CarbonCo–op

WP4 D2: Data access plan and early-stage data collection report

RetroMeter Alpha (SIF)

Date: 12 April 2024
Author: Matt Fawcett
Version: 1.2

1. Executive Summary

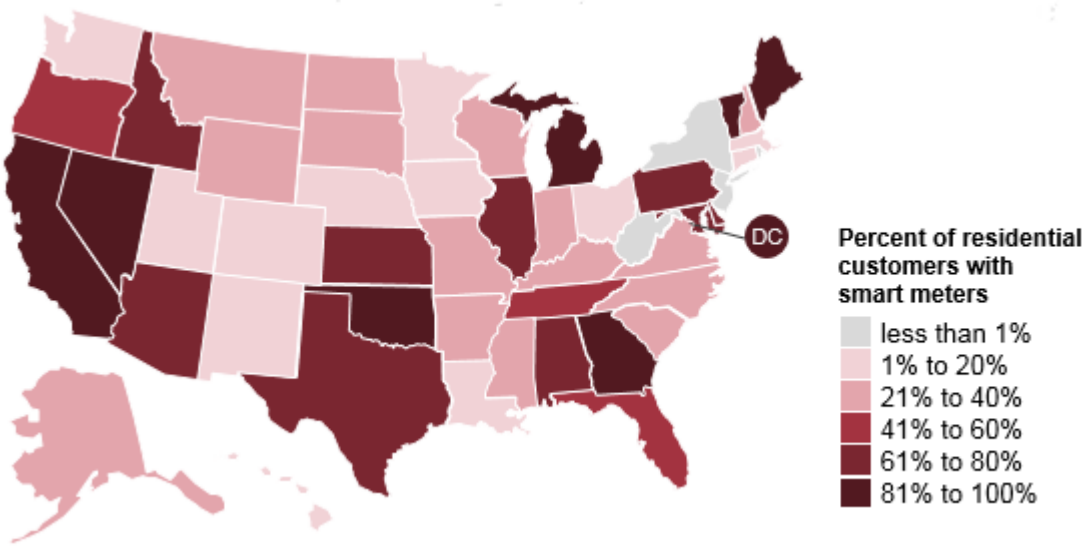
Our existing complementary ‘Engagement Summary’ and ‘Beta Phase Plan and contractor engagement’ reports lay out plans for the engagement of tenants and contractors in a future phase of RetroMeter. While these reports cover the collection of what we might regard as static data points (building size, type, location etc), this report will deal specifically with the gathering of dynamic data to support Metered Energy Savings (MES) assessments. The report will cover an overview of the options investigated, initial results and recommendations for the delivery of a future trial of RetroMeter.

2. Background and data challenges

2a The Foundations of Metered Energy Savings approaches

The availability of reliable smart meter data in certain US states was central to development of the MES methodologies from the mid-2010s onward. In particular the development of the OpenEEmeter (formally CalTRACK) methodologies grew out of specific market conditions in California and almost total coverage of residential smart meters. The Investor Owned Utilities (IOU) in California are heavily vertically integrated (providing a mixture of generation, transmission, distribution and retail services) and therefore have access to smart meter data covering extensive geographical areas, see figure 1 for the smart meter adoption rate across the US. OpenEEmeter grew out of a process involving state regulators, energy efficiency providers and IOUs, with Pacific Gas & Electric the first to pilot the methodology for a pay for performance programme in 2017.

Fig 1: US residential smart meter adoption rate by state 2016



Source: U.S. Energy Information Administration, Annual Electric Power Industry Report 2016. Map: EIA

2b. GB Data challenges - availability

This data dependency presents a number of challenges in a GB context, because of delays with smart meter rollout, current data reliability and the reliance on legacy communication technologies. Originally scheduled for completion by 2019, the latest quarterly report on the smart meter rollout gives an installation figure of 32.9 million residential smart meters (~61% of all domestic meters)[1]. However, 11.9% of these smart meters are operating in 'traditional mode' (i.e not providing data to the smart metering network), with that figure rising to over 16% in the case of gas meters specifically[2]. Further meter outages are projected with over 20% of current smart meters due to lose communications as a result of the switch off of 2G and 3G mobile communications networks, requiring the installation of new communications modules.[3]

The quarterly smart meter rollout updates do not provide an indication of the quality of available data, but significant research has been done with the Smart Energy Research Lab (SERL) dataset containing over 13,000 meter points. A comparison of valid vs missing data points found:

"In terms of individual meters, 82% of [electricity] meters have at least 90% of their half-hourly electricity active import reads flagged valid; 75% of accessible gas meters have at least 90% of their half-hourly gas reads valid. These numbers are lower for daily reads: 56% of electricity meters have at least 90% of reads valid; 71% for daily gas."[4]

[1] Smart Meter Statistics in Great Britain: Quarterly Report to end December 2023, OGL.
[2] Smart meters in Great Britain, quarterly update December 2023: statistical bulletin
[3] Update on the rollout of smart meters, Committee of Public Accounts, Oct 2023.
[4] Energies 2021, 14(21), 6934; https://doi.org/10.3390/en14216934

For this reason, SERL researchers suggest the use of summed half hourly rather than daily data and proposes a number of mechanisms for data cleansing which may be of interest to MES researchers. With MES methodologies requiring a relatively high bar for both consistency (over 90% of data points) and longevity (~2 years), acquiring suitable data is challenging, particularly in the case of gas.

2c. GB Data challenges - accessibility

In GB smart meter data is owned by the consumer and governed by the General Data Protection Regulation (GDPR) and the Smart Energy Code (SEC) as private data. However, wider accessibility of smart meter data is recognised as foundational to the delivery of a UK net-zero energy system. The very first recommendation of 2021's Energy Digitalisation Taskforce report was to simplify smart meter data access by "developing a customer consent dashboard to help consumers understand who has access to their energy data, and why – building trust and consumer protection".
We remain some way from this goal, with no common standard for how users access their data or manage consent for others to access their data. The high barriers to entry for becoming a licensed 'other user' party to the Data Community Company (DCC) system means all data providers discussed in this report access user data via a third party 'other user'. There are some potential limitations to this approach.

- The data available to DCC 'Other user's' is a limited subset of the overall data points collected, in particular there is no access to actual meter readings or billing data which would provide a useful check on reported usage. We clarified that the DCC 'other user' from whom the comparison dataset was sourced, creates daily figures from the sum of available half hourly data. Where gaps exist in half hourly data there will be a disparity between energy usage in our dataset and the energy usage recorded at the meter.
- Data intermediaries and end users are subject to the terms and conditions set by the 'Other user' with no control over how said data may be used or monetised. The appearance of hitherto unknown companies in legal agreements complicate the building of trust and may limit take up.
- Current authentication mechanisms for householders to provide consent use the MAC address of the In Home Display (IHD), in our experience IHDs are regularly missing, particularly in rented accommodation.

3. Required dynamic data collection points required to support MES assessment methodologies

During the RetroMeter Discovery phase the methodology team established the data points that would be required to support validation of the three distinct

methodologies they are testing in the Alpha phase. The table below lists each methodology in turn, with the required dynamic data points highlighted in green.

Table 1: Data required for each methodology – dynamic shown in green.

Methodology	Data/information needed for current approaches	Pre-retrofit	Post-retrofit
OpenEEMeter daily (per Retrometer use case)	**Retrofit dates** - start and end date	✔	
	Household location (derived from postcode) so we can get weather data	✔	
	External temperature at location (extracted from weather data sources using location)	✔ One year	✔ Aligned to available meter data
	Smart meter data - gas	✔ One year	✔ Winter season (minimum). Ideally one year.
	Sub-metered electric heating (e.g. heat pump) data (if household moved from gas to electric heating (e.g. heat pump) as part of retrofit)		✔ Aligned to available meter data
Comparison methodology based on archetypes *	**Category/attributes of home** - e.g. building age, size, type.	✔	
Physics based	**Internal temperature data**		✔ Aligned to available meter data.
	Smart meter data - gas	✔ One year	Winter season (minimum). Ideally one year.
	Smart meter data - electricity	✔ One year	✔ Winter season (minimum). Ideally one year.

4. Levenshulme Area Based Scheme (community intermediary model)

4a. Project history

Carbon Co-op is currently delivering an Area Based Scheme in Levenshulme in Manchester. Working to retrofit energy efficiency measures into seven households[5] across three streets in a network of terraces, this pilot project seeks to bring together innovative forms of finance, bulk procurement, contractor training, and householder and community engagement to pilot a closed-loop economic system for local domestic retrofit through a community client intermediary. The approach taken can be characterised as:

- enabling progress towards a whole house retrofit plan (and not piecemeal or single measures)
- the centreing of residents in design and delivery
- area and neighbourhood-based approaches
- bringing together innovative forms of finance
- a high degree of control around design, specification and installation
- a focus on high quality works
- high-resolution monitoring across a broad range of energy and environmental metrics.

A full range of monitoring equipment was installed in a test property during October and November 2023, this was then rolled out across a further five properties between December-February 2024. As of March 2024, one property is still pending due installation because of illness.

4b. Smart meter data source

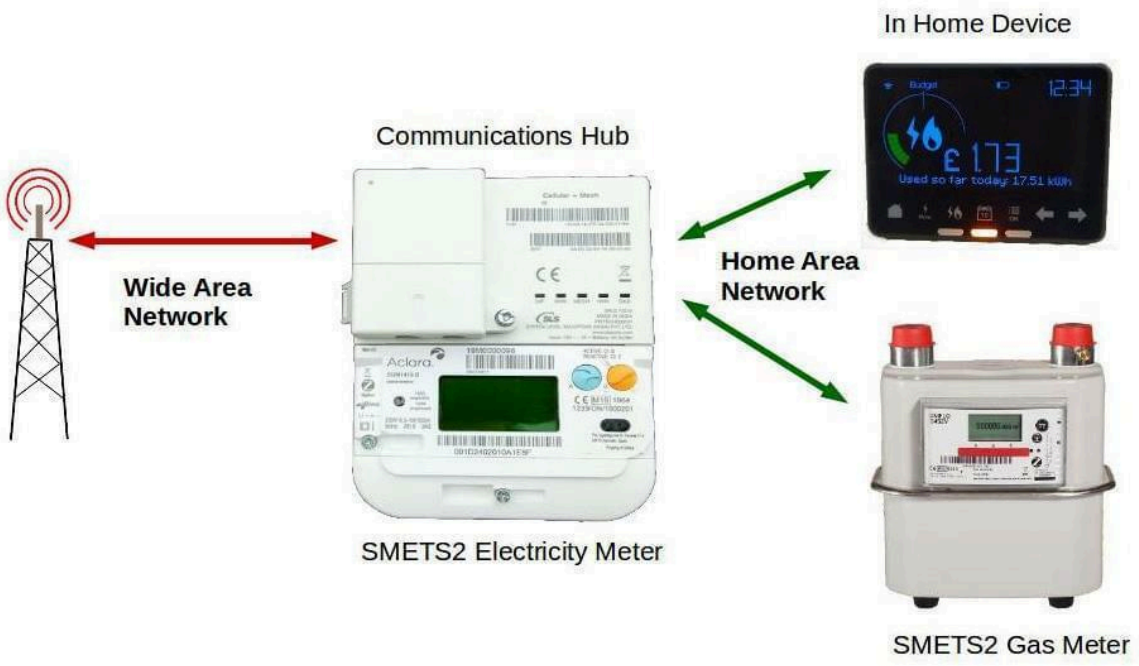
Since 2021 Carbon Co-op has been running a smart meter data service for its members and subscribers, called PowerShaper Monitor. The web application accesses data from smart meters via an SEC licenced DCC 'other user'. The advantage from the point of view of meeting MES requirements is that up to 13 months of data are stored on the meter itself, potentially providing sufficient historical data from the moment of householder consent.

During the Retrometer Alpha phase, we have tested meter connections via two DCC 'other users', N3rgy Data Limited and the Glowmarkt service from Hildebrand, with both offering similar levels of data quality overall, although we noted data gap differences in individual meters. The advantage of the Hildebrand route is the ability to easily integrate its Consumer Access Device (CAD), which enables direct

[5] As of December 2023 this was 6 due to a dropout.

access to data on the Home Area Network (HAN) to overcome connection problems on the Wide Area Network (WAN). In the case of our ABS test property, the feed to PowerShaper and the household's energy supplier ended abruptly in June 2022, but the installation of a CAD in November 2023 has restored consistent data for both gas and electricity. Unfortunately, the CAD is not able to access the historic data on the meter, meaning this household won't meet the requirements for a MES evaluation.

Fig 2: UK smart metering simplified diagram (SmartUK)



The rate that meters fail the consent process (or pass consent but provide no data) is higher than would be suggested by Ofgem's 12% figure (smart meters known to be operating in 'traditional mode'). In addition to this, well over 25% of successful connections provide electricity data only, while some will be electricity only households, installation rates for gas smart meters are lower and their failure rate is higher. In general, we have more significant data quality issues with gas data, likely as a result of the physical distance between the gas meter and the communication hub (co-located with the electricity meter).

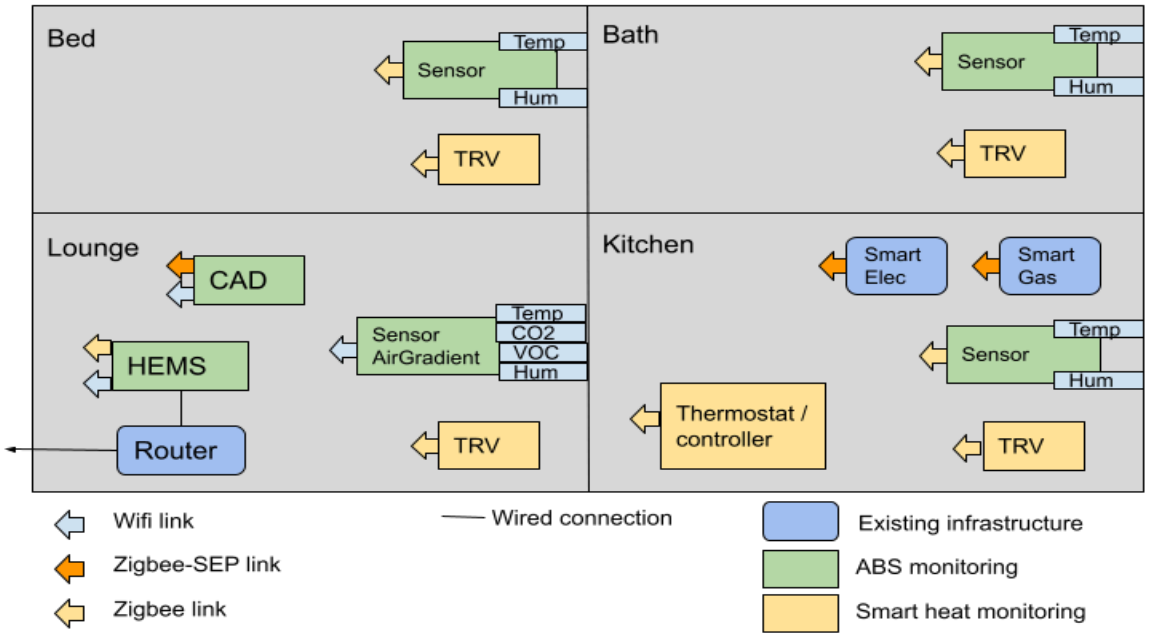
As both the proposed pilots rely on gas data for the counterfactual (gas->gas for the ABS and gas->electric for SHDF), the fact that the majority of UK gas meters do not provide data to the smart meter network is a cause for concern.

4c. Additional data points

As MES are only one of the methodologies that will be used for the evaluation of the current Area Based Scheme, the number of data points being collected is greater than that which will be required for RetroMeter. **Temperature data (alongside humidity)** is collected **room by room** (**pre** and **post works**). In the

context of a RetroMeter trial, these could be provided as a whole house average or separately for more accurate **Home Transfer Coefficient (HTC) calculations**. We are also collecting **carbon dioxide** data (as an aid to occupancy and ventilation quantification), as well as **heating system activity** (**pre** and **post works**). The smart heating system controller chosen (Schneider Electric Wiser) supports both gas and electric heating (alongside submetering), so could potentially be used in gas to electric heating pilots.

Fig 3: Diagram of sensor points, metrics and communications in ABS households



4d. In-home device for data collection (Carbon Co-op HEMS)

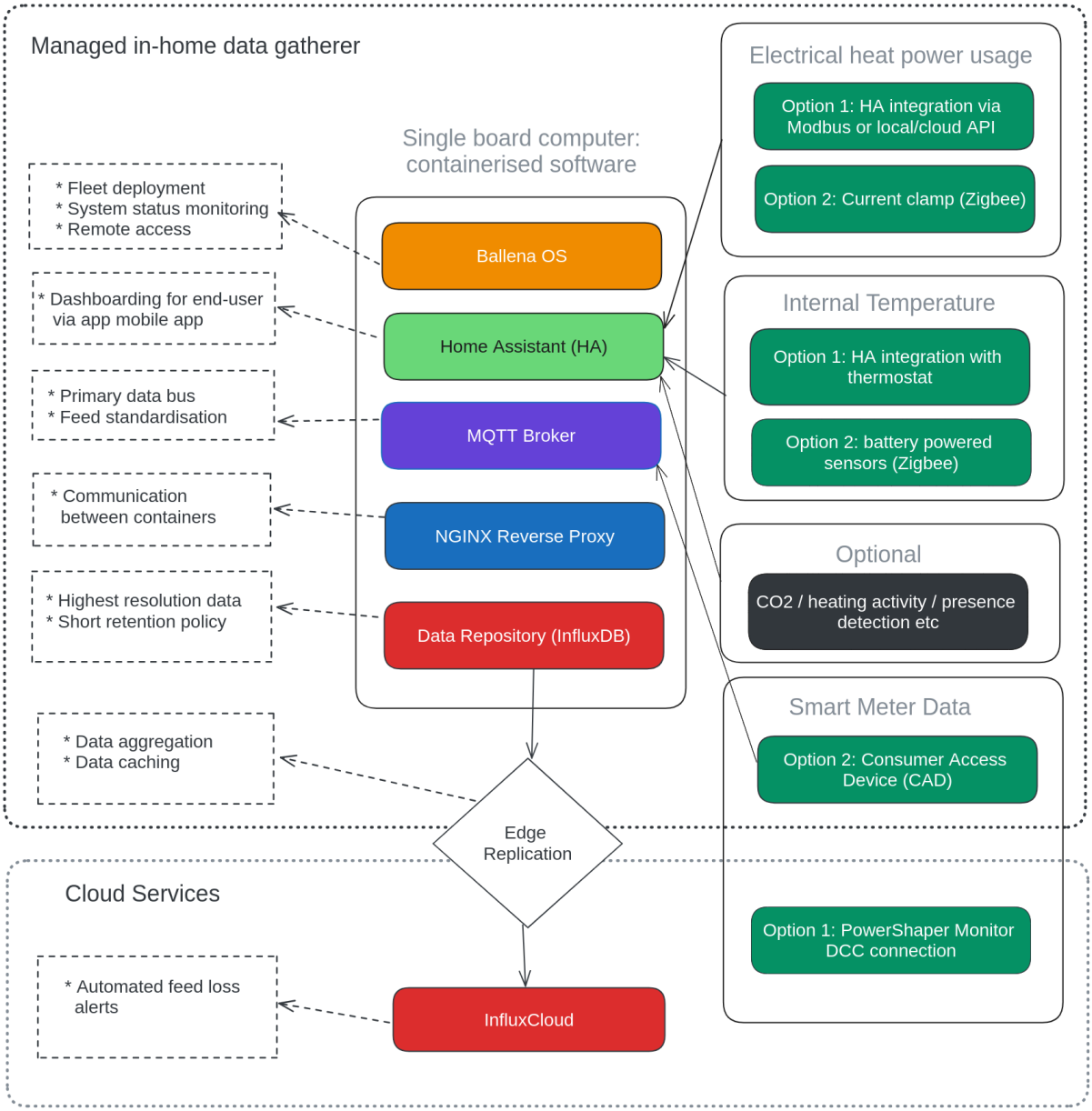
For the data collection Carbon Co-op is relying on a single-board computer running a series of containerised software packages. The software packages are deployed and updated using the Balena Cloud IoT dashboard that enables remote configuration, status monitoring and firmware updating of devices in the home. For data storage we utilise InfluxDB on the local device, syncing with a centralised InfluxCloud dashboard via edge replication. This data system has three key benefits:

1. Local data gathering is not dependent on internet provision and even in the case of complete outage for a number of days the system will continue to log data from the Zigbee network.
2. On restoration of connection, the edge replication system uses this locally cached data to fill any missing data on the central data store
3. By using a central data store we are able to monitor individual data feeds in real time. Alerts are issued when an expected data point is missing, initiating intervention to avoid any problematic data gaps.

Electrified heat power monitoring

While the current ABS pilot focuses on fabric measures, meaning the homes will have gas heating both pre and post retrofit, we also made provision for the monitoring of electrified heating systems in future phases. As the manufacturer of the heat pumps for Manchester City Council's (MCC) Social Housing Decarbonisation Fund (SHDF) scheme was not known during the first four months of the Alpha phase, we focused on exploring API connections with popular brands and were able to successfully track system power usage for Vaillant, Nibe (albeit via a subscription service) and Mitsubishi.

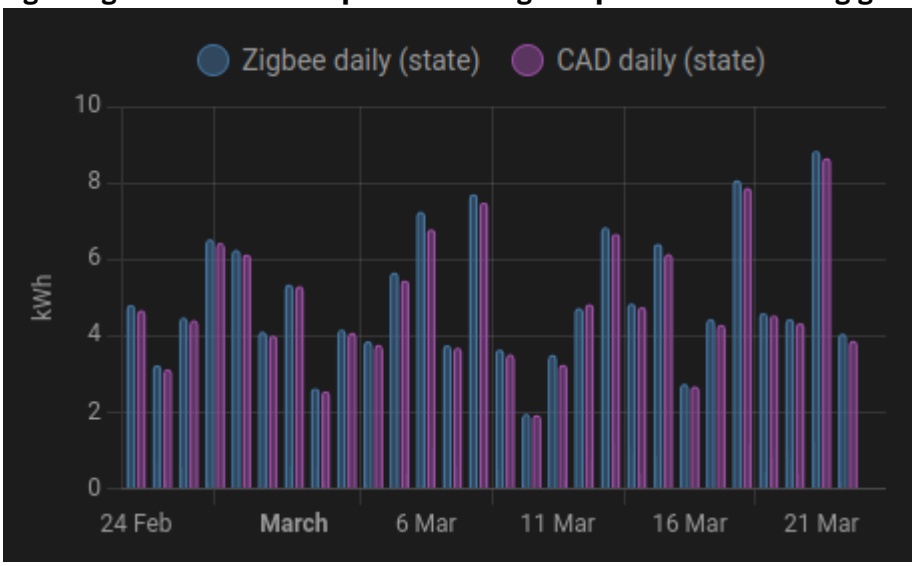
Fig 4: In home data collector against Retrometer data requirements



We also investigated a generic submetering solution that would enable us to provide the requested post-works heating load for electrified heating retrofits.

Trialling two Zigbee metering options (current clamp-based) for accuracy, based on whole house monitoring against a billing grade Consumer Access Device.
Both current clamp meters over-reported usage, though in the case of the best performing this averaged a +2.3% daily average, with a daily error range between +0.5 and +5.2% over a three-month period. We consider that this should be sufficient for comparative analysis.

Fig 5: Zigbee current clamp submetering comparison with billing grade metering



4e. Early stage data collection

Below are the results to date, showing that only two of the seven houses engaged have sufficient accessible, historical smart meter data to enable a metered energy savings calculation - given an intervention start date of April/May 2024.

Table 2: Summary of the results of early ABS data gathering (by property)

Property	Electricity meter data	Gas meter data	Internal temp
H1	*Successfully consented - **no data available** via DCC*	***No meter record***	*5/5 reporting*
H2	*First record: 09/01/2023 Quality: 99%+ (4 missing)*	*Data start: 09/01/2023 Quality: 96% (778 missing)*	*5/5 reporting*
H3	***First record: 29/01/2024*** *Quality: 98% (35 missing)*	***First record: 01/11/2023*** *Quality: 99%+ (4 missing)*	*5/5 reporting*
H4	*Non-smart meter*	*Non-smart meter*	*5/5 reporting*
H5	***Dropped out***	-	-

H6	*First record: 18/02/2023* *Quality: 99%+ (40 missing)*	*First record: 18/02/2023* *Quality: 99%+ (41 missing)*	*5/5 reporting*
H7	*Not consented*	*Not consented*	*Not installed*
Test	***No data via DCC*** *(CAD installed)* *First CAD record: 25/11/2023* *Quality: 100% (0 missing)*	*First CAD record: 25/11/2023* *Quality: 100% (0 missing)*	*5/5 reporting*

5. Social Housing Decarbonisation Funding (publicly funded retrofit)

5a. Project history

This potential MES pilot relates to social housing managed by MCC Housing Services. The council's current SHDF programme includes six projects across different parts of the local authority. During RetroMeter Alpha we focused on the potential to integrate with the boiler replacement strand, which initially targeted the switching of around 1,000 homes from gas boilers to Air Source Heat Pumps (ASHPs).

5b. Data source 1 - PowerShaper Monitor & data loggers

The initial proposal for data gathering at SHDF households agreed with MCC in October 2023 was as follows:

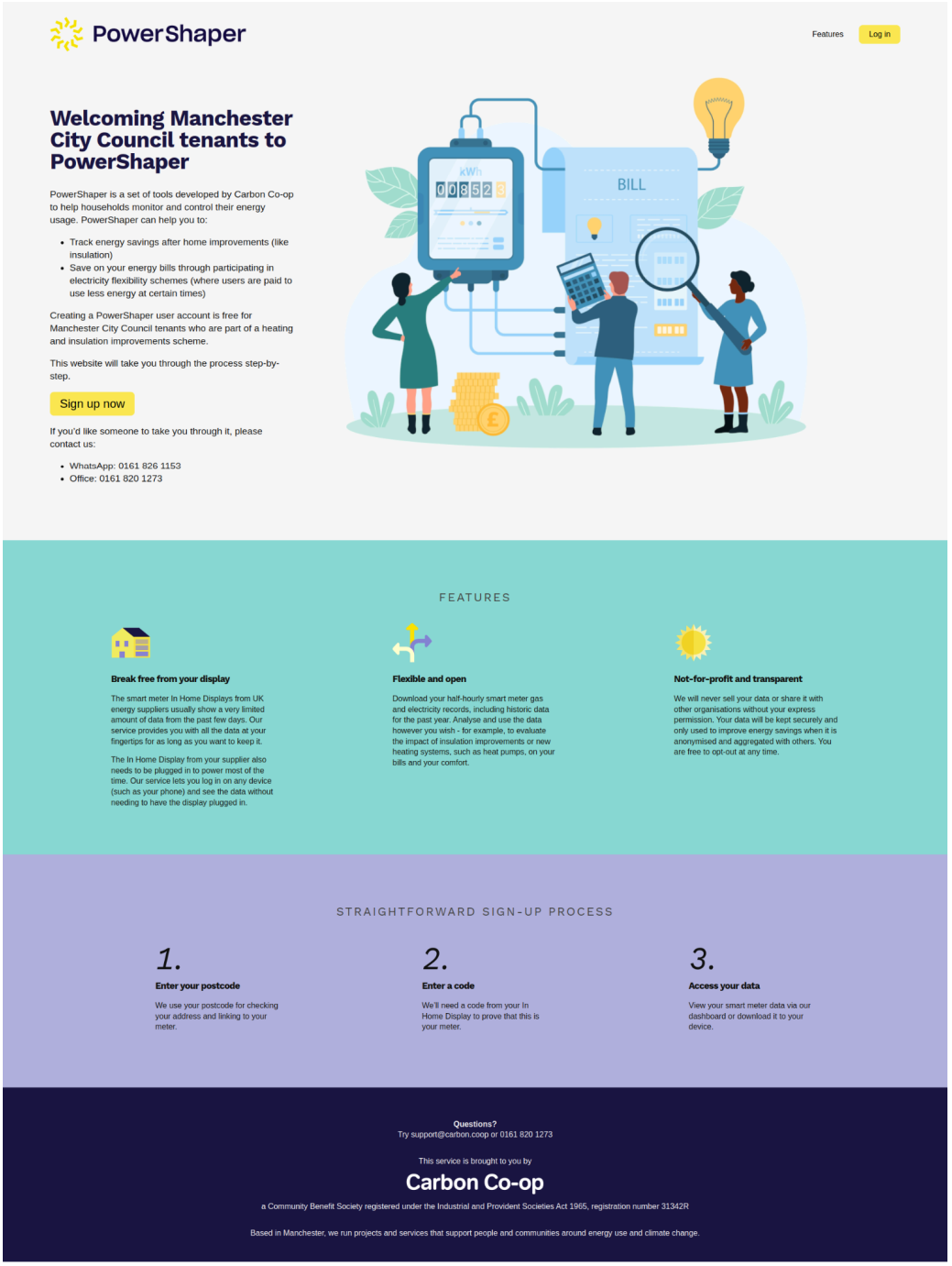
- 150 properties with smart meters, incentivised with vouchers to sign up to the PowerShaper Monitor service.
- 50 of the above properties would be incentivised to host temperature sensors.

Smart meter sign-ups

The process for sign up was as follows:

1. Initial tenant engagement via distribution of our RetroMeter booklet (see 'Engagement Summary Report' - Appendix 1)
2. User visits https://mcc.powershaper.io via QR code.
3. Step by step tailored smart meter consent process (detailed in the smart meter sign-up service process deliverable).
4. Users are taken to a dashboard to view their smart meter data.
5. Automated delivery of a voucher for participation.

Fig 6: PowerShaper portal for MCC smart meter sign up



Temperature Data Loggers

The decision was taken to adopt data loggers as opposed to internet connected sensors, because they are low-cost, easy to deploy and have lower barriers to adoption. The devices chosen were the Elitech RC-4HC, temperature and humidity sensors (as used in a SMETER project and a commercial HTC calculation service), as our staff had previous experience using them.

The devices were tested in the main living space in each of the ABS households in order to provide an early data point in advance of the full monitoring installation. Four of these have been collected to date, three of which have a complete data set, the fourth stopped collecting data two weeks after installation (despite high battery levels). It is not clear whether this was a technical fault or due to accidental user intervention. This demonstrates a significant weakness in the data logger approach vs internet connected devices, that it is impossible to remotely monitor for feed consistency. Another disadvantage is that the data is not easily available to the end user and this changes the dynamic of the relationship with the householder, making them more subject than participant. Our plan for the SHDF households had been dual installation, main living space downstairs and an upstairs bedroom in order to provide a form of backup in the case of data loss.

Due to staffing changes and SHDF programme delays (as detailed elsewhere), RetroMeter booklets have not been distributed and no smart meter sign ups or deployments of data loggers have occurred with MCC tenants. We have instead explored a number of alternative data collection options as discussed below.

5c. Data source 2 - Switchee

With support from a separate digitisation funding stream MCC hoped to gain oversight of the impact of the boiler replacement scheme by connecting a subsection of properties to a landlord data portal. MCC are already monitoring a number of properties that make up part of their estate, via the Switchee system. Switchee is a platform developed specifically for social housing providers, to allow more proactive management of property portfolios.
In terms of data gathering the system centres around an internet connected home thermostat, with a range of optional additional sensors. While primarily focused on providing insights into mould risk and the underheating of properties, Switchee have developed their own systems to report Heat Loss Rate (HLR) alongside an add-on HTC service - via a data partnership with n3rgy.
Initially the aspiration was to install up to 100 units, 15 of which would have the ‘Enhanced Monitoring Pack’ featuring submetering of the electrical heating load. We have been able to form a positive relationship with Switchee, signing a Non-Disclosure Agreement in November 2023, that paved the way for a third-party data sharing agreement between Carbon Co-op, MCC and Switchee for the periodic export of CSV files for MES analysis. It was confirmed in March 2024 that all the properties scheduled for heat pump installation would be offered a Switchee Thermostat with the HTC smart metering service. The target of installations with ‘Enhanced monitoring’ remains at 15 properties.

Advantages

- A significant advantage is the use of GSM for data communications, removing necessity for wifi access in the property (and its associated issues).

- Reduced installation cost for a Beta phase meaning installation budget could perhaps be focused on increasing the number of properties with the 'Enhanced monitoring pack'.
- Simplicity of data agreement, with a single data sharing agreement with MCC rather than with individual householders.

Potential disadvantages

- Periodic CSV download doesn't provide oversight of any data quality issues, in a way that allows intervention before it risks data suitability.
- Engagement around the smart meter consent process is key to maximising signups. Current plan is that Switchee units will be installed by the overall retrofit contractor, may risk conflating with general installation pressures or consent being deprioritised by installer. This may be mitigated by Core Task Group involvement.

Table 3: Summary of the data points available via various Switchee services

Data point	Smart meter data	Internal temp	Electric heat (kWh)	Extras
Service	HTC service (additional)	Default installation	Enhanced monitoring pack (additional)	Focus: mould risk, Fuel poverty, under-heating. Data collection: Floor area, EPC, Building type End user alerts Comms: GSM
Numbers of installation properties under SHDF	Up to 550 units* Target pool ~200	550 units	15 units (targeting those with complete smart meter datasets).	
End user agreement	Separate consent	Thermostat app sign-up	Thermostat app sign-up	
3rd party access	Single data agreement between MCC, Switchee & Carbon Co-op			
Notes	Use of n3rgy data connection	Pre & post in some cases	Only additional £200 if part of initial installation	

*subject to existence of smart gas meter, functioning data connection and data viability. National averages for gas give a suggested pool of 200 (with 100% opt-in).

5d. Data source 3 - Daikin

Daikin Europe is the heat pump manufacturer that was selected in December 2023 as the supplier of all the heat pumps for the MCC SHDF boiler replacement programme. Since this time we have held regular meetings with Daikin delivery and

engagement staff as well as the technical team to explore additional potential data delivery solutions.

The options discussed were as follows:

- **Daikin Cloud Service** - an installer/facility manager solution, to allow monitoring and troubleshooting. The solution is able to monitor temperature and, for the most recent models, power usage, but currently has no smart meter integration. The service is primarily used in a commercial context at present but there is active development of the solution to be more landlord facing. The service is based on subscription but was not taken up by MCC as part of the current installations.
- **EKRHH Home Hub** - Daikin's home energy management system, primarily targeted at improving PV self-consumption. Allows for 3rd party control for flexibility aggregators but has no current integration with GB smart meters.
- **DCOM / Modbus gateway** - separately installed hardware to provide local monitoring and control of the heat pump via a wired connection. Highest number of monitoring and control data points (including temperature and power usage). Has an RS485 interface which is common on a range of submeters but not standard for GB smart meters.
- **Daikin Developer Portal** - Daikin Europe launched their developer portal in November 2023 to standardise API access to their products. The service is still in active development but is increasingly well documented.

Essentially all the solutions discussed required additional hardware installations or service contracts with the exception of the developer portal. The units chosen for installation are all variations of the Altherma Mini R32 Monobloc which come with a WLAN connection as standard.

Access to credentials for API usage are established via sign up to Daikin's smartphone **Onecta app**. Via this interface it is possible to connect the HP unit to the local wifi network in the property and establish remote device control. The requirement for a local wifi connection and a smartphone for onboarding will likely prove a barrier in some instances.

Heating system power usage (kWh) is provided as standard for the heat pump model chosen for the MCC SHDF properties - `"sensoryData": "consumptionData"`.
This call returns 'W' and 'D' arrays. 'D' (day) 24 data points showing today and yesterday's data in 2hr blocks. Block one is yesterday 00:00 - 02:00, block 24 is today 22:00 - 00:00. 'W' (week) provides 14 blocks, showing last week (Mon-Sun) and this week (Mon-Sun).

Example data from Daikin API for daily power usage data

```
"w": [ 18, 16, 24, 32, 44, 39, 28 , 27, 31, 40, 42, 26, null, null ],
```

In the example above the first data point is Monday last week and the final is Sunday this week (which is null as it hadn't yet happened at the time of the call).

Internal temperature data is also available via the API, but is not provided by the heat pump itself, it is only available where the default Madoka thermostat is installed. As MCC has now chosen to pair each of the heat pumps with the Switchee thermostat, the Daikin API route will not be available for this measure.

The Daikin Developer Portal has limitation of 150 API calls per day, however we are able to pull up to 13 daily data for an individual device via a single call. Further testing is needed to establish what is possible within these limits via judicious planning of API calls. It should also be noted that the developer user agreement is based around testing new integrations and is subject to change at any time.

Table 4: Summary of required data points available via Daikin services

Data point	Meter data	Internal temp	Electric heat	Extras
Service		Heat pump API (if used with default Madoka thermostat)	Heat pump API (over WLAN)	Via the API additional data is available on heat pump usage, performance and error logging. The Daikin Cloud Service is new and under active development. This has not been taken up by MCC for the SHDF properties, it potentially offers a similar single data agreement, but currently lacks meter data integration.
Numbers (SHDF)		0 units (due to move to Switchee)	Up to 550 units	
User agreement		App sign-up	App sign-up	
3rd party		End user agreement (provision of API key)	End user agreement (provision of API key)	
Notes	Home Hub option allows '3rd party SG control'.	Integration to allow		

6. Data access: proposal for RetroMeter

6a Smart meter first, followed by deeper engagement and other data points

As outlined in this report there remain significant challenges in attaining adequate smart meter data. Working on national averages, less than half of all gas meters are reporting data to the DCC, of those that are, around 25% will fail to meet minimum data quality requirements. Therefore engagement and recruitment should prioritise:

1. Smart meter sign up at the earliest possible stage in order to identify suitable candidate households, before building user expectations or investing in potentially costly sensors or submetering installation.
2. Clear communication, to build trust and encourage an informed consent process for smart meter data access.
3. Ongoing engagement with householders to maintain buy-in, not only to ensure continued participation but also to provide the householder with value from the data collected.
4. A staged incentive programme to ensure that householders (particularly those in a social housing context) are rewarded for participation and the sharing of their data.

6b Multiple pilots, multiple data sources.

As has been aptly demonstrated in the 'Beta Phase Plan and contractor engagement' report, the level of complexity and propensity for delay in multi-million pound retrofit programmes, can present barriers to timely data collection. We would propose that a range of additional options are identified as part of the scoping of any future trial phase, in order to ensure minimum data requirements are met and to reduce pressure on the staff team and partners.

Area based scheme - next phase

Carbon Co-op are already exploring follow on options for further Area Based Schemes, building on the learning of the current phase. Current discussions revolve around a follow up in Levenshulme (to capitalise on previous engagement) or Oldham where the Council are interested in supporting a further pilot.

In such schemes Carbon Co-op maintains a close working relationship with the householders, as the primary engagement organisation and primary contractor. Under these conditions we would continue with our usage of an in-home data gatherer as described in this report, as it provides us with the maximum level of control and flexibility. The model is predicated on high levels of householder engagement due to the requirement to deploy equipment in the home and where possible to use the household internet connection for intermittent data transfer.

MCC SHDF – boiler replacement programme.

While the planned rollout of sensors and smart meter sign ups in Alpha phase was hampered by programme delays, close working with the MCC engagement team, and suppliers of thermostats and heat pumps has laid good foundations for any future trial phase. The scaling up of the roll out of Switchee devices to all of the homes in the scheme represents an opportunity to scale up a pilot to a significant number of homes. In terms of data collection it includes:

- **Post work internal temperature data** for all units installed (**up to 550 homes**)
- **Pre works internal temperature data** (**dependent on installation schedule**).
- **Gas consumption data** – if following national averages for installation, connectivity and data quality (**~200 potential properties, subject to use consent**). We predict fewer problems with consistency of tenure impacting data within social housing than we would with private rented due to secure tenures.
- **Electricity consumption data** – more prevalent than gas data, as more electricity smart meters are installed and generally report fewer data outages. The requirement of the physics based model for the complete set of both gas & electric data, will likely slightly reduce overall numbers.
- **Electric heating consumption data** for **15 properties**. This could be increased by focused engagement with householders that met the other data requirements, either by retrofitting 'enhanced monitoring' to existing Switchee equipment or via the Daikin API.

Glossary

Area Based Scheme (ABS): Area based retrofit involves undertaking retrofit projects in large numbers in one local area. Definitions vary, but when we talk about an ABS approach, we refer to the bringing together of innovative forms of finance, contractor training and householder and community engagement for a closed-loop economic system for local domestic retrofit. By combining different tenures in similar properties, the process is more cost-effective because bulk procurement facilitates one process for design and delivery. This creates a model for neighbourhood energy action that places householders and collective action at the centre of the process.

Consumer Access Device (CAD): A Consumer Access Device (CAD) securely accesses real-time smart meter data directly from the Home Area Network (HAN) and sends data to a cloud service or local data aggregator.

Data Communications Company (DCC): Since being awarded the Smart Meter Communication Licence in 2013, the DCC has designed, built, and now manages the telecommunications technology infrastructure that underpins the smart meter roll-out. The DCC is responsible for smart meter enrolment (not installation, which is the responsibility of energy suppliers), developing, operating and maintaining the network in line with security standards.

Heat Transfer Coefficient (HTC): The Heat Transfer Coefficient is a widely recognised metric for describing building heat loss expressed as the rate at which heat is lost per degree Celsius air temperature difference between the inside and outside of a building in units of W/K. It includes the heat loss by conduction through the fabric and by infiltration and ventilation. A lower HTC demonstrates a lower rate of heat loss and therefore better thermal performance (BEIS, 2022).

Hildebrand: a company that acts as a smart meter data provider.

Home Area Network (HAN): A Zigbee SE network within a property that allows communication between gas & electric smart meters, the 'In Home Display' and the Communications Hub.

In Home Display (IHD): An in-home display (IHD) is a small digital device with a screen that connects wirelessly to gas and electricity smart meters. Householders can use it to see how much energy they are using and how much it costs. IHDs are provided by a householder's energy supplier. The code on the IHD is one way of smart meter data providers verifying that a smart meter matches the address.

Investor Owned Utilities (IOU): a regulated energy utility in the US, typically characterised by an element of vertical integration (providing a mixture of generation, transmission, distribution and retail services in a particular geographical area).

Metered Energy Savings (MES): a mechanism to calculate efficiency savings via analysis of Smart Meter and other data sources. In other locations this is also termed 'avoided energy use' or 'Normalized Metered Energy Consumption' (NMEC).

N3rgy: a DCC registered 'Other user', that acts as a smart meter data provider.

OpenEEmeter: an open source toolkit for implementing and developing standard methods for calculating normalized metered energy consumption (NMEC) and avoided energy use. It is hosted by LF Energy.

Pay-for-performance: In a pay-for-performance scheme, the finance provided is linked to the performance outcomes of a project. In the context of Metered Energy Savings, this means that payments would be linked to the actual metered (and weather normalised) energy savings.

Smart Energy Research Lab (SERL): A collection of research data (primarily for academic and policy research) based on feeds from smart meters in over 13,000 UK homes.

Social Housing Decarbonisation Fund (SHDF): A funding programme administered by the Department for Energy Security and Net Zero (DESNZ) to improve the energy performance of social homes in England.

Wide Area Network (WAN): the means by which the DCC sends, receives and conveys communications to and from the Communications Hub within the property.

Appendix 1: End user data agreement for ABS householders.

CarbonCo–op

Data & Monitoring Agreement

For Levenshulme Area Based Scheme.

Date: 02/01/23
Version: Version 1.1

Between:
Carbon Co-op
22a Beswick St
Manchester
M4 7HR

And:
[Householder's Name]
[Address]
[City, Postal Code]

Date: [Date]

Background:

This Data Monitoring Agreement (the "Agreement") is entered into on [Date], by and between Carbon Co-op and [Householder's Name] ("Householder").

1. Purpose:

Carbon Co-op will monitor and collect data related to energy usage, heating system usage and environmental conditions at the Householder's premises (the "Property") located at the address above.
The purpose of the data gathering is the evaluation of the impact of energy efficiency improvement works (the "Improvement Works"), carried out at the Property as part of the Levenshulme Area Based Scheme.

Specifically the data collection will provide:

- The Householder with a user dashboard showing current and historic data gathered about their property, contextualised to average usage and health recommendations.
- Data for the performance evaluation assessment of the Property.
- Evidence of the effectiveness of an area based / whole house approach, alongside learnings to benefit similar schemes in other communities.

2. Duration:

This Agreement shall commence on the effective date mentioned above and will continue until the completion of data gathering (the "Monitoring Period") for the performance evaluation of the Improvement Works. The Monitoring Period ends one calendar year after completion of the Improvement Works.

3. Data Collection:

Carbon Co-op will collect data from sensors in the Property which may include:

- Temperature and humidity at various locations in the Property
- Air quality in the main living space via an 'AirGradient Pro' sensor (https://www.airgradient.com).
- Heating system activity via a 'Drayton Wiser' smart thermostat (https://wiser.draytoncontrols.co.uk/how-it-works)
- Electricity and gas usage from your smart meter via a 'Glow CAD/Display'. Access to smart meter data is tightly regulated by the Smart Energy Code (SEC) and access can only be granted via an Ofgem regulated data provider. Carbon Co-op's chosen provider is Hildebrand Technology Ltd ("Hildebrand"), who require specific consent from the Householder and agreement with Hildebrand's Terms & Conditions.

4. Data Use:

The collected data will be used for the following specific purposes:

- Early identification of any under-performance by; or unintended consequences of, the Improvement Works for the benefit of both Parties.
- Testing and refining methodologies and services for metered energy savings, retrofit design and/or retrofit performance evaluation by Carbon Co-op.
- The delivery of retrofit performance evaluation services to the Householder.

Carbon Co-op may share anonymised or aggregated data with partner organisations or third-party researchers, in order to advance the specific purposes laid out above. Carbon Co-op will not share any personal data relating to the Householder for any other purpose without requesting specific prior permission.

5. Data Security:

Carbon Co-op will take reasonable measures to ensure the security and confidentiality of the collected data. Access to the data will be restricted to authorised Carbon Co-op employees and safeguards will be implemented to prevent unauthorised access, disclosure, alteration, or destruction of the data.

6. Ownership of Data:

The Householder retains ownership rights to the data collected at their premises. Carbon Co-op shall not claim ownership rights to the data and will not use the data for any purpose other than that outlined in this Agreement without the specific agreement of the Householder.

7. Ownership of monitoring equipment:

Carbon Co-op retains ownership of the monitoring equipment for the duration of the Monitoring Period. At the end of the Monitoring Period the Householder may opt to a) keep the Monitoring Equipment at no cost to Householder or b) have the equipment removed by Carbon Co-op, again at no cost to the Householder.

8. Responsibilities of Carbon Co-op:

8.1 Ensure that all pre-agreed appointments are met and that all monitoring equipment installations comply with all relevant codes of practice, standards, guidelines and regulations applicable.
8.2 Provide timely support for any issue raised by the Householder in relation to the operation of the monitoring equipment.
8.3 Provide the Householder with a Retrofit Performance Evaluation Report, within 2 months of the end of the Monitoring Period.

9. Responsibilities of the Householder:

9.1 The Householder agrees to provide access to their Property for the installation and/or maintenance of monitoring equipment at pre-agreed and mutually convenient times.
9.2 The Householder agrees to provide power and internet connectivity to the monitoring equipment for the duration of the Monitoring Period.
9.3 The Householder agrees to promptly notify Carbon Co-op of any issues or concerns related to the monitoring equipment or data collection.

[Your Name/Your Organization's Name] [Householder's Name]
[Your Signature] [Householder's Signature]
[Date] [Date]