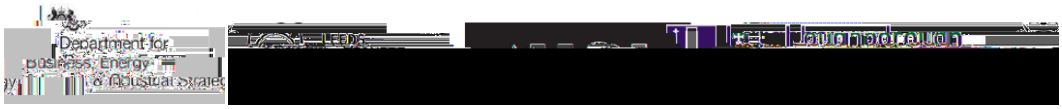


In-use thermal performance metrics workshop: 12th April 2021 Executive summary

The workshop was convened to share findings of the Technical Evaluation of SMETER Technologies (TEST) project and consider how to design and deliver an effective in use thermal performance metrics system in the UK.

The TEST project ran alongside the SMETER[1] Innovation Competition, which aimed to accelerate the delivery of SMETER products to the market and provide BEIS with confidence that these products can meet accuracy, effectiveness and acceptability user requirements. Eight products were tested in a total of 30 occupied homes; participating organisations were asked to measure the Heat Transfer coefficient (HTC) in a blind trial against HTC as measured using a gold standard physical method (co-heating test).

Results showed that three out of the eight SMETER products showed very little bias and relatively high precision (better than an RdSAP assessment carried out by an expert). A late joining SMETER method also successfully predicted the HTC of two separate homes.

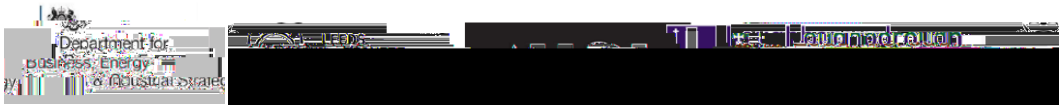
On the , participants argued that SMETER accuracy should be as good as or better than alternative methods, and accuracy requirements should be determined in relation to the application. Higher accuracy will be needed for regulatory purposes, but less precise methods would have other uses (e.g., detecting badly performing outliers in the stock, evaluating impacts of measures over multiple homes). Consistency, robustness and reliability are also important, especially for regulatory purposes, as is the ability to take account of wider developments such as heat pumps.

should be considered, in order to make full use of accurate metrics to deliver consumer benefits; by consumers, and the of devices and data sharing mean that the benefits should be clear to them.

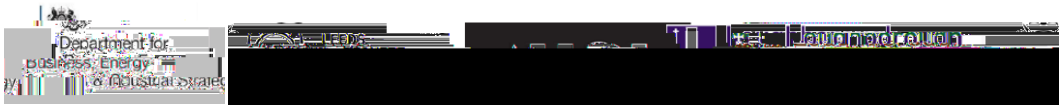
On , participants' comments suggested that (using the same communications routes for multiple data requirements to produce in use metrics) and (including "open data" principles to avoid the need to duplicate existing data streams) are desirable.

Policy levers were seen as important to market development: including to reward accurate metrics (e.g. within EPCs) and encouraging adoption through pathfinder policies, publicly funded retrofit schemes and trials; and considering mandating to support SMETERs.

Some form of was generally felt to be required, to ensure accuracy and provide confidence to consumers and other stakeholders. This might, for instance, involve establishing a



In-use thermal performance metrics workshop, summary report



An independent project evaluation based on questionnaire surveys and follow-up discussions with project participants brought forward ideas on: policy and market development; further testing; improved data access; incorporation into SAP calculations; testing new capabilities; development of QA methods; and, crucially, making the resulting metrics relevant to consumers and impactful in terms of behaviour change.

Introducing requirements for a new system of metrics

Accurate in-use thermal performance metrics would create new possibilities for supporting the delivery of Net Zero: in particular, metrics can serve a number of functions, including diagnosis, public information and "pay for performance" [see associated slide pack for further details].

Measured heat loss metrics could be incorporated into the existing models (in particular SAP and RdSAP) and metrics which underpin current policies, to provide greater accuracy and validate modelled predictions (which will still be necessary for design and other purposes) through feedback on actual outcomes, supporting existing and new functions.

The design criteria for any new system to measure in use thermal performance metrics should be steered by their purpose and functions:

most frequently mentioned consumer use/understandability as the key criterion, followed by accuracy, repeatability and consistency. Participants also identified a range of interested stakeholders, and wider developments such as heat pumps, demand management and future changes to the regulatory system, which would be relevant to any new system of in use performance metrics.

Accuracy

The introductory presentation explored the requirements of accuracy for different purposes and the dimensions of accuracy (true accuracy, precision, repeatability and reproducibility). Reasons for variation in HTC estimates were reviewed in the context of ISO 13789:2017, followed by some of the drivers of uncertainty, including confounding heat gains and losses, data-related issues and storage. Additional presentations provided information on the repeatability of HTC measurements over time, sensor accuracy and the assumed relationship between measurement duration, number of data inputs and estimation accuracy. [see slide packs for details]

Participants were asked:

The following is a summary of the key points made on this question:

- may be more important than accuracy (and need to be assessed alongside it). If used for regulatory purposes, methods would have to be robust enough to reproduce a similar HTC value under different occupancy scenarios.
- Accuracy should be , so that methods perform in accordance with their advertised capabilities.
- Accuracy may be more difficult to achieve for more efficient homes, which may need different accuracy criteria. E.g., than a percentage of the HTC measurement, for such homes.
- There is a

- [An additional, broader comment on this session] Isolating and removing the benefit of solar gains may underscore a well-designed home: this is an argument for a broader approach to in-use performance measurement, going beyond fixed fabric heat loss to include built form and the benefit of solar gain.

2)

- ; including the effect of being in direct sunlight (although it was also suggested that this could be diluted by having 4-5 sensors in different parts of the house); also: position of sensors near to the ceiling, proximity to heat emitters, or being coupled to the building structure and its thermal storage.
- The in measuring indoor temperature (a bias of 2° C will lead to a difference in HTC of around 10%).
- Links to unheated areas such as a connected garage, or where large amounts of energy is used outside of the main envelope (e.g., home offices in garden sheds, workshops, hot tubs etc.).
- Existence of unheated spaces within the main envelope, or the relation of where temperatures are recorded to where heating is used.
- Heat metering is essential for heat pumps.
- The assumptions that underpin a SMETER method are critical e.g., different assumptions about party wall heat loss and hot water use can cause a large difference in HTC estimates. Cross-validation of output calculations in a wide range of homes, with a range of occupants, levels of fabric heat saturation, leakiness, weather etc. should be built into SMETER approval
- Defining whether issues are a matter of variation in HTC or bias was not clearly aligned across the participants; however, the importance of addressing them was agreed.

- Collection of data from new boilers, heat pumps (including return water temperature) and heat meters on heat networks, integrated in the above data collection process.
- Metering local energy generation and submetering for EV's.
- Mandating systems to be open, if they don't actually run on the DCC.

- Use of IHDs to communicate with/engage occupants.
- User-centred energy and carbon savings information/analytics (e.g. projected energy costs for upcoming week).
- Targeting of the most vulnerable in society with appropriate energy measures.
- Also, assessment of mould risk, compliance with Buildings Regulations Part F and the new Part X overheating standard.

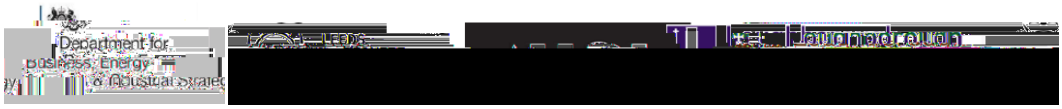
A summary of key points made by participants on the question of :

- Making it easy for third parties to connect to the HAN and use the DCC data network, e.g. via an API, with customer consent.
- Being proactive in opening up data, to avoid having to install yet more hardware to duplicate data streams that already exist.
- Ensuring households can access the data themselves.
- Making SAP-predicted HTCs available through an open access API.

- to reward accurate metrics (e.g. augment EPCs to include) and encourage their adoption through pathfinder policies, e.g. building into an ECO commitment and adopting SMETER on publicly funded retrofit schemes (which require PAS2035 compliance) and trials, as part of funding terms and conditions.
- Mandating to incorporate SMETERs.
- Generally, using regulation in order to make in use performance measurement mainstream.

- Making a for new SMETER methods, e.g., using test houses and known reference models.
- Developing a to accompany in use HTC measurements
- (otherwise measurements from add-on devices will be insufficiently accurate)

- Opportunities for energy suppliers and others to develop "guaranteed" energy performance products and retrofit installations – with the guarantee being demonstrated by savings in energy bills combined with data from SMETERs.
- Promote the use of accurate performance measurement within the property market.


Department for
Business, Energy
& Industrial Strategy

net zero carbon in mind. Whole building performance metrics and valid diagnostics for services and fabric are essential for building owners to make informed maintenance and improvement decisions. Once measurements of fabric (HTC) and services can be relied on, the ability to influence ethical and responsible changes in occupant behaviour are possible and can also be measured. Central to the above is the valid assessment of the building fabric's energy efficiency based on reliable HTC data. Studies have found erroneous data in EPCs that limit reliability. The use of a validated smart data driven system offers potential to improve on the current position; however, trust in those systems used to measure the HTC must exist.

"what requirements would a system of validation need to meet?"; "What specific approaches do you think should be included?"; "How could a validation system be delivered in practice?":

- there should be oversight and approval by an independent, non-commercial third-party body, with clear governance, and possibly a supporting expert panel. This body would enable competing methodologies to be validated, with an "open door" certification approach, with auditing regimes that report on and incentivise accuracy. This could approve applications for different purposes, depending on their accuracy. Such a body could have the right to examine the internal working of different methodologies.
- : a validation system should cover in-use measurements for all/a wide variety of housing types/ages; also, wide variation in occupancy, weather conditions, orientation and heating system types. Any exclusions should be clear (e.g. by providing a method for identifying where an algorithm is unlikely to work).
- : a number of different requirements and approaches were suggested, including:
    - A requirement to demonstrate strong external validity against physically measured HTCs (focusing testing on the relation to the true value).
    - Cross validation as well as external validation are essential to build confidence.
    - Establish diva21(t)8(e)7(r)4(na)4(l)-5( )8(v)-20(a)6(l)-5(i)-5(da)4(t)8(i)-5(on)5(a)6(r)4(e)7( )-941.8 reW