Project Case Study: Advanced modelling for heat as a service

Project theme: Innovative financial models for heat pump deployment

Project lead:

City Science Corporation

Partners:

N/A

Contact:

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Funding:

£492,692

What were the objectives of the project?

The project aimed to facilitate heat-as-a-service (HaaS) contracts in the social housing sector. Specifically, the project aimed to:

1. **Reduce the commercial risks of HaaS[1] contracts for social landlords** by developing a methodology to accurately predict future heat demand based on monitored data from the property, thus increasing confidence in the expected savings and costs.
2. **Help social landlords prioritise commercial opportunities for HaaS** by developing a HaaS simulation tool and an intuitive portfolio mapping platform called Cadence.

What activities were funded?:

- **Installation of in-home monitoring hardware in trial households** to collect Smart Meter Thermal Energy Rating (SMETER) data. This included the installation of temperature sensors, humidity sensors and CO2 sensors.
- **Engagement with residents to understand their attitudes towards in-home monitoring software** and positive and negative perceptions associated with their installation.

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[1] **Heat as a Service (HaaS)** is a model for providing heating solutions that focuses on delivering comfort rather than simply selling energy. Instead of paying for kilowatt-hours, consumers pay for the experience of being warm and comfortable in their homes. This approach allows service providers to tailor heating solutions to individual needs, ensuring optimal comfort and efficiency.

HaaS models are still in the early stages of development and adoption, with ongoing trials and limited implementation.

- Utilising historic SMETER data to **develop an energy model to predict future energy demand and inform HaaS cost.**

What did the project achieve?:

The project **deployed in-home monitoring hardware in trial homes;** however, a low number of trial participants limited the number of properties in the live trial. Six properties owned by Exeter City Council provided data on housing stock energy usage. Trialing the solution in 20 City Science employees' homes bolstered this dataset to make it more robust to help the development of a HaaS solution.

The project **developed a methodology for using Smart Meter Thermal Energy Rating (SMETER) data to predict future energy demand** that could be used to improve the commercial modelling of HaaS contracts. They achieved this through comparing change estimates with actual measurements, establishing the relationship between internal temperature, climate, and energy inputs.

Market research showed that, **while some residents are receptive to installing monitoring equipment, many households are reluctant,** citing concerns over inadequate anonymisation of data and the potential lack of transparency regarding what data is collected. Of the positive responses received, the most common motivators were reducing the cost of energy bills and wanting to reduce the home's carbon emissions.

The project **developed a toolkit to provide landlords with insights into their property portfolio,** consisting of two main components:

1. A visual report for the property portfolio manager. The visual report shows a representation of a landlord's building stock, with key data, including EPC rating and information on the building fabric.
2. A financial modelling package. The financial model offers building portfolio managers a view of financial data, including current, historical, and projected financial information on each property. This includes estimating ongoing costs to determine how to price HaaS contracts correctly. To determine retrofit pathways, the finance model evaluates the following sequence of steps:
    a. Define each dwelling's current state
    b. Estimate current energy consumption, carbon emissions and cost
    c. Determine fabric retrofit pathways
    d. Determine heating system recommendations
    e. Determine cost models per dwelling

These are collated to inform decision-making regarding the suitability of HaaS contracts within a property portfolio.

Project objective 1: Reduce the commercial risks of HaaS contracts for social landlords

Why is this important?:

The **commercial viability of the HaaS model relies on accurate energy demand predictions** to understand how much energy is required to deliver the temperature set point conditions. If the energy use predictions are too low, the service provider will be exposed to higher than anticipated operating costs; if they are too high, the customer proposition may be unattractive and provide poor value for money. Previous trials have identified the inability to accurately predict energy requirements as a significant barrier to the commercial success of HaaS offerings.

This project hoped to 'de-risk' HaaS-style contracts by improving the accuracy of energy usage predictions by deploying in-home monitoring hardware and advanced modelling. The intention was to develop a more accurate billing system, reducing the financial risk for both the landlord and the consumer.

What activities were funded?:

- **Engagement with social housing landlords to identify trial households.**
- **Consumer recruitment to deploy in-home monitoring equipment**, including user research to understand attitudes toward in-home monitoring equipment and help develop tailored onboarding strategies.
- **Development of energy modelling software** to predict the future energy demand of trial households.
- **Develop a software solution** (beta stage) to evaluate HaaS options for households and create a financial model for HaaS service providers.

What were the project findings and did the project achieve this objective:

Tenants were reluctant to engage in energy use monitoring

In partnership with Exeter City Council (ECC), the project aimed to deploy monitoring hardware in 50 households. However, the project encountered delays in onboarding, leading to equipment being installed in only 6.

Subsequently, research was conducted to gather information on public perceptions of smart monitoring technology and participant feedback on the hardware. There were 85 respondents to the research survey across a range of demographics and levels of technical knowledge.

City Science found that many potential customers were apprehensive about installing monitoring equipment in their homes for various reasons, including data privacy and security concerns. For example, 50% of respondents indicated concern about the inadequate anonymisation of personal data. Moreover, 55% of respondents said they were concerned about the security measures in place to protect the data collected.

The consumer research also explored motivations for potentially taking part in the project. Reducing the cost of energy bills (54% of respondents) and concern for climate change (43% of respondents) were the two biggest motivators. Onboarding strategies were developed to address the identified concerns and communicate the perceived benefits, however sign-up remained lower than anticipated.

To begin the data-gathering process with a sufficient sample size, the City Science team set up monitoring hardware in their own homes to gather initial insights. In total, monitoring equipment was set up in 20 homes.

It is important to install the right monitoring equipment to get the granularity of information required

the process ran smoothly in the trial homes, with in-home monitoring technologies being easily deployed. However, the modelling capabilities were constrained by the limited data granularity of the monitoring hardware. To overcome this issue, City Science changed supplier to obtain more granular information. For instance, using a Hildebrand Consumer Access Device (CAD), data was collected at 1-minute intervals for electricity meters and 5-minute intervals for gas meters, significantly improving the previous half-hourly readings. It is key that any in-home monitoring technology is easy to install for tenants but will also provide robust data for portfolio managers.

The collection of in-situ monitoring data was intended to inform the development of energy models. However, beta code development for the HaaS software module was delayed to allow for more data collection over the winter heating season. Findings relating to model development and the ability to accurately predict future energy demand to inform service costing are, therefore, limited.

Project objective 2: Help social landlords prioritise commercial opportunities for Heat as a Service

Why is this important?

Social housing providers often have a large portfolio of households, often with variances in specifications, including building age, insulation level and heating requirements. This variance in specification can impact the suitability of HaaS contracts on a property-by-property level. Moreover, house variance is brought about through differences in occupancy patterns and heating behaviour. The development of this toolkit was intended to provide a portfolio-level view that allows social housing providers to identify and prioritise the most suitable homes for HaaS contracts.

What activities were funded?

- **Development of a toolkit** that combined various data sets to provide portfolio managers with key insights into their portfolio, including the dwelling characteristics (including Energy Performance Certificate (EPC), fabric and heating system) and estimated heat demand.
- **Alpha code development** for a household options evaluation model to assess HaaS options for an individual household, as well as developing a financial model for a HaaS service provider.
- **Retrofit case studies** based on standard housing archetypes were conducted to show how HaaS could be used to spread the cost of retrofit.

What were the project findings and did the project achieve this objective?

City Science successfully developed a toolkit to provide landlords with insights into their property portfolios that can be of benefit when making decisions about HaaS suitability. This toolkit comprised two main components: a financial modelling package and a visual portfolio manager report. The financial model offers building portfolio managers a view of financial data, including current, historical, and projected financial information on each property. This includes estimating ongoing costs to determine how to price HaaS contracts correctly. This is done using City Science's heat demand API, which estimates the current state of dwellings by identifying the existing heating system, dwelling fabric, thermal performance and heating costs.

The visual portfolio manager's report collates and displays various data, including financial and SMETER data from trial homes, to inform decision-making. The tool, Cadence, is an existing software already used by City Science, with visualisations being developed as an add-on for this project. The report shows dwelling characteristics and identifies improvement measures to achieve future goals, for example, in meeting the social housing decarbonisation fund target of reaching an EPC C rating for all properties by 2035. This platform allows portfolio managers to overlay energy efficiency, emissions, space heating and hot water demand data to identify properties more suited to HaaS contracts (*Figure 2*). The project scope did not include testing and feedback from portfolio managers.

Figure 2: The Cadence data visualisation tool which can be used by portfolio managers to assess the energy profile of individual properties.

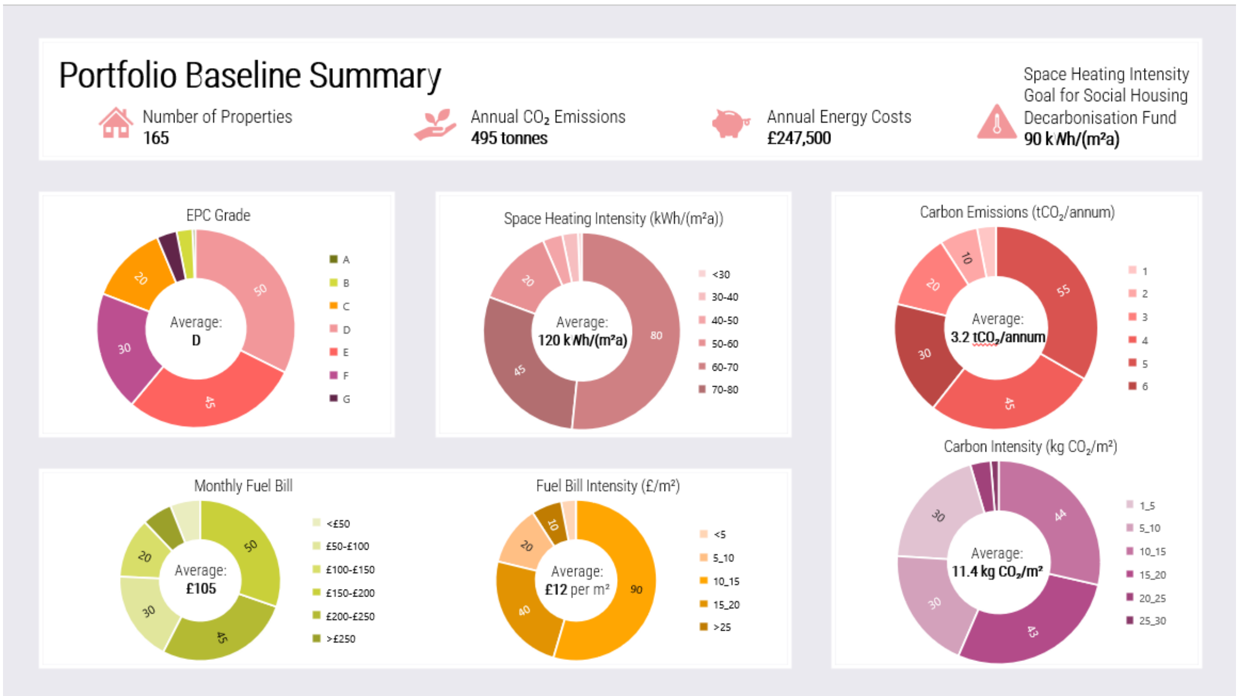

Figure 3: The portfolio baseline summary, which allows portfolio managers to assess the current state of their portfolio, helping gain insights into potential work needed to achieve future goals.

A property-specific report was developed to illustrate current dwelling characteristics and the impact of HaaS contracts across multiple retrofit scenarios. The report presents contract options for individual buildings, outlining the impact (capital cost, changes in operational costs, and carbon savings) of various retrofit interventions (Figure 4).

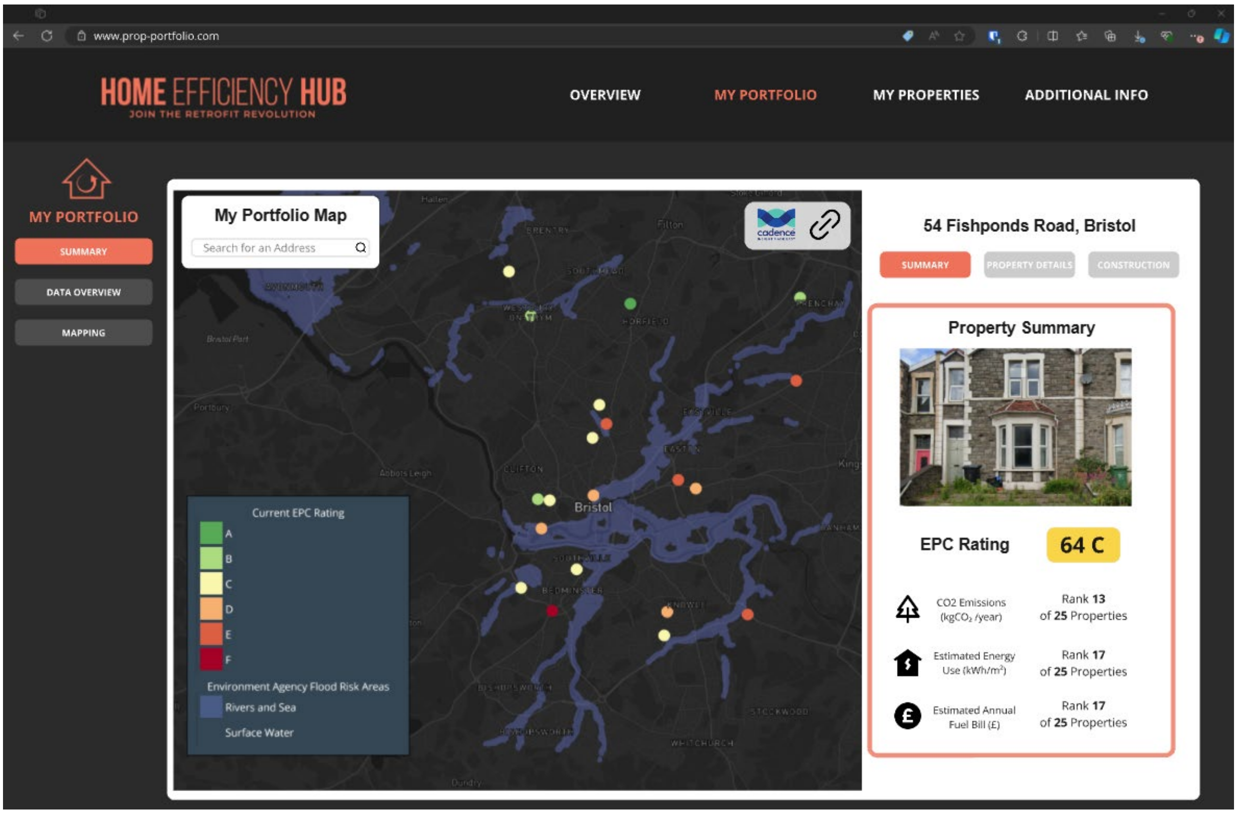

Figure 4: An example overview of the current state of the property from the Single Property Report.

Summary:

What impact could this have on accelerating the heat pump rollout?:

The project developed a platform for identifying properties suitable for HaaS-style contracts. However, by the project's conclusion, the HaaS solution was not ready for commercial rollout. City Science identified several barriers that need to be addressed for future projects aiming to successfully commercialise and scale HaaS contracts, including consumer attitudes towards adopting in-home monitoring equipment and ensuring the collection of reliable and usable data.

What's next?

City Science plans to continue supporting the adoption of HaaS contracts. Further research is required to:

- Develop and test participant onboarding strategies for in-home monitoring technology, leveraging insights on user acceptability, focusing on addressing data privacy and security concerns as key obstacles to adoption.
- Collect sufficient household monitoring data to inform the development of energy models that increase the accuracy of energy predictions and reduce the commercial risks of HaaS contracts for social landlords. These predictions should account for the impact of household characteristics and tenant behaviour.
- Additional development and testing of consumer-facing outputs is necessary to ensure their suitability and efficacy from a tenant and service provider's perspective. Outputs should allow homeowners to understand retrofit pathways, costs, grants, and environmental impacts. The service provider should understand their key financial contributions, costs, grants, and revenues, with modules for income statements, balance sheets, and cash flow models.

Where to find out more

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