Smart Meter Energy Data:
Public Interest Advisory Group

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

PIAG Phase 2 – Workshop Report 3

The potential 'public-interest' value of access to smart-meter data for devolved governments and local authorities

Author: Simon Roberts, Centre for Sustainable Energy
with input from Maxine Frerk & Judith Ward (Sustainability First) and Dr Sarah Becker (CSE)

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 10 July 2020

The presentations mentioned in this paper are available here on the PIAG website (where all Phase 1 outputs and Phase 2 outputs to date can be found www.smartenergydatapiag.org.uk)

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Centre for Sustainable Energy (CSE) and Sustainability First

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PIAG Workshop – 10 July 2020

Introduction

One of the public interest use-cases for smart meter energy data identified in Phase 1 of PIAG was 'Local level energy system planning'. The summary description of that use case is reproduced below.[1]

Use Case: Local level energy system planning

There is a public interest in enabling local actors (such as local authorities, community interest groups etc) to establish a detailed picture of their local energy system and the fine-grain patterns of energy supply and demand within it. This will enable better infrastructure planning (for example, to install heat networks or EV charging points) and the design and targeting of more effective interventions to reduce carbon emissions, improve system efficiency and secure local economic benefit (such as balancing local electricity supply and demand more effectively, aggregating neighbourhood demand response, or monitoring the impact of local low carbon housing refurbishment initiatives).

Regional and local-level energy system planning is increasingly being recognised as vital to inform and shape key decisions in the UK energy system transition towards net zero carbon emissions, particularly in relation to the decarbonisation of heat, the planning of building retrofit programmes and new developments, and the shift to electric vehicles.

For example, Ofgem has indicated its interest in local area energy planning as a key input to future energy network planning within RIIO-2[2]. In its most recent report to Parliament, the Committee on Climate Change gives its backing to local area energy planning becoming a routine and systematic activity.[3]

Of course, the absence of smart meter energy data has not prevented local level energy system planning from being undertaken. Nor has it stopped decent local energy initiatives being designed and delivered.

Until now, local area energy plans have typically relied on models (such as the Energy Systems Catapult's EnergyPath Networks model and the Centre for Sustainable Energy's THERMOS tool) and datasets and associated tools (such as the London Heat Map). These all seek to make the best use of the data which is available.

1 For further detail on how we concluded that the use case could be fulfilled without compromising consumer privacy, see PIAG Phase 1 Stimulus Paper 5, particularly page 8. All other PIAG stimulus papers and the report of Phase 1 can be downloaded from www.smartenergydatapiag.org.uk

2 https://www.ofgem.gov.uk/system/files/docs/2020/07/ed2_ssmc_overview.pdf paras 4.46-4.47. p 36

3 https://www.theccc.org.uk/publication/reducing-uk-emissions-2020-progress-report-to-parliament/

But the models inevitably have to make assumptions or construct and use proxies to fill in the gaps in available data associated with the variables in which we are actually interested. These gaps include:

- **Energy demand (power and heat) at individual building level**. Currently energy consumption data is only publicly available for the whole country (to ONS statistical standards) at Lower Level Super Output Area (LSOA) level (typically c 500 homes) as single annual consumption values for electricity and gas for the whole area, often based on estimated reads.[4]
- **Seasonal and daily patterns of demand (including peak demands for heat and power) at individual building level**. Currently such patterns of demand are typically estimated using national standard profiles (of which there are only two for domestic electricity consumers[5] and one for gas[6]), with complex modelling alternatives currently limited in availability and validation. If these standard profiles are used in modelling, they are then applied to building-level heat or power demands which have themselves been modelled.

In the absence of the actual data, the modelling 'work-arounds' (many of which are ingenious) do limit the accuracy and therefore the value of the modelling results for any given place. In some cases, the gaps are left, for want of a suitable proxy. This limits the insights about current and future options for local energy system change which can be gained from such analysis. As it has been said; "if the actual data exists, why are we making it up for our models?"

The UCL-led SERL project is in the process of establishing a nationally representative dataset of domestic smart energy meter data, but the SERL dataset cannot address this particular regional and place-level challenge. While the SERL dataset has the potential is to create better proxies for use in local energy system modelling (by, for example, generating a more extensive set of archetypal domestic energy use profiles which include socio-demographic data), it will not be sufficiently extensive geographically to be able to provide actual local smart meter energy data which is reliably representative of local conditions.

The PIAG workshop on 10th July heard from key stakeholders and experts about their place-based energy programme ambitions (Greater London Authority and Scottish Government) and about their approaches to local area energy modelling (Energy Systems Catapult and CSE). Their contributions combined with structured responses from the Welsh Government, Greater South East Energy Hub and University of Exeter and perspectives from other PIAG members to explore three questions:

a. Which gaps in available data most frustrate efforts to build an accurate picture of the local energy system to inform planning and project design?
b. What difference could knowing individual building level energy consumption data potentially make to the accuracy of assessments of different heat decarbonisation options in a local area?
c. How would the availability of suitably anonymised spatially and temporally fine grain smart meter energy data (i) improve the quality and value of local energy system modelling and (ii) enhance local abilities to plan change in the local energy system to realise local ambitions and contribute to national objectives?

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4 For explanation on the Sub-National Energy Consumption Statistics see PIAG report. April 2020 - 'Government approaches to published data and statistics for energy consumption https://d37809f7-dc9f-4c4f-835a-410a5acfa633.filesusr.com/ugd/ea9deb_093531e8c1b748659aa74263da4707d1.pdf

5 Non-restricted Load Profile 1 (effectively peak consumption early-mid evening) or restricted Load Profile 2 (Economy 7 off-peak customers with peak consumption between 00.00h-0700h)

6 Differentiated Standard & Pre-Pay Customers

This short report captures the key points from that discussion, organised around two clear themes which emerged from the workshop around local energy planning, and draws some conclusions for PIAG to take forward. Presentations made at the workshop by the GLA, the Scottish Government, the Energy Systems Catapult and CSE can be found here. The GLA and Scottish Government presentations additionally highlighted the important role smart meter data could play for local and devolved nation government in enabling more timely and accurate monitoring of performance against climate targets and evaluation of programmes such as the effectiveness of retrofit initiatives in achieving anticipated energy efficiency gains.

Theme 1: Local energy planning is critical to the transition to net zero and needs high resolution 'accurate enough' representation of local energy use to achieve its potential

All contributors to the workshop highlighted the importance of well-informed local energy planning and decision-making to support the delivery of the technical and social changes required to make the transition to a net zero energy system and to achieve other energy-related goals such as addressing fuel poverty.

This is not instead of national action but a close partner of it – turning national policies and programmes into locally relevant initiatives and feeding better information and more grounded perspectives into those national activities.

Local planning and decision-making are particularly important to those aspects of the transition that have a strong place-based dimension in terms of: (a) how local conditions impact the validity of different approaches to achieving net zero outcomes and/or; (b) what needs to be known about people and their location to underpin effective action planning, solution design, targeting and engagement. At the local level, these include:

- decarbonising heat (including assessing the relative merits of different approaches such as heat networks vs individual building solutions);
- building retrofit (including smart solutions and assessing the impact of improvements made);
- new developments (including monitoring their actual performance against plans);
- uptake of EVs and growth of associated charging point infrastructure (including potential impact on local distribution networks and opportunities for demand side response);
- locating and understanding potential locational value of distributed generation and storage;
- engaging consumers and the public in collective solutions (such as demand side response and local energy trading);
- improving consumer engagement and protection around specific system changes.

To engage meaningfully with each of these seven aspects listed above requires a relatively accurate and high resolution picture of:

i. Where energy use happens at building-level, or at the very least electricity network feeder- level (though the latter is less useful for heat demand data which is currently principally gas)

ii. When that energy use happens in each building (particularly for peak usage, but also, to understand collective peaks across an area and demand across different times of the day in different seasonal conditions[7])
iii. The energy-related physical characteristics of the buildings and the equipment in them and the socio-demographic characteristics of the occupants.

In their presentations to the workshop, the GLA and Scottish Governments, alongside other local, regional and devolved nation authorities, confirmed that they see themselves having a critical role providing 'as best they can' this picture for other stakeholders (including local authorities, existing and potential delivery partners, energy networks etc). They outlined the challenge, reinforced by other contributions at the workshop, that the accuracy and resolution of this picture is compromised by the lack of readily available high-resolution data on the realities of each of i. – iii. above. Instead, the picture relies on *estimates* for the building-by-building level picture, often derived from modelling approaches which seek, in various largely non-validated ways, to disaggregate area-based official statistics for energy consumption[8] or to adjust for known inaccuracies in building-level data (such as EPCs).

While the extent or consequence of these compromises are not known (nor can be without having the actual data), the Energy Systems Catapult and Centre for Sustainable Energy both presented their current modelling approaches to provide this picture and the 'work arounds' they use to overcome data limitations.

Both of these approaches highlight the power of establishing a detailed local picture in terms of how it can guide thinking and decision-making about the seven aspects of system change listed in the bulleted list above. They also reveal the potential improvements in accuracy and resolution available from having access to smart meter energy data (to attain better resolution on i. and ii. above) and, alongside this, improved building, equipment and socio-demographic data (to attain better resolution on iii. above). These would affect both the 'baseline' picture for an area and enable the models to produce better forecasts of patterns of energy consumption and carbon emissions in different future scenarios, depending on technology, system and behaviour changes.

These improvements would sharpen understanding of the potential costs and benefits of different local approaches to achieving net zero, particularly net zero heat, and reduce uncertainties with respect to the potential implications for energy networks, particularly the electricity networks, as

7 As discussed at the workshop, it is not enough to know the peak demand for each building to understand the peak demand for a neighbourhood because the building peaks may well happen at different times so the collective peak is the highest sum of simultaneous use across the buildings, not the sum of all peaks. Indeed, summing individual building peaks to arrive at a collective peak may well grossly exaggerate that peak. For electricity use, this 'load diversification' (that peak load for a group is less than the sum of every member's own peak because they happen at different times) has historically been acknowledged and factored into electricity network capacity planning on an approximated 'rule of thumb' basis. However future changes in technologies and consumer behaviours could well alter patterns of load diversification in different localities. Moreover, there is limited knowledge about load diversification for peak demand for gas associated with provision of heat; this will become increasingly important to understand as gas heating is displaced by electric heat pumps.

8 BEIS Sub-national Energy Consumption Statistics - https://www.gov.uk/government/publications/regional-energy-data-guidance-note and https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/853760/sub-national-electricity-and-gas-consumption-summary-report-2018.pdf

they plan network investment and operational improvements and make their business plan funding case to the energy regulator.

The value of these potential improvements was acknowledged at the workshop by GLA and Scottish Government and in the contributions from representatives of Welsh Government, Greater South East Energy Hub, University of Exeter, University of Cardiff, Northern Powergrid and National Grid ESO.

With the value of accessing fine-grain consumption data for local area energy planning clear, the question then shifts to how best to use smart meter energy data if it were available on, for example, a building-by-building historic basis (e.g. previous year) to improve this 'local picture' (as proposed in PIAG Phase 1). The workshop discussion on this question gave rise to the second theme.

Theme 2: Use the 'actual' smart meter data or make better models by training them on actual data?

The workshop contributions raised the question of how best to use any smart meter data that was to become available to improve the 'local picture'.

There was undoubtedly enthusiasm at the workshop for having access to and using 'the actual (smart meter) data' for local area energy planning in a given locality. This enthusiasm was informed by a sense of how much more information about local energy use patterns would be available if the smart meter data was available.

However, several contributors cautioned against assuming this would inevitably improve the quality of that 'local picture' (and certainly not in the near term). This is because: (a) smart meters are not yet ubiquitous so they cannot currently provide a complete dataset for anywhere; (b) there are privacy risks and access issues associated with obtaining and using the data (as explored in detail in Phase 1 of PIAG - see Phase 1 Final Report), and; (c) the challenge would remain of linking smart meter gas and electricity data with high resolution building and socio-demographic data at *building level*, given these types of high resolution data are also currently limited in their availability.

As a result, the smart meter data that currently could potentially be made available is incomplete and would thereby still be inadequate to meet the demands of local area energy planning and other local public interest purposes identified by contributors. But this gives rise to the question of whether anything can usefully be done *in the meantime* to improve such activities, given these data limitations.

In response to this question at the workshop, the ESC and CSE both independently proposed that an extensive but incomplete smart energy dataset could helpfully be used to train, test and, to some extent, validate the models being used to generate the 'local picture'. By so doing, the representations of items i. – iii. (above) generated by these models become more reliable at a building-by-building level.

Machine learning techniques could use such data to test and improve the quality of the algorithms which the models are using to generate their predictions of current energy use patterns (when they lack the actual data). The better-trained models would then also be able to produce better predictions in future – and better representations of the patterns of energy use across the local energy system – without the need to use directly what would currently be an incomplete local smart meter dataset.

Moreover, the building-by-building energy-use pattern data then used in local area energy planning would still, as now, be predictions generated by a model (albeit a model trained to be more accurate). This means that a more accurate high resolution representation of local energy demand patterns can be available, without the risk of publishing or sharing any actual smart-meter data in the presentation and dissemination of modelling results.

This 'model training' approach does still require an extensive smart meter energy dataset for both electricity and gas of sufficient size and range of buildings and users that it is reliably representative of the specific locality (or any locality if the dataset is national). At the workshop it was generally felt that the UCL SERL project's dataset would of itself not be large enough to fulfil this test (as discussed on page 3 above), though it could well still have certain value for model training.

The need to find a route to sufficient data for effective local area energy planning therefore still remains. However, the potential of its near-term use being 'behind the scenes' to train and test models rather than put to use directly should, in principle, further reduce concerns about data privacy. Such model training using the data could be done under carefully controlled conditions (such as used by the ONS for access by researchers to personal data it holds).

This said, the access challenges associated with smart meter data identified in Phase 1 of PIAG remain: there is no central database of gas and electricity smart energy data being assembled for anyone to access for use under any conditions, including government and the regulator. Unless and until an access route is identified – and for both electricity AND gas smart meter data (because the latter represents the principal source of information about levels and patterns of heat demand in buildings) – the potential of using this smart-meter data to improve local area energy planning modelling will be left unrealised. This initial step of using smart meter data to improve models would also be a practical 'demonstrator' of the wider potential public-purpose benefit that access to fine-grain smart-meter data would eventually bring.

It should be noted that this proposed model training approach is designed to address the current incompleteness of the smart meter dataset. It is unlikely to prove a long-term substitute for providing access to appropriately anonymised local smart energy data for local energy planning purposes once the installation of smart meters is near completion and achieves more-or-less full coverage of every building.[9] It is also not a substitute for making use of data from smart meters already installed to improve the quality of sub-national energy statistics in the near-term by, for example, improving their accuracy and speed of availability on gas and electricity consumption (by eliminating the use of estimated meter reads for annual consumption initially, and, for the future, enabling accurate monthly consumption data also to be collected) and providing provide granular data about the timing and size of peak gas and electricity demands.[10]

9 Note that a more complete smart meter dataset would also enable even better training of models. This is an important consideration given that the models are still necessary for producing forecasts of energy consumption patterns and carbon emissions in different future scenarios, even if actual smart meter data could ensure that the baseline starting point was accurate.

10 For more discussion of the value of these potential improvements to national and sub-national energy statistics, see report from PIAG phase 2 workshop 1 on national energy statistics

Conclusions

The workshop contributions and discussion reinforced the conclusion of Phase 1 of PIAG that there is considerable potential value in using smart meter data to sharpen understanding of energy use patterns in local energy systems and underpin local area energy planning. With no plans to provide access to this data, this potential value is at risk of not being realised.

The workshop also reiterated the importance of local area energy planning as a vital activity in achieving the transition nationally to a net zero energy system. Planning and achieving key aspects of that transition, from heat decarbonisation and building retrofit to EV charging infrastructure and the performance of new developments, are heavily dependent on local decision-making informed by accurate high resolution representations of local energy systems.

Developing a high-resolution representation of local energy-use patterns and modelling how these would change as a result of different approaches to achieving net zero is central to local area energy planning. Such representations are currently heavily compromised by the lack of available smart meter data and the important details it can provide. Some modelling approaches have found ways and proxies to fill in the gaps left by this lack of data but with considerable uncertainties as to their reliability and accuracy of some key values, particularly the nature and timing of peak demands for heat and power which are likely to prove critical in future system planning for an effective transition. Access to representative smart meter data at scale could make a considerable contribution to addressing these uncertainties at a regional / local level.

Importantly, the workshop has added to PIAG thinking by introducing the potential for a stepped approach on how to make use of smart gas and electricity meter data to improve local area energy planning in the near-term. This helps to address the concern that the current progress with the smart meter rollout means that local datasets that could be available now would in reality be too limited in coverage to realise their potential value as a direct input to local energy planning and other local uses.

Addressing this concern would involve making use of the currently incomplete fine-grain smart meter data in controlled conditions to train and thereby improve local area energy planning models. This initial step could offer a number of broad advantages by potentially helping to:

- Address the problem that that smart meters are not yet geographically ubiquitous so any dataset would be incomplete (because the model training can still make use of an incomplete dataset).
- Address concerns about data-privacy since building-specific energy use pattern values would be derived from models, not the actual data.
- Reduce the data-handling capabilities needed by local authorities or other public-interest actors with a regional focus to curate and analyse smart meter data.

This approach could however create a longer-term reliance on what could end up being a relatively small number of models which have had access to the data for model training purposes. In these circumstances, it may be appropriate for BEIS (as potential gatekeeper to the data) to allow access to the data in return for agreements with model owners as to the terms on which they are made available for use by other parties.

Improvements to models by training them on smart meter data would help immediately to provide more reliable inputs to local area energy planning. Nevertheless, in the longer term, as the smart meter roll-out is completed, the full smart meter dataset would still prove valuable as a direct input to such planning and also to help fulfil other local use cases (such as design, targeting and evaluation of building retrofit programmes).

The workshop highlighted the potential benefits which could be unlocked in the context of local area energy planning with smart meter energy data. However, whether for model training purposes in the near term or as a direct input to local energy planning in the long-term, the central challenge of accessing the smart meter energy data remains.

We will return to these issues in our final PIAG report.