Smart Meter Energy Data: Public Interest Advisory Group

A policy dialogue and work programme
led by
Centre for Sustainable Energy & Sustainability First

PIAG Phase 2 - Workshop Report 4

Heat de-carbonisation: potential benefits of smart-meter energy-consumption data

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Status of this Report

This paper was prepared as an input to the work programme of the Public Interest Advisory Group on access to smart meter energy data.

The paper pulls together contributions made at a workshop with PIAG members held on 11 November 2020 and some follow-up bilateral conversations.

Sustainability First & CSE
PIAG
(Public Interest Advisory Group on access to smart meter data for a public-interest purpose)

Workshop 4 Report

Heat de-carbonisation: potential benefits of smart-meter energy-consumption data

PIAG Workshop – 11 November 2020

Summary

Heat de-carbonisation is one of the biggest challenges that GB needs to address if it is to meet net zero by 2050. The consensus from this fourth PIAG workshop was that there is a paucity of data around patterns of domestic heat usage that could help inform key policy decisions. Heat policy in particular has the feature of requiring far-reaching physical change in 27 million homes. Policy makers will need to understand how changes will impact on household budgets and comfort levels across the population if politicians are to have the confidence to take the decisions required. Smart meter data should be a key enabler to filling this evidence gap.

Insight into individual patterns of heat-usage have long been fundamental from an affordability and fuel-poverty standpoint. However, from a system perspective, insight into individual patterns of usage has historically been less important: the gas network is inherently flexible and (other than Economy 7) relatively little heat is currently electric. With a move to de-carbonisation of heat, a better understanding of patterns of demand across seasons and times of day by geography will be important in attempting to then anticipate how this will translate into demands on the electricity or future hydrogen system.

The discussion at the workshop was framed around a number of areas where smart meter data could provide important additional evidence. These covered:

- Understanding and improving the **energy performance of buildings**, using smart meter data to provide evidence on actual rather than modelled consumption. This is important in developing plans for energy efficiency retrofit and for testing the "performance gap" on new build properties. The BEIS SMETER programme and a similar UCL SERL project should help with this.

- Improved evidence on **user behaviours** and how patterns of heat demand vary with house type and socio-demographics, as well as personal preference. Understanding the extent to which people tend to use bursts of heat in the morning and evening or maintain a steady temperature through the day will affect the acceptability of heat pumps as main-stream heating appliances and how they are used. Actual usage data could also help scale the problem of under-heating among those in fuel poverty.

- Improved understanding of **gas usage**. While the focus of most policy thinking to date has been on gas-usage for space heating, **hot water** has been estimated to account for 22% of annual household gas demand but this will vary – potentially significantly – by household. Granular gas consumption data could shed light on the present heat / hot-water split and the potential for future net-zero hot-water alternatives (eg by comparing summer and winter usage).

- Improved understanding of **electric heating** and how heat pump electricity consumption varies in practice across the day and across seasons. This is important to the policy debate and to DNOs. More and wider evidence on heat pump performance (including running costs) could also be key to helping households have the confidence to invest in an unfamiliar technology.

- More informed **policy making and delivery** of heat programmes, linked to the previous workshop on the value of smart meter data in developing Local Area Energy Plans.

In the first phase of PIAG we had highlighted that little attention was paid to gas data and that gas networks were not collecting daily or half-hourly smart-meter data themselves which limited the options for providing wider access to aggregated or anonymised gas data. It was accepted that this was reasonable historically but that a stronger focus on gas was now required, given its role as the principal fuel for heating today and the need to phase out its use to meet the net zero target.

The UCL Smart Energy Research Laboratory (SERL) is collecting half-hourly gas smart-meter data and is a key resource that could provide additional evidence on heat. Some interesting projects are being developed utilising the smart-meter data linked to socio-demographic information, external temperature and the behavioural questionnaire completed by all participants. However, as previously, we noted that the size of the UCL SERL sample (10K homes) limits the scope for this to be used for local area planning, for example, and there may be particular housing types (apartment blocks, electrically heated homes) that are significantly under-represented as there is not a SMETS solution for them yet. As recommended in the PIAG Phase 1 Report we would like UCL SERL to consider ways in which summary statistics and anonymised records from SERL can be made more widely available, including to other non-academic researchers.

Two basic questions about current gaps in available heat-data were raised in the workshop discussion. The first was whether internal temperature data was needed as well as smart-meter data. It was felt that this would be very valuable but that the smart meter data would still be of value without it. The second was whether the analytical focus should be on the modelled typical performance of the building itself - or, whether one needed actual usage data to understand variations in behaviour, including likely under-heating. The conclusion was that both data-items are important but that the distinction needs to be better understood.

Given the urgency of national policy-making and decisions around heat, the group were keen to find ways to capture better data in the near term, from whatever sources were available. At the same time, it was clear that it continued to be very important to explore options for obtaining wider access to aggregated or anonymised smart meter data in the longer term.

Since the workshop we have identified a number of additional near-term sources of data relevant to heat demand, including an energy usage Follow-Up survey that BEIS have carried out with English Housing Survey participants, due to be published shortly.

The paper reinforces a number of the recommendations from the first phase of the PIAG work as well as identifying other potential opportunities for improving heat analysis in both the near and medium-term.

Introduction

This fourth workshop in Phase 2 of PIAG explored the potential uses of smart meter data to help inform the policy decisions that need to be taken on heat de-carbonisation. This discussion was timely given that BEIS would be publishing an Energy White Paper shortly (now published) plus a Buildings and Heat strategy early in 2021. The Scottish Government would also be producing a Buildings and Heat strategy shortly while the CCC would cover heat to some degree as part of their 6th carbon budget in December 2020. Phase 1 of the PIAG work had highlighted the lack of focus on gas smart-meter data as an analytical resource and through this workshop we hoped to redress that balance.

This report draws on a number of conversations held with stakeholders ahead of the workshop as well as the presentations and discussions at the workshop itself, and some follow-up discussions afterwards. The slides from the workshop are available at PIAG - Workshop 4 Slides - Heat .

The de-carbonisation of heat is acknowledged to be one of the major challenges in meeting net zero by 2050 with no clear roadmap at present. Improving the thermal efficiency of buildings is accepted as being an essential no/low regrets step – but one that remains difficult to deliver. Beyond that, different pathways for heat are envisaged in terms of electrification (primarily using heat pumps), repurposing parts of the gas grid to use hydrogen and some use of district heating (with a low carbon heat source). The expectation is that the best solution may well vary by region and hence Local Area Energy Plans, developed by devolved and local government, are expected to cover heat, but set within a national framework. There is also debate around how best to encourage consumers to replace their heating systems with very different alternatives and whether heat as a service models could play a far more significant role.

As context, one of the most influential graphs in the heat decarbonisation debate, produced by Grant Wilson of Birmingham University, highlights the very strong seasonal pattern in gas demand. The frequency with which this graph is used in presentations on heat policy shows the added value of more granular data to help scope the heat de-carbonisation challenge and in particular to scale the additional electricity capacity that would be required to cope with a significantly greater winter heating peak. However, this is a national picture built up from total gas consumption by LDZ (including industry and generation). Access to aggregated smart meter data would enable the particular contribution of domestic heat demand to be separated out and geographical differences to be explored, alongside the effects of more efficient heating.

Given the scale of the heat-decarbonisation challenge, little attention is being given to the potential use of gas smart meter data to help gain considerably better insight on current heating patterns, to inform these very significant policy choices. The workshop explored a number of areas where smart meter data (in an aggregated or anonymised form) could be of value. These can be grouped under five themes, discussed further below:

- Understanding and improving the energy performance of buildings
- Understanding user behaviour
- Unpacking gas usage (space heat v hot water)
- Understanding electric heating
- Informing policy choices and delivering de-carbonised heat

The paper then sets out a number of additional potential sources of data on gas usage and finishes with some reflections and conclusions.

Understanding and improving the energy performance of buildings

Understanding the current energy performance of properties is important both for policy makers and for individuals thinking about retrofit options, with improved thermal efficiency acknowledged to be a no/low regrets option that would be needed under any future heat pathway.

The workshop discussed three broad areas in which smart meter data could play a role – in enabling smart Energy Performance Certificates which would be more reliable measures of thermal performance; in facilitating assessments of interventions through modelling based on more granular data than the current estimated annual energy usage data that is used; and in refining the domestic energy models used to assess policies.

Energy Performance Certificates

MHCLG have recently published an Action Plan on Energy Performance Certificates (EPCs) which reinforces the importance of better information in this area and references their ambition to make use of smart meter data to create smart EPCs. As well as working with assessors to improve the quality of EPCs they are also looking at attaching a UPRN (unique property reference number) to the EPC which will make it easier to link it with other data, and are working with the ONS to identify potential opportunities, taking account of data protection requirements.

On the use of smart meter data to create **smart EPCs**, BEIS has funded a number of welcome innovation projects as part of their SMETER (smart meter enabled thermal efficiency ratings) programme. The overall aim of the programme is to create new methodologies for calculating a Heat Transfer Coefficient (HTC) for a dwelling. At present, the best available method to measure an HTC is the co-heating test, but this is expensive and requires a two-week monitoring period in a vacant property.

At the workshop CSE provided an update on their project as part of the SMETER programme where they have been working with the University of Bristol to trial machine learning methods with easy-to-obtain data, i.e. half hourly gas and electricity readings, plus average internal temperature data and external temperature data. They were using *simulated* data to train their algorithms which would then be tested against smart meter data from a sample of 30 houses that had undergone a comprehensive HTC survey. The ability to use *actual* smart meter data to train the algorithms would be a clear benefit from wider access to that data.

It was acknowledged at the workshop that the UCL SERL database is particularly valuable for looking at heat issues as it links smart meter data with EPC data, external temperature, demographic data and the results of a survey (including eg heating arrangements) that participants are asked to complete. The SERL database is being used for a Smart EPC project as part of the CREDS research programme.

Aside from being easier to produce, the benefit of smart EPCs is that they allow you to look at both "as built" and "as used" energy consumption not just "as designed". There is wide interest (eg from CCC, GLA and CIBSE) in using these techniques to measure the "performance gap" on new build properties between claimed and actual building efficiency, to help inform development of future building regulations plus approaches to compliance.

Improving the accuracy of EPC ratings is also very important given they underpin a number of other policies including eligibility for funding through the RHI or Green Homes Grant plus minimum energy efficiency standards in the private rented sector (PRS MEES).

More accurate EPCs should also increase trust in the assigned EPC ratings and hence increase the extent to which they influence property purchase / rental decisions. They could also make it easier to identify dwellings to target for energy efficiency measures and to provide affordable warmth energy advice.

For similar reasons the CCC have recommended the use of "Green Passports" for buildings which would provide detailed guidance on the actions required – and already undertaken – to improve a building's energy efficiency and comfort, based on building fabric and operational data. They could include a digital EPC and in future could provide more information including linking to smart meter data with the customer's consent.

In summary, wider access to aggregated / anonymised smart meter data would be of value both in developing methodologies for generating reliable smart EPCs and then rolling these out.

Assessment of interventions

The second opportunity highlighted by both the CCC and UCL would be to use smart meter data to **analyse the impacts of installing energy efficiency and other measures**. At present this is typically done using BEIS NEED data (National Energy Efficiency Data). This is based on annual estimated consumption data inputted to the sub-national energy consumption statistics [1]via suppliers. As discussed at the first workshop the ability to use smart meter data to provide more accurate and more granular data inputs into NEED would represent a very significant improvement – with many wider analytical benefits - even if this was only monthly consumption and maximum demand data to start with.

UCL presented their view of how smart meter data could be used to assess the impacts of energy efficiency interventions by training models on the data - pre-intervention to take account of weather etc - and then comparing the modelled and actual consumption post-intervention. This would enable more accurate, low-cost and rapid performance evaluation of energy efficiency measures and flexibility services – looking at the energy, carbon and bill impacts. As part of the SENS (Smart Energy Savings) programme[2] BEIS have provided funding to SERL to collect energy consumption data from trial households (with customer consent) to enable the evaluation of the SENS projects, which include innovations like tailored energy efficiency advice using smart meter data and energy-aware smart thermostats.

Improved modelling

MHCLG said at the workshop in January 2020 that they were interested in using smart meter data to "**validate**" the existing Building Research Establishment **Domestic Energy Model** (BREDEM) which

[1] See Workshop Report 1 for more explanation of the annual estimated reads - Government approaches to published data and statistics for energy consumption. April 2020.
https://d37809f7-dc9f-4c4f-835a-410a5acfa633.filesusr.com/ugd/ea9deb_093531e8c1b748659aa74263da4707d1.pdf

[2] A BEIS programme to develop and trial innovative feedback, products and services that use smart-meter data to help households reduce their energy consumption
https://www.gov.uk/government/publications/smart-energy-savings-sens-competition

underpins most analysis of heat policy options. Academic research[3] looking at NEED data versus modelled consumption has shown a significant disparity. However, it was noted at that workshop that there was an important distinction between the *modelled* data which represents the level of heating needed to achieve defined acceptable temperatures and *actual* consumption. The issue is not simply about validating the model. It is also about understanding the problem of under-heating, a concern of fuel poverty groups like NEA, plus understanding behavioural differences as discussed below.

That said there would be clear value in using smart meter data to help with better modelling of energy performance. This is key to both policy development and also, as discussed at workshop 3, to Local Area Energy Planning.

Understanding household behaviours around heat

The BEIS 2018 "Summary of Evidence" on heat focussed primarily on the technical characteristics of different options with the demand side picture drawing purely on national energy use statistics with no evidence on how individual customer usage patterns might vary. Some work has been done subsequently looking, for example, at "hard to decarbonise" properties[4] – including smaller homes where heat pumps are not an option – but this is based on modelled energy consumption not real data.

Different forms of heat have different features (steady heat v quick response). Understanding how different households use heating at present could provide insights into their expectations of alternative heat solutions in the future and how they might tend to use the replacement technology which in turn has implications for grid requirements and flexibility.

Smart meter data could be used to understand current heating patterns and how this varies by age and demographic (eg number of people in the household and whether people are at home all day) as well as by geography. As discussed in workshop 2, Jacopo Torriti from Reading University has been using diary data to understand time spent on different activities and how this varies by season which could have a bearing on heat requirements. Smart meter data linked to demographic information could help build this crucial broader understanding.

The ESC talked at the workshop about their Living Lab project. The Living Lab is a real-world trial facility of 100 connected homes, expanding to 200 later this year, where innovative businesses can rapidly design, market-test and launch smart energy products and services. For example, they were able to explore use of hybrid heat pumps – running initially as gas only, then hybrid and finally heat pump only – carrying out before-and-after analysis to understand the energy consumption, bill impacts and consumer feedback on comfort.

[3] A.J. Summerfield, T. Oreszczyn, J. Palmer, I.G. Hamilton, F.G.N. Li, J. Crawley, R.J. Lowe,
What do empirical findings reveal about modelled energy demand and energy ratings? Comparisons of gas consumption across the English residential sector, Energy Policy Volume 129, 2019
http://www.sciencedirect.com/science/article/pii/S0301421519301168

[4] Analysis on abating direct emissions from 'hard-to-decarbonise' homes. Element Energy & UCL for the CCC. July 2019
https://www.theccc.org.uk/publication/analysis-on-abating-direct-emissions-from-hard-to-decarbonise-homes-element-energy-ucl/

The value of the Living Lab is that it allows trials to be set up quickly and issues to be explored in depth, including looking at combinations of interventions eg heat, EV, batteries, solar. However, the sample size is small and the participants will be subject to multiple interventions. The ability to test key findings about heat behaviours with a much larger dataset would be a benefit of wider access to smart meter data.

The ESC also suggested that access to a larger dataset of this kind could be used to develop a broader set of energy usage profiles and archetypes. As discussed at workshop 3, this would be one way to deliver benefits from smart meter data in the near term without necessarily making granular smart meter data more widely available. The idea of archetypes was supported by academics at the workshop and could offer a valuable way forward provided that a diverse enough set of property types and geographies were considered alongside an improved understanding of the range of behavioural influences.

Actual energy consumption will depend on a range of contextual and cultural factors within the home, such as who controls the thermostat. It was noted that putting the same appliances into identical houses could often result in very different outcomes in terms of energy consumption. Again there are questions about whether desired comfort levels are being reached and, as noted above, internal temperature data would help in understanding that.

Unpacking gas usage for space heat v hot water

While the policy discussion is primarily couched around space heating, gas is also used for hot water (and cooking) and this balance is not well understood. Looking at patterns of gas usage across the seasons and by time of day could allow more robust assumptions to be made around the breakdown between different categories of usage – and how these vary by household.

The BEIS publication Energy Consumption in the UK[5] shows that 22% of domestic gas consumption is estimated to be for hot water (with 76% for space heating and 2% for cooking) but this is based on modelled data.

The balance between space and hot water heating can also be expected to vary significantly by household. For smaller, energy efficient properties the space heat requirement will be low and hence most of the gas demand will be for hot water. Understanding the diversity of demand, not just the average, is important for electricity distribution networks as heat is electrified.

An additional complexity is that hot water can be either stored in a hot water tank or provided instantaneously. For gas, this distinction does not matter too much as there is flexibility via line-pack in the gas network. For the future, in an electric heat world, this difference would have significant implications for the grid and the opportunities for flexibility from hot-water. Again there is potential for smart meter data to be used to understand a great deal more about how hot-water is heated today and likely future system impacts of changes to water heating.

The only actual data we could locate on domestic hot water consumption was a Defra study from 2008 based on 120 homes. This is still used by BRE for their modelling, including estimates of hot water usage in assessing heat pump efficiency where they acknowledge the potential for the usage to vary from that assumed.

[5] Taken from end use tables - https://www.gov.uk/government/statistics/energy-consumption-in-the-uk

It was confirmed at the workshop that we currently lack even a basic understanding of how hot water demand varies over the day, across the week or between seasons, or its relative materiality in the gas and electricity systems. Smart meter data could help with this.

Hot water tanks are of particular interest in the context of the electrification of heat as they are a thermal store and hence can provide essential flexibility to the system. At the workshop Ecuity presented on their pilot to use hot water tanks to provide DSR services, in particular Fast Frequency Response to National Grid ESO. They have not been able to use smart meters to effect the load control (because of technology limitations) or to audit the DSR delivered (which requires highly granular data – down to 1 second). However our assumption is that smart meter data could potentially be of value in assessing the scale of the opportunities like this.

Given the importance of thermal stores to a cost-effective transition, it is concerning that the number of hot water tanks in homes has reduced sharply over the past decade, largely due to the uptake of combi-boilers. The latest English Housing survey reports that the proportion of dwellings with central heating with a separate hot water cylinder has decreased from almost half of the stock (48%) in 2008 to just over a third (34%) in 2018. Again, better data could help in tracking this more closely and understanding the impacts of this major shift.

Understanding electric heating

In preparing for this workshop a number of stakeholders asked about the availability of robust information on the **energy performance of heat pumps** in a GB context and whether they are being used in the way they are designed / expected to be used. This is needed to understand the grid implications of increased heat pump take-up, including the level of flexibility that heat-pumps could deliver, to inform policy choices. Comparing detailed performance data from smart heat pump trials with larger data-sets of electricity smart meter data could potentially help "train" models using smart meter data and hence allow fuller evidence to be gathered relatively easily from smart meters as heat pumps are rolled out more widely.

Given the importance of flexibility in heating loads to avoid undue strain on the electricity grid, the CCC highlighted the potential value in smart meter data to build a better understanding of the potential for pre-heating homes, linked to the energy performance of homes discussed above.

Richard Carmichael of Imperial College has been looking at the potential for smart, flexible electric heating systems and acknowledged the paucity of data around gas usage to provide insights into patterns of usage. In his latest report he had to use data from a study of 19 homes in 2006/7 to get a simple time of use profile for domestic gas consumption. He is now exploring the potential to gather energy data from new heat pump users – ideally getting BEIS to make provision of smart-meter data a condition of getting RHI funding. This would allow an assessment to be made of the real-world performance of heat pumps.

With **hybrid heat pumps** there is an additional need to understand how the gas and electricity consumption is balanced in practice and when the pump operates in different modes. Very few datasets exist that bring together gas and electricity demand data but this will become increasingly important for developing a whole-systems approach to heat.

Through the Electrification of Heat demonstration project BEIS is funding the installation of 750 heat pumps (including some hybrid heat pumps) in order to provide the evidence on the feasibility of a

large-scale rollout. As a part of this they will be collecting highly granular data on heat provision through heat meters and they expect that data to be made available, possibly later this year.

However, they have not sought to collect electricity consumption data given the additional complexities that would have entailed. This feels like a missed opportunity to get a clearer picture of both the thermal performance of the dwellings (and how that is influencing heat pump performance and consumption) and the potential grid impacts of significant levels of heat pump installations. Now that the SERL system is up and running it should be relatively easy for similar projects going forward to collect smart meter data from participating households who have smart meters.

Finally, it is worth remembering that currently ~2.2 million homes are electrically heated of which 1.4 million use electric storage heaters. Understanding of heat use in these electrically heated homes is very poor as set out in a recent Grid Edge Policy report on **smart electric storage heaters**[6] which argued there was a potential role for flexible smart storage heating in smaller, more energy efficient properties. One of the report's recommendations was that better data on household electricity usage at different times / rates would allow Ofgem to better understand the impacts of their policy decisions on this critical group of customers.

The report also noted that many new build properties are apparently being fitted with direct electric heating (as lowest up-front cost for the developer) and instantaneous electric showers rather than hot water tanks (to save space). Using smart meter data to monitor electricity consumption in these new build properties could help inform thinking around future building standards and compliance with current standards.

Informing policy choices and delivering heat-decarbonisation

Having an improved understanding of current heat usage and behaviours as set out above would help inform the policy choices around future heat sources and support evaluation as solutions are rolled out. Given the variety of property types, lifestyles and household preferences there has to be an element of "**horses for courses**" and understanding the range of impacts across different demographics and heat behaviours is important in setting policy and **ensuring proposals are "fair".**

Recognising the importance of local geography in future decisions on heat, and the varying climate ambitions of local authorities, there is a growing emphasis on the development of Local Area Energy Plans. As discussed in workshop 3, the development of **Local Area Energy Plans** requires a view of the heat load by geography (alongside EPC and other data) to inform consideration of the different options that exist for heat in an area, as part of a whole systems view.

Having a better understanding of current heat usage could also help inform policy decisions around changes needed to **facilitate new business models** such as **heat as a service** and also to assess the case for funding support to be provided for new variants of heat pump and other potential solutions.

At the workshop Delta-EE drew on their work in the UK and Europe to reflect on how smart meter data could help shape the market for heat. In line with the structure of this paper they started with understanding the base case: how and when do people use heat and hot water and how do heating

[6] 'An Electric Heat Pathway: Looking Beyond Heatpumps'. Maxine Frerk. Grid Edge Policy - available here

systems perform? They then talked about how to enable markets that support de-carbonisation: how could timing of heat use be influenced and how could data be used to enable new services? The focus on timing is important given that the value – and current carbon footprint - of energy is increasingly defined by the *timing* of demand, not just the volume of demand. Smart meter data is critical to **enabling this flexibility market**. Equally, Heat as a Service is projected to grow significantly this decade (upto perhaps 10% of the market by 2030 compared to 1% today), and could play a key role in enabling decarbonisation of heat. Smart meter data is a core enabler of this heat services market as potential providers look to develop their offerings.

Turning to delivery, widespread electrification of heat will create **challenges for distribution networks**. As highlighted in workshop 2, spatial variations in where heat pumps are installed (scattered or clustered) can have a big impact on the level of network investment required. While in theory DNOs should be notified when heat pumps are installed, this only happens in around 50% of cases. UKPN suggested networks could use smart meter data (with machine learning) to help track uptake and to identify potential growth areas and pinch points. Using smart meter data in this way could help initial identification of where investment in more costly LV monitoring equipment is needed, which can then be used to assess the case for procuring flexibility / reinforcement.

Collecting evidence on the actual performance of heat pumps could also help **build trust** in what is a relatively unknown technology in the UK (so little scope for "social contagion") and where there is no scope to "try before you buy". The idea was raised of having a database of anonymised case studies (including drawing on smart meter data) which could then be made available to help in building confidence in the technology among customers and advisers.

Finally, while the **gas distribution networks** have not needed smart meter data to date because the gas network is inherently flexible, this data will become more important going forward. For the gas networks themselves, potentially needing to decommission parts of their network in the medium to longer term, having a better understanding of what is connected to them and the use being made of them would seem to be increasingly important as they plan for a very different sort of future.

Additional sources of data on gas usage

While we continue to advocate for wider access to smart meter data to help fill some of these evidence gaps, since the workshop we have sought to identify other data sources that could potentially be of value in understanding gas consumption patterns and hot water usage in the short run and which merit further exploration. These include:

BEIS Energy Follow-up to English Housing Survey: BEIS has carried out a follow-up survey with participants in the English Housing Survey who have previously been subject to a full property survey. This was last done in 2011 and that report provides useful insights on actual versus modelled energy consumption and comfort levels although it did not look at hot water. The latest BEIS survey covers nearly 3,000 households who were interviewed about their heating system, occupancy patterns and levels of comfort. They have also carried out half-hourly temperature monitoring in 5 rooms for 750 households and collected half-hourly gas consumption data from 150 households. Reports summarising the findings are due to be published shortly and they would then expect to make an anonymised dataset available through the UK Data Archive for accredited researchers to access.

Boiler manufacturers: George Bennett at UCL is using data from Bosch boilers to split out heating and hot water usage. The research, while very pertinent, is limited to one manufacturer and one energy supplier so may not be fully representative. Smart meter data could provide a route to validate this kind of analysis. There would also be value in discussions with manufacturers (through for example BEAMA or the Hot Water Association) to understand what data they might have that government could access.

Water industry: One additional source of insight we identified is an Energy Saving Trust report on water usage (At Home with Water) based on households filling in a water consumption calculator. This allows estimates to be made of hot water usage including splitting out bathroom v kitchen usage for example. Given the synergies with the drives to improve water efficiency there would be value in exploring whether there are other resources in the water sector that could help.

XOServe: As the industry settlement body, XOServe collect daily gas consumption data from a sample of households to calculate profiles that are then used within the settlement calculations[7]. More recently there has been a requirement on suppliers to provide daily data for a sample of their customers to boost this sample. Anonymised records are available to industry participants. There would be value in exploring with XOServe whether aggregated / anonymised profiles could be made public without breaching any data protection rules, in the same way Electralink and other central bodies are starting to do on the electricity side.

Gas Networks NIC projects: As a part of their Real Time Networks project SGN have installed loggers in 1200 homes and businesses to collect 6-minute gas consumption data to help them understand future demands on their network. The report that has been produced focuses on the process and uses that SGN are making of the data rather than wider insights and says the data cannot be made public because it is personal data. This contrasts with electricity NIC projects which have made anonymised data available which has been drawn on heavily by researchers as noted in earlier workshops. Other gas NIA / NIC projects that could potentially offer demand data and insights include WWU's Freedom project (hybrid heat pumps), National Grid's Clean Heat Pathway model and Cadent's HyDeploy. There would be value in a clear expectation being set by Ofgem that demand data from these projects should be made available where it can provide wider insights and opportunities, drawing on the approach taken in electricity.

Reflections

One question that was raised in the workshop was whether or how far **internal temperature data** was needed to complement smart meter data in understanding the energy performance of buildings. The conclusion was that this data would be very valuable but that it was still worth having better access to smart meter data even without it. In parallel further thought should be given as to how this data could be collected. For example, research projects linked to SERL could usefully consider deploying stand-alone remote temperature sensors which would then allow temperature data to be collected and stored alongside the smart meter data. The BEIS energy Follow-up survey will hopefully demonstrate the value of such data.

[7] Further details available from the XOServe website eg https://www.xoserve.com/services/demand-estimation/

The question was also raised as to whether, longer-term, this could become a standard part of the smart meter infrastructure. However, positioning of the sensors has a big influence on readings and this probably could not be controlled if they were part of the wider infrastructure.

Another question raised was whether the emphasis should be primarily on the performance of the property, recognising that over time there will be a number of different occupants, or whether the actual metered energy usage is what matters, taking account of the extent of variations in household behaviour. Our conclusion is that both are important but that the distinction needs to be better understood and considered and that smart meter data could make a valuable contribution to such understanding.

As proposed in workshop 3 there is value in using smart meter data to train **models** so their predictions and forecasts more accurately reflect the typical "as used" performance of buildings. These models and archetypes can then be used in long term local area planning and in developing and policing building standards, for example.

However, there is also a separate need to have access to a full smart meter dataset to understand the range of **actual usage** and how this might vary by demographic or behaviourally, for example. This is important in terms of understanding the range of bill impacts that would result from policies, for understanding the scale of under-heating and issues around fuel poverty, and to help DNOs and GDNs in understanding the diversity of future loads. It could also shed light on the extent to which controls and heating systems are actually being used as designed and hence the potential for more user-friendly controls, or clearer information, to help reduce energy consumption.

Finally, returning to a theme from PIAG phase 1 where we discussed the potential for a "**walled garden**" of smart meter data with a free-for-all of use of personal data occurring beyond the smart-meter privacy rules, it was notable that in many cases data on heat was being collected through separate channels over customer broadband linking to smart hot water tanks or boilers. This data will be commercially proprietorial and hence not generally available to feed into policy making. Access to smart meter data would provide a potentially more open and transparent source of evidence. The point was made that smart meter data can tell you what is happening - not why. However using a combination of detailed equipment-specific data from pilots together with smart meter data could provide insights and models that could then be applied more widely using smart meter data as inputs.

Conclusion

Given the scale of the challenge with heat de-carbonisation our major conclusion from Workshop 4 is that there is a real paucity of actual customer data to inform policy thinking on heat – and hence a real opportunity to make use of aggregated or anonymised smart meter data to fill these significant evidence gaps.

The SERL database, combining gas and electricity half-hourly smart meter data with EPC ratings, external temperature and responses to a questionnaire covering demographic and heating behaviour, provides a vital new resource in this space. However as discussed at previous workshops there are limitations given the SERL sample size (which even at 10,000 households is not adequate for local planning or robust regional comparison) and the fact that some property types (including eg 1.7m customers with economy 7 electric heat) are not yet covered by the smart meter rollout. Access is limited to academic researchers. UCL acknowledge these issues and set out at the

workshop how in their view wider access to smart meter data could deliver additional benefits by providing:

- More accurate, rapid, and lower-cost evaluation of impacts for policy decision-making
- Larger, more representative samples
- Greater certainty in results that are more generalisable
- Reduced participant burden and costs associated with obtaining consent.

In line with previous PIAG discussions, a number of the workshop participants confirmed that a lot could be done to improve understanding of heat with daily, or even monthly, NEED-style data. This level of data is presently seen as less sensitive from a data privacy perspective than half-hourly data.

The discussion at this workshop reinforces a number of the recommendations from Phase 1 of PIAG in particular:

- UCL and BEIS should consider how aggregated or anonymised outputs from the UCL Smart Energy Research Lab could be put to wider use outside the academic community to support public interest purposes including public policy making.
- BEIS / ONS should open a discussion with Energy-UK on behalf of retailers and with relevant central code bodies about preparatory work to allow more granular data to be collected (under existing legislative provisions[8]) as the smart meter rollout approaches completion. This would enable improvements to the subnational energy consumption statistics and inputs to the NEED Framework.
- BEIS should work with gas distribution networks, Ofgem and others to develop a clearer view of how gas smart meter data could be expected to deliver system benefits (eg supporting assessment of options for heat de-carbonisation) and the potential role in the long-run of the gas distribution networks in that.

As we come to prepare our final report for Phase 2 of PIAG we will revisit with the parties concerned the progress that has been made against these and other Phase 1 recommendations.

We have also identified other sources of data that could be explored in the interim that might help fill some of the evidence gaps around patterns of gas usage. We have also confirmed the conclusion from workshop 3 around the potential role of archetypes to help improve modelling – but have highlighted as well the need to understand the variability in usage within groups, reflecting different patterns of behaviour. Recommendations in each of these areas will be included in our final report.

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22 February 2021

[8] The Statistics of Trade Act 1947 used by BEIS to collect annual data at present