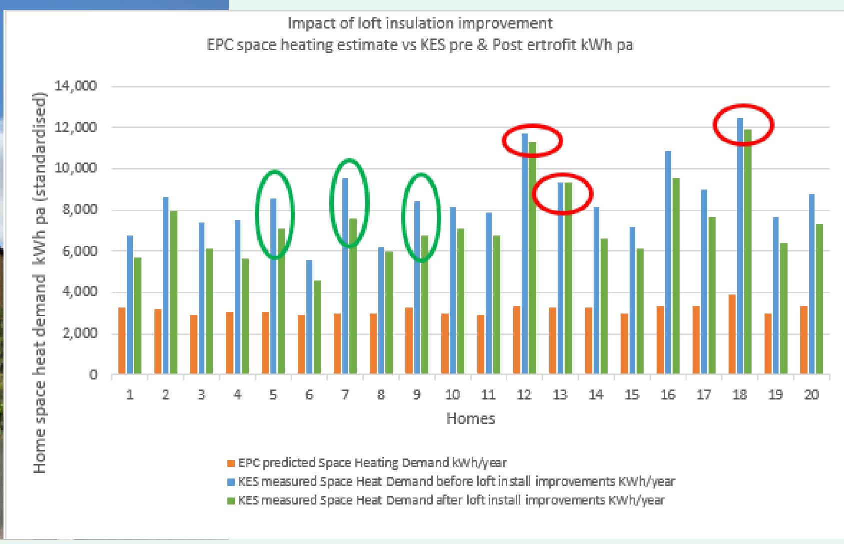
Without a shift toward rewarding verified performance, risk remains with occupants, and poor retrofit practices persist. Lessons from other models, such as Heat Geek's "Zero Disrupt" model for heat pumps, show that combining guarantees with supportive policy can drive better outcomes. Building similar mechanisms for fabric performance could enable the supply chain to differentiate on quality rather than price and support paying for actual outcomes rather than proxies.

Case Study

Knauf study on 20 new build homes.

Figure 3: 20 occupied new build homes

Figure 4: Impact of loft insulation improvement for 20 occupied new build homes



BASELINING BETTER

Poor starting data undermines retrofit success

Poor starting data doesn't just distort predictions; it undermines every stage of a retrofit project, from scoping and funding to design and evaluation. When starting assumptions rely on EPC ratings or physical building information only, errors can cascade through the process, leading to misaligned budgets, missed performance targets, and wasted effort. The example here is for a single project, and can be scaled to a project programme or national-level baseline modelling.

At the scoping stage, predictive estimates can overstate or understate retrofit needs, skewing funding applications and project prioritisation. During design, limited feedback on actual in-use performance restricts opportunities to refine solutions. Post-installation, minimal checks mean gaps persist, leaving occupants at risk of poor outcomes. Contractors and designers rarely have feedback and learning needed for building the national skills base and productivity.

Programmes based on building component data (such as identifying uninsulated walls or lofts) face similar limitations. They often fail to capture the quality of install, and impact, as well as the potential need for further intervention or indication of heat pump readiness. Asset data derived from EPC or component-level information is frequently inaccurate and typically needs validation through an on-site survey.

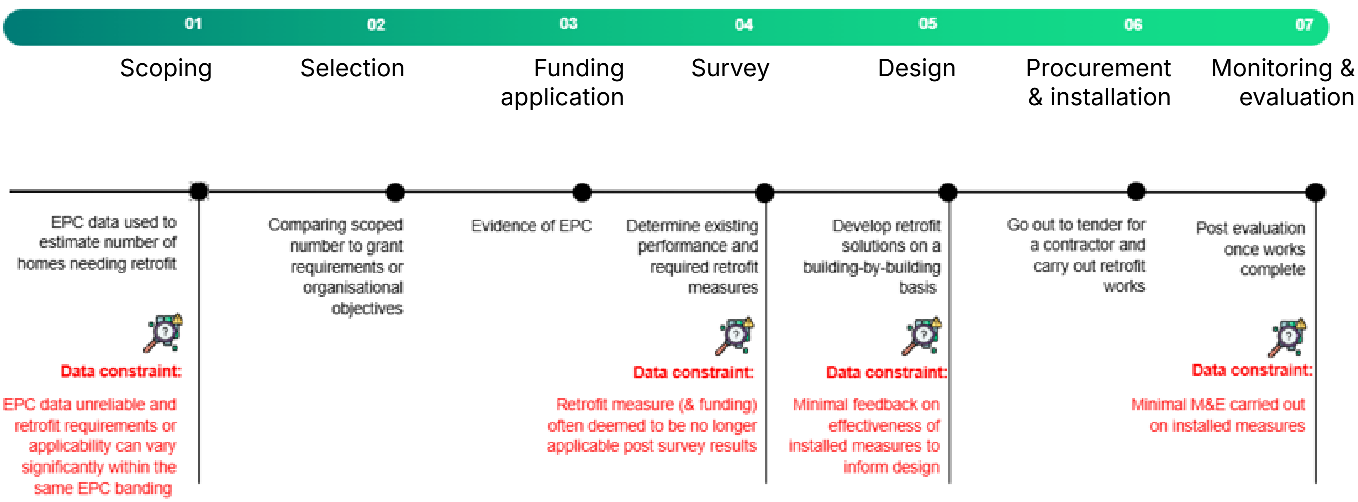


Figure 5: Impact of poor data on the lifecycle of a retrofit project[1]

BEYOND THE HOME

How inaccurate assumptions disrupt energy networks and the net zero transition

Retrofit decisions do not happen in isolation. When performance-based measures aren’t captured, the effects extend beyond individual homes to the wider energy system. Grid operators, local authorities, and energy suppliers rely on aggregated demand forecasts to plan infrastructure upgrades, manage peak loads, and integrate low-carbon technologies such as heat pumps.

If retrofit programmes overestimate savings or underestimate demand, network decarbonisation plans, and wider net zero transition can be put at risk.

For example:

- **Grid planning:** Misaligned demand projections affect investment in reinforcement and flexibility measures, risking delays or unnecessary expenditure.
- **Policy and investment:** National and regional decarbonisation strategies depend on accurate modelling of demand reduction. Poor data undermines confidence in progress tracking and projection of work needed.

The transition to net zero requires a whole-system approach. Moving from predictive to measured performance is not just about improving retrofit outcomes; it is essential for aligning building-level interventions with network-level planning and underpins investment decisions by both the public and private sector to ensure resilience as energy systems decarbonise.

EXPLORING A SOLUTION:
SMETERS-HTC

EXPLORING A SOLUTION:
SMETERS-HTC

HOW DOES IT WORK?

Traditional HTC Testing: Coheating Test

Historically, a building's heat transfer coefficient (HTC) was assessed using methods such as the coheating test, where a property is maintained at a constant indoor temperature to calculate heat loss. While accurate, this method can be expensive, requiring several weeks of stable conditions and monitoring without occupants, to eliminate variables like ventilation, infiltration and occupant behaviour. This can also be referred to as measured HTC.

Innovative HTC Testing Methods

Recent innovations enable less intrusive approaches using SMETER (Smart Meter Enabled Thermal Efficiency Rating) technology. These methods analyse smart meter data alongside outdoor, and often indoor, temperature readings to estimate HTC under real-world conditions. Algorithms aim to separate fabric heat loss from behavioural factors through long-term monitoring and statistical modelling, though short-term data can be skewed by occupant behaviour.

Modelling approaches and monitoring periods vary across SMETER technologies. An evaluation by BEIS[1] concluded that SMETERs have the potential to support a consistent national database of home energy efficiency, provided validation and audit mechanisms are in place. Currently there is no common framework to evaluate or communicate the reliability of SMETER technology.

Beyond heat loss measurement, SMETER manufacturers are working to measure additional functions such as mould risk analysis and heat pump sizing assessments.

The QUB test is the fastest HTC method and its accuracy sits between co-heating tests and SMETERS. This report considers pre and post conditions at minimal resident disruption, as the property must be vacant during the test period, this test is not the focus of this report but the benefits of the measured performance discussed, also apply to QUB.

Figure 6: Build Test Solutions SmartHTC product, presenting live via a smart meter In-Home Display[2]

1 BEIS, Technical Evaluation of SMETER Technologies (TEST) Project, (2022)
2 Build Test Solutions, Smart HTC product

INFORMATION SOURCES FOR DESIGN

How does it all fit together?

The table on the right compares SMETERS-HTC and four other key information sources. Each source offers unique insights, and many are complementary rather than interchangeable. SMETERS-HTC values and smart meter data, can provide the strong foundations for retrofit designer pre- and post-retrofit. Thermal imaging in this case is assumed to be on street and external measurement only.

Ultimately, the choice of which sources to use can depend on capacity, accessibility, data quality, scalability, and wider programme aims. This table is generally aimed at those working in large retrofit programmes, and a full set of diagnostic methods, please refer to the Future Homes Hub guide for housebuilders[1].

	Information source				
Retrofit designer data:	**Lodged EPC data (assumed values in SAP & rdSAP)**	**Smart meter Data**	**Thermal imaging**	**SMETERS-HTC**	**Physical building characteristics**
Heat loss	Predictive estimate based on inputs and assumptions	Provides energy consumption data for inference	Identifies localised surface temperature changes	Direct measure of overall heat loss (W/K)	Presence or not of insulation (loft or cavity wall)
Air tightness	Default/input modelling values in RdSAP/SAP	-	Implied drafts and thermal bridges through surface temperature change	-	-
Dimensional survey	Basic dimensions assumed or estimated	-	Only if accompanied with LiDAR	-	-
Occupational behaviour	Default occupancy profiles in model	Captures usage patterns (heating, appliances)	-	Aims to separate via algorithms	
Route to measured data pre and post retrofit	Weak: Relies on modelled performance and assumptions	Strong (energy): Compare energy use before/after	Good (external): Visual comparison before/after	Strong (fabric & energy): Compare pre- and post-retrofit HTC and energy use	Weak (fabric and energy): Can be used for decision making

1 Future Homes Hub and Building Performance Network, Building Performance Evaluation (BPE) – Where to Start Guide (2023)

WHAT OPPORTUNITIES DOES THIS UNLOCK?

When combined with supportive policy and robust validation frameworks, SMETERS-HTC can enable several improvements in retrofit planning and delivery:

- **Improved retrofit programme planning and delivery**

Measured performance data helps prioritise homes for retrofit and reduces delays caused by redesigns or unexpected site conditions.

- **Better design and reduced abortive costs**

Measured performance data supports right-sizing interventions and avoids unnecessary works, improving design confidence and reducing reliance on conservative assumptions. For example, accurate heat loss data can minimise radiator upgrades during heat pump installations.[1]

- **Cost and carbon benefits**

Reliable measured performance data can prevent over-specification of equipment, lowering capital costs and embodied carbon. It also improves cost certainty by aligning budgets with actual needs and supports lifecycle planning, extending plant life and avoiding premature upgrades. In some cases, existing equipment may remain fit for purpose, further reducing costs, embodied carbon and waste.

- **Demonstrating value, performance monitoring and closing the gap**

Comparing pre- and post-retrofit HTC enables evaluation and continuous improvement via information gathering. SMETERS-HTC can help check and verify the design intention has been met, taking some of the risk of bad installs from consumers and onto the industry. This approach can also support Pay-for-Performance models, where funding is tied to verified outcomes rather than predictions, though such schemes require additional monitoring and compliance measures[2]. To operationalise this, further research is needed to address the technology uncertainty when it comes to capturing what can often be a small improvement due to retrofit. Solutions could include longer monitoring periods to reduce uncertainty bands.

- **Long term impact**

Potential to enhance and expand guarantee offers, given the outcome measurement. Building trust in retrofit outcomes could potentially reduce the need for subsidies over time and supports ESG objectives, creating investable pathways for housing providers and financial institutions.

- **Resident perception**

As this technology measurement is outcome and quality focused, it could support building resident trust.

1 Childs et al, Predicting the heat pump readiness of existing heating systems in the UK using diagnostic boiler data (2025)
2 Build Test Solutions, Crossway Performance Monitoring case study

WHAT'S THE PROPOSED APPROACH?

Deploying SMETERS-HTC technology reliably before and after retrofit would enhance decision-making throughout the project lifecycle. Rather than relying solely on predictive data in early stages, this approach uses measured data to improve accuracy at every stage.

Pre-retrofit SMETERS-HTC data can inform scoping and selection, ensuring homes with the worst energy performance can be prioritised. By building in measurement requirements, funding applications can be supported by robust evidence. During survey and design, measured performance can enable tailored solutions, avoiding unnecessary works and oversizing. Procurement and installation can then be aligned to clear performance targets, while post-retrofit SMETERS-HTC validation can support monitoring, evaluation, and continuous improvement.

This approach supports policy objectives by linking funding to verified outcomes rather than predicted metrics or benchmark values[1].

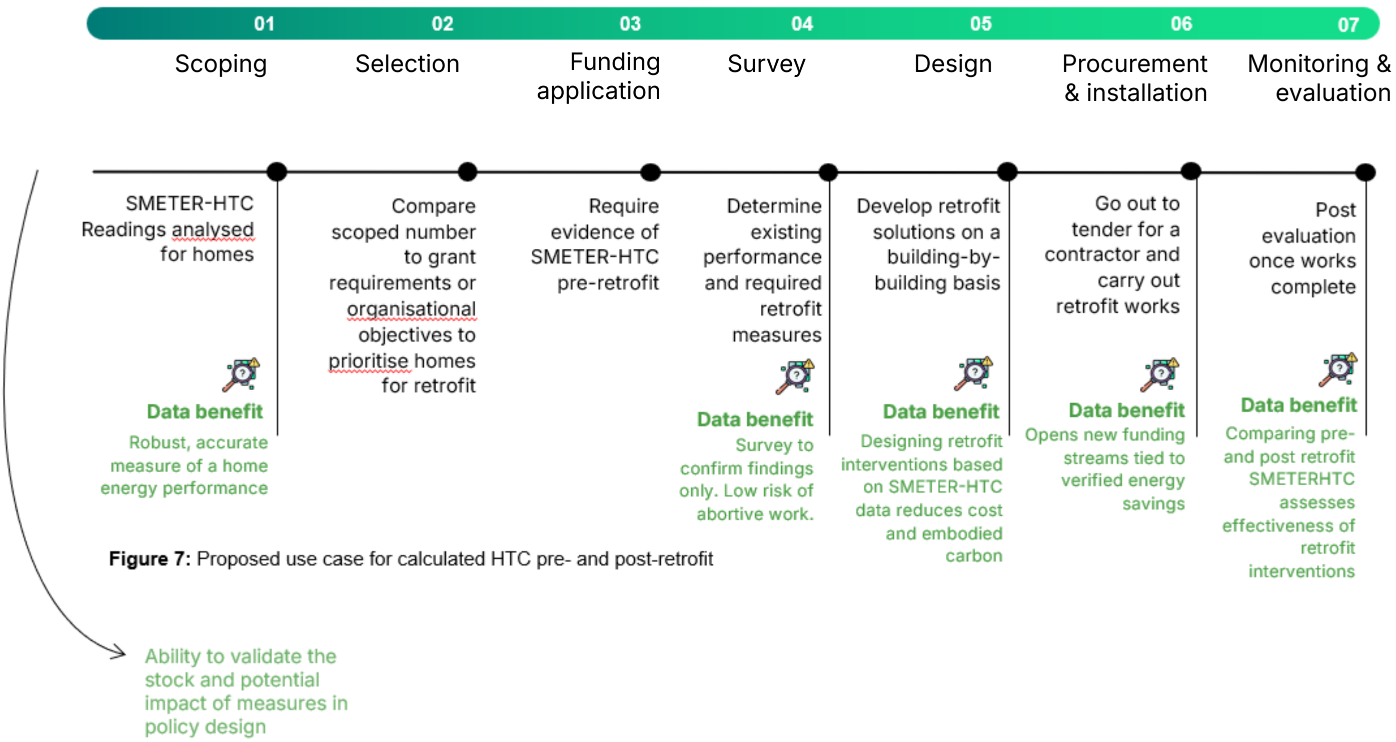


Figure 7: Proposed use case for calculated HTC pre- and post-retrofit

1 National Retrofit Hub, Measuring For Success?, (2025)

EXPLORING A SOLUTION:
SMETERS-HTC

WHAT VALUE COULD IT BRING?

Whilst it is not the only opportunity unlocked via performance measurements, this simple cost-benefit analysis uses radiator replacement, a small portion of ASHP cost, to illustrate how savings can be realised via performance measurement. This analysis is intended as an illustrative example rather than a definitive projection.

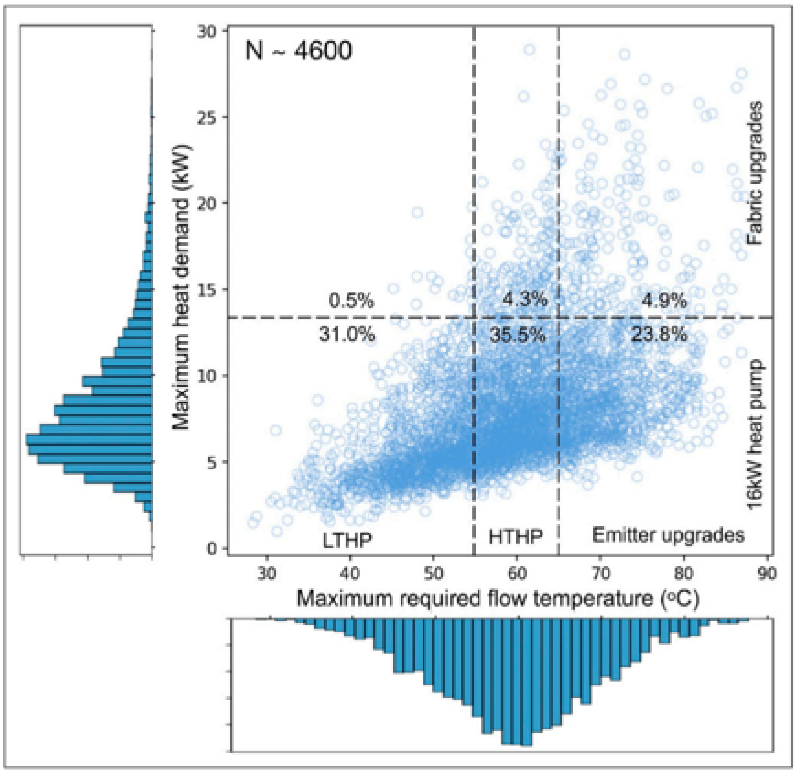
Why radiators matter in ASHP retrofits

Air Source Heat Pumps (ASHPs) operate at lower flow temperatures (typically 35–55°C) compared to gas boilers (70–80°C). At these lower temperatures, many existing radiators may not deliver sufficient heat output, leading to widespread replacement or upsizing. Although this is a relatively low cost in comparison to the total ASHP installation, it is a very disruptive element for residents.

What difference measured data could make

Childs et al. (2025), conducted a study on 4,500 homes with combi boilers, and found that one-third of UK homes could operate with low-temperature heat pumps without radiator replacement. This result was obtained using actual performance data, and challenges assumptions of universal radiator upgrades.

The accompanying graph[1] plots the flow temperature and heat demand profiles, along with the flow temp ASHP suitability. Another large portion (35%) of homes are also suitable for high temp ASHP without upgrades, but this hasn't been considered in our calculation.



The primary results for 6-h averaging of heat demand, showing a scatter plot between maximum heat demand and maximum required flow temperature for each boiler analysed (N = 4594). Accompanying histograms of each axis are provided. The results are segmented into the six heat pump readiness categories, with proportions displayed.

1 Childs et al, Predicting the heat pump readiness of existing heating systems in the UK using diagnostic boiler data (2025)

EXPLORING A SOLUTION:
SMETERS-HTC

WHAT VALUE COULD IT BRING?

How SMETER-HTC can benefit

As SMETER-HTC can provide property-specific data, giving more confidence in heat loss predictions and costing of unnecessary radiator replacements early on in the design process. This approach could eventually support other decisions, such as heat pump sizing and mould risk analysis.

Given that current design practices almost always lead to replacement of existing radiators, our calculations assume only 10% of homes keep their existing radiators during ASHP installation.

Potential Savings of avoided radiator replacement

According to CCC's 7th Carbon Budget projections, 1.5 million heat pumps need to be installed by 2035. Installing SMETER-HTC across all properties could save £450 million on a £22 billion programme.
Using a similar methodology for the Social Housing Decarbonisation Fund (SHDF) Wave 2.1, where 881 ASHPs were installed at a cost of £12.9 million, a saving of £260,000 could have resulted from undertaking SMETER-HTC on all homes.

Implementation at scale

The benefits are clear, but the reality of measuring all homes is difficult. Combining calculated HTC with other performance is explored to unlock further efficiencies.

Important note

HTC alone does not guarantee outcomes. It should be combined with other metrics such as airtightness, heating system efficiency, and occupancy patterns for robust decision-making, and accurately identify under-sized radiators.

Key assumptions	Values
ASHP installation cost	£14,700/heat pump (incl. radiator replacement)[1]
Radiator replacement cost	£3,000 (assumed 10 radiators per home at £300 each). Only one third of homes
Calculated HTC cost	£300 per home (assumed to include equipment and installation)

Scenarios	Number of homes with ASHPs	Cost benefit of using Calculated HTC
1. SHDF Wave 2.1	881	£260,000
2. ASHP CCC 7th budget 2035 target	1,500,000	£450 million

1 Department of Energy Security and Net Zero, SHDF Wave 2.1, SHDF_Release_January_2025

ADOPTING AT SCALE:
ENABLING BETTER BASELINING

ADOPTING AT SCALE

CURRENT APPROACHES

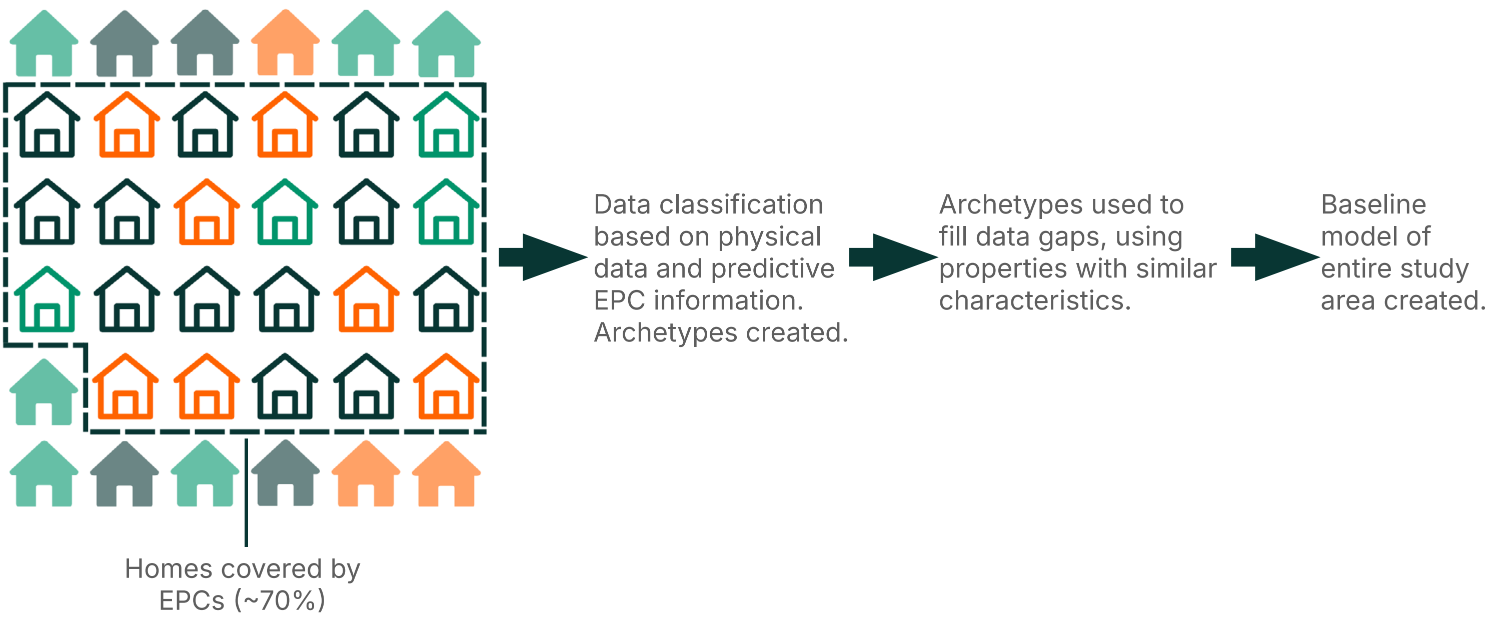
How SMETER-HTC can benefit

Measurement technologies can be deployed in programmes or pilots, but scaling up to a national or large building populations raises a key question: how do we bridge the performance measurement gap and build confidence in its use for policy decisions?

As discussed, EPCs and building characteristic databases provide extensive coverage, yet they fall short of reflecting real-world performance. Despite these limitations, they are often used to inform policy and grant schemes, as highlighted in the National Retrofit Hub's recent Measuring for Success? paper.

Implementing SMETER-HTC in every home would be a major undertaking. However, given the other types of measured data and technologies available, could we adopt a more targeted, evidence-based approach at scale?

Data Baselining via predictive data to estimate the performance across different types of homes



REINFORCING WORKFLOWS

This table explores the potential to use combined data-sets to enhance the coverage and accuracy of the overall data baseline. Links were categorised as strong when the combined datasets added something to one another, and weak when one dataset just validates another. Moderate also indicates a benefit, but there is still information missing.

If SMETER-HTC could provide a robust measure of overall heat loss, this can then be enhanced by thermographic imaging for localised defect detection and detailed surveys of accurate geometry and material data

Case Study

Cotality take an approach which integrates smart meter data, measured RdSAP inputs, and sensor data into its stock modelling platform for over 2.5 million homes. This approach replaces default assumptions with real-world measurements, including HTC, energy bills, and occupancy profiles, improving accuracy and enabling more reliable retrofit decisions from the outset.

	Information source			
	Thermographic imaging (with LiDAR)	**Smart meter**	**Detailed surveys**	**EPC** (assumed values in SAP & rdSAP)
SMETER-HTC	Strong: Imaging pinpoints localised defects while HTC quantifies overall heat loss. Together, they could validate performance and identify problem areas.	Smart meters are part of SMETER-HTC	Strong: Surveys provide geometry and material data to improve HTC accuracy.	Weak: EPC predictions can be checked against SMETER-HTC for performance gap analysis.
Thermographic imaging (with LiDAR & RGB imaging)		Moderate: Imaging shows local defects; smart meter gives consumption data anomalies, but thermal performance missing.	Moderate: Surveys give context for thermal and condition anomalies.	Weak: EPC predictions can be checked against imaging to estimate performance gap.
Smart meter			Moderate: Surveys help interpret energy trends by linking them to building characteristics.	Weak: EPC predictions can be checked against metering data to estimate performance gap.
Detailed surveys				Weak: Improves EPC input quality but does not guarantee real-world accuracy.

ADOPTING AT SCALE

PERFORMANCE BASED APPROACH

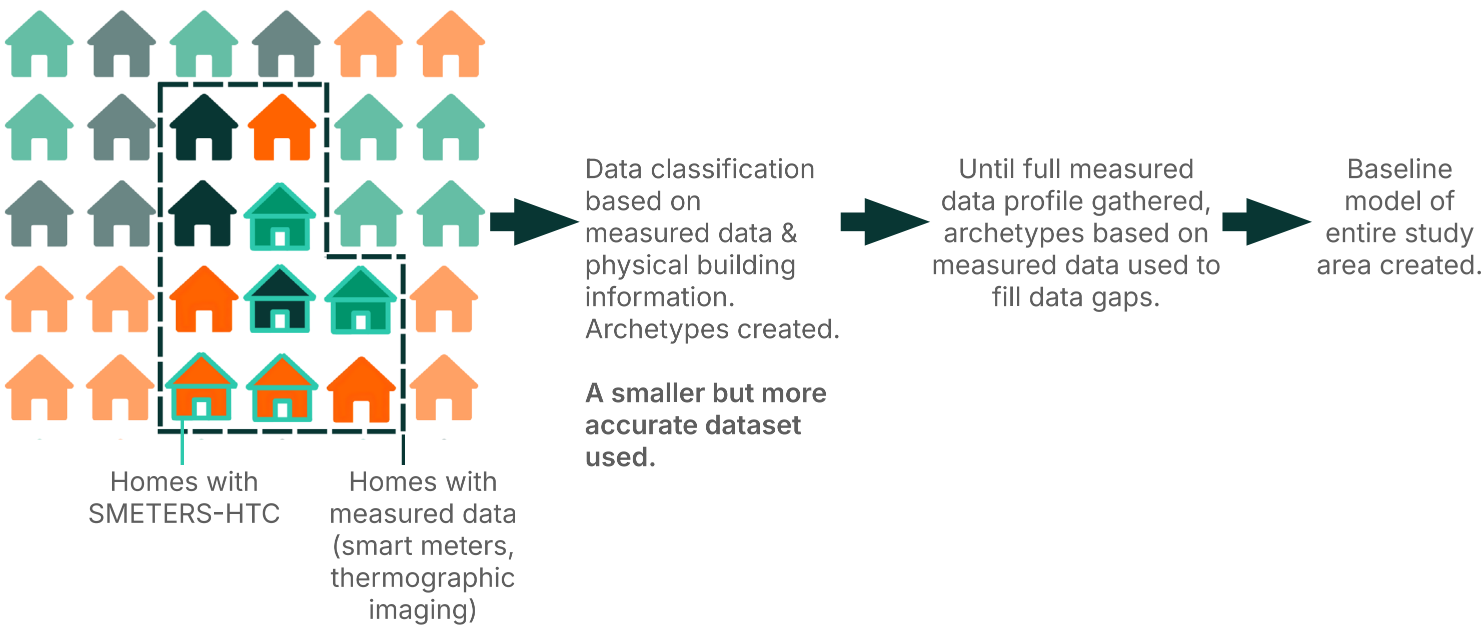
Scaling Retrofit Accuracy Through Combined Performance-Based Data

One approach to scaling baseline performance accuracy could be to start with a subset of homes that have accurate SMETER-HTC data. This dataset could be enhanced with thermographic imaging and relationships between measured datasets better understood.

By integrating and learning from these datasets, baseline models could be recalibrated to better reflect real-world conditions. This would still include a predictive element given the data-coverage gap, at least in the near term, but models are starting from a more accurate base-case.

Further research is needed to define optimal sample sizes and protocols for combining datasets at scale. Collaboration between housing providers, technology platforms, and policy teams will be critical to achieving this.

Data baselining via measured data to estimate the performance across different types of homes



NEXT STEPS

NEXT STEPS

SMETERS-HTC can only scale within the bounds of smart meters or similar embedded devices and at the consent of the occupant. However, there are emerging methods to gather measured data at scale, supported by policy updates, could help the market respond effectively.

Recommended next steps

Further validation and standardisation are required, as well as terminology harmonisation. Many methods include internal validity protocols, yet there is no common framework to evaluate or communicate their reliability.

Further guidance on the different versions of HTC measurements and technologies need to be understandable to stakeholders making decisions based on the HTC measurements. (SMETER HTC, QUB and co-heating tests).

Identify opportunities to embed performance-based approaches into funding frameworks, working collaboratively with housing providers, local authorities, and policy teams.

Develop practical guidance for landlords on how calculated HTC data might inform retrofit planning and contractor engagement.

Discuss options for validation mechanisms, so landlords and households are not solely responsible for interpreting outputs.

Continue industry dialogue on measurement standards, recognising that different tools use varying sensors and algorithms such as those led by DESNZ working groups.

USEFUL LINKS

Review of methods for assessing the measured heat transfer coefficient:
https://www.sciencedirect.com/science/article/abs/pii/S0360132325015483

DESNZ SMETERS evaluation:
https://www.gov.uk/government/publications/green-homes-grant-ghg-smeter-project-evaluation

OFGEM's Demonstration Actions:
https://www.ofgem.gov.uk/sites/default/files/2022-08/Completed%20DA%20Independent%20Report%20-%20Energiesprong%20Whole-House%20Retrofit.pdf

The QUB test accuracy:
https://doi.org/10.1016/j.enbuild.2018.06.002

Future Homes Hub BPE guide:
https://irp.cdn-website.com/bdbb2d99/files/uploaded/BPE%20Guide%20-18.10.23.pdf