Project Case Study: Performance

Project theme: Innovative finance models

The findings will be relevant to **consumers, financial institutions and landlords** interested in **affordable finance for heat pumps,** through better understanding savings once measures are introduced.

Project lead:

Parity Projects

Partners:

This project was delivered in collaboration with London South Bank University (LSBU), ICAX Ltd, RetrofitWorks and Cambridge Energy.

Contact:

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£670,708

Project duration:

2022-2025

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What were the objectives of the project?

The Parity Performance project aimed to deliver insurable **performance-backed financial guarantees**[1] for domestic energy efficiency projects (inc. heat pumps) and, in doing so, reduce the risk for lenders and the cost of borrowing for consumers. Specifically, the project aimed to:

- **Provide assurances of the cost and energy-saving implications of a planned retrofit project** by developing a software algorithm that accurately estimates household energy consumption.
- **Establish insurable, performance-backed financial guarantees** by working with financial providers to incorporate predictive energy modelling into their financial offers.

[1] The ability to accurately predict the future energy use in dwellings once energy efficiency retrofit measures and heat pumps are installed will allow customers and, crucially, financial institutions to determine the financial benefits of the measures, which can be insurable through financial institutions.

What activities were funded?

- **Installing in-home monitoring hardware to better understand home energy usage.**
- Using data from in-home monitoring technologies to **develop and refine energy prediction modelling capabilities**.
- **Developing an app** to provide information on home energy usage.
- **Stakeholder engagement** with a variety of Financial Institutions (FIs) to discuss a finance-backed guarantee.

What did the project achieve?:

1. **The project successfully developed its future energy usage modelling** by deploying in-home monitoring tools (to within 5% error).
2. It is unclear if the financial guarantee product will proceed as originally envisaged. The project is currently developing its offering to better allow banks to report their **Partnership for Carbon Accounting Financials (PCAF)** credentials.
3. This project led to the **development of two research papers** published in the CIBSE technical symposium in April 2024. Based on the published conference paper: 'A New Simplified Energy Analysis Model for Residential Heat Pump Retrofits (Day, Morris, Chaer, Gillich)', the team was invited to submit a paper to the journal Building Services Engineering Research and Technology.

Project objective 1: Provide assurances of the cost and energy-saving implications of a planned retrofit project by developing a software algorithm that accurately estimates household energy consumption.

Why is this important?:

The Performance project developed a tool that tracks heat loss in different rooms of a home, helping to accurately estimate the cost savings and carbon benefits of heat pumps and energy-efficient upgrades. By enhancing predictive modelling for future energy usage, the Performance project can more accurately predict how much energy a home will use. Using this more accurate prediction, the project hoped to enable Financial Institutions (FIs) to offer financial guarantees of savings.

More specifically, the modelling aimed to:

- Accurately predict energy consumption for a household after a heat pump has been installed.
- Optimise the size and configuration of the heat pump
    - Recommend the most cost-efficient heating pattern to satisfy household comfort requirements.

What activities were funded?:

- **Install in-home monitoring hardware to better understand home energy usage.**
- **Using data from in-home monitoring technologies –** develop and refine energy prediction modelling capabilities.
- **Develop an app** to provide information on home energy usage.

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

Parity Projects completed 16 Phase 1 monitoring hardware installations, which involved a larger sensor specification including heat meters, and 18 Phase 2 installations, where the sensor specification was reduced based on initial findings. This enabled comprehensive measurements across different heating seasons and iterative model refinement. In collaboration with Retrofit Works, **sensors were installed in various houses to measure key parameters** such as room temperatures, heat meters in heating and hot water circuits, electricity and gas meters, CO_2 levels, window and door statuses, and weather conditions. Data was collected at 15-minute intervals to analyse the building's thermal behaviour. The project focused on four main areas:

- Building thermal characterisation
- Base temperature and degree-day development[2]
- Predictive model validation
- Specifying a measurement and verification process for the heat pump's post-retrofit operation.

Installing the in-home monitoring equipment can be a challenge. Many houses can appear suitable on paper, but the nuances of the British housing stock can influence the time required and the suitability of installs. The main challenge has been around Phase 1 installs of monitoring hardware. The project requires certain in-home conditions to install the heat meters; many properties initially recruited for Phase 1 were found to be unsuitable due to nuances in the home. For example, some homes were unsuitable as there was insufficient space beneath the boiler or around the hot water cylinder to fit heat meters. Another reason was that there was no smart meter and nowhere to fit a sub-meter. To compensate for the number of homes deemed unsuitable, the project monitored more Phase 1 homes than were necessary. Eventually, the Phase 1 monitoring specification had sensors which were no longer needed as they could be replaced with data science. While the number of unsuitable homes delayed Phase 1 installs and reduced the total number of planned installs, it didn't materially impact the project.

To inform initial assumptions, the project **conducted a literature review** to identify state-of-the-art algorithms for estimating building heating parameters using data from smart energy meters, such as heat loss, thermal mass, and solar gains. **The review found no clear winning strategy** but used findings from the study to guide the project's modelling work. A few key findings which were used include:

- The heat loss coefficient (HLC) value will vary seasonally due to slowly changing ground temperatures. In homes with solid floors, this can cause variations of up to 10%.

[2] A degree day is the difference between the daily mean temperature and the base temperature, measuring how hot or cold the weather has been over a 24-hour period

- All methods assumed a constant heating efficiency, from which it was assumed that obtaining variation in efficiency with this sort of Smart Meter Enabled Thermal Efficiency Rating (SMETER[3]) monitoring was impossible.

Alongside project partner **The London Southbank University (LSBU),** the project has developed a deep understanding of the data science and physics needed to **accurately predict energy usage**. This includes incorporating SMETER data into modelling and improved accuracy based on weather compensation. The initial exploration of the SMETER datasets involved calculating the Standard Assessment Procedure (SAP) score for a sample property using the SAP 2012 method. By changing inputs like property size, boiler type, insulation, and window size, the project assessed how these **factors affect the Energy Performance Certificate (EPC) rating**. This helped determine the importance of different factors for a building's energy performance. The SMETER dataset provided additional insights, including sensor data for over 30 properties and measurements of the Heat Transfer Coefficient, which are hard to obtain in occupied homes.

The project developed an app to provide a visual display for the project's understanding of in-home current and predicted energy usage. This will enable the customer to **visualise their current and predicted usage** and see how introducing different measures will impact potential savings. Below is a mock-up of how the app's savings tab will look (**Figure 1**). These potential savings are disaggregated on

Figure 1: Mock-up of the app's savings tab. On the left is actual energy usage. On the right is the projected energy usage after introducing retrofit measures.

SMETER data refers to real-time and historical energy consumption data collected from smart meters, enabling accurate billing and energy efficiency monitoring.

a room-by-room basis throughout the home, meaning a homeowner can see the potential for savings in each room (**Figure 2**).

While predicting future fuel tariffs is challenging, the retrofit scenario aims to estimate potential savings for a typical home with standard usage patterns. The project focuses on predicting energy use by analysing the building physics of a given property. To inform these predictions, tariff forecasts from other sources can be utilised. To estimate savings, the project calculates the payback time by considering the net value of capital expenditures (CAPEX) and determining the annual savings.

Figure 2: An early mock-up of the 'My Home' page of the application, showing useful metrics for the home.

Project objective 2: Establish insurable, performance-backed financial guarantees by working with financial providers to incorporate predictive energy modelling into their financial offer

Why is this important?

The upfront costs associated with heat pump installations and energy efficiency measures within domestic homes have been identified as a key barrier to widespread adoption. By creating a highly accurate tool to identify potential savings, financial lenders can have increased confidence in the expected cost savings. This will help them mitigate risk and offer homeowners rates below the current market options. This could reduce homeowners' costs and accelerate the lending market for heat pumps and energy efficiency, supporting the UK's decarbonisation ambitions.

By achieving a very high degree of accuracy for the cost and carbon benefits, the proposed measures can be insurance-backed by a financial lender. This helps the lender manage its risk and, therefore, offer more preferable interest rates to the consumer, reducing the overall cost of the low-carbon retrofit.

What activities were funded?

- Stakeholder engagement with a variety of Financial Institutions (FIs)

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

Based on early engagement with various Financial Institutions, the **finance-backed guarantee will not go ahead as initially envisaged**. Parity interviewed several large high-street banks who found the product interesting, although not for a finance-backed guarantee. Rather, banks are increasingly interested in tools that help them report to the **Partnership for Carbon Accounting Financials (PCAF)[4].** PCAF is an international framework where organisations report on the emissions for which they are directly responsible. In the case of this project, this applies to banks' mortgage books. PCAF requires financial institutions to measure and disclose the greenhouse gas (GHG) emissions associated with their loans and investments, including mortgages. For instance, a high street bank may hold mortgages on 4 million homes, effectively owning 50% of these properties. This translates to a substantial carbon liability, making it imperative for them to have a **robust plan for reporting and reducing emissions**. PCAF mandates that banks develop such plans, which is where Parity Projects hopes to help the market. As banks require data on building-level energy consumption, Parity can provide data on building size, geographic location and building type, and energy use collected from metered data. While initial discussions have taken place, the development of this offering has been flagged as beyond the remit of what will be achieved within the Heat Pump Ready timeline. Considering this, the project found two key points:

1- There are alternative uses for the technology designed during this project.
2- There is significant appetite to use the mechanism related to the Green Deal[5], powered by the product, to use a conduit for finance.

Since the project started, Parity has been acquired by CoreLogic, a UK housing data company with strong links to banks (through mortgage surveys). CoreLogic is well placed to bring all the components

[4] Partnership for Carbon Accounting Financials (PCAF)

[5] The Green Deal is a government initiative that provides homeowners with finance to make energy efficiency improvements to their properties, with repayments tied to energy bills.

of a finance scheme together and make this second option work. The project team will develop this new development related to the Green Deal after the Heat Pump Ready programme timeline.

Summary:

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

This project has developed a deep understanding of the technical requirements needed to accurately predict energy usage in buildings. The results of this research are positive, with the project able to predict energy usage with a 5% margin of error. Moreover, the project successfully developed an app to visually display current and predicted energy usage.

The project hoped to combine these strong results with the lending power of large FIs, enabling finance-backed guarantees to unlock affordable finance for retrofit measures. Early engagement with these FIs showed that their initial interest is in **supporting their PCAF reporting processes**. PCAF reporting is an important part of enabling retrofit measures. By enabling FIs to align their lending and investment activities with the goals of the Paris Agreement, PCAF aims to drive the transition towards mass heat pump rollout.

What next?

The project has identified a number of development areas which would support the refining of the model to better predict future energy usage:

- Investigate how occupant behaviour and additional heating sources, like wood burners, affect energy usage predictions.
- Develop strategies to adjust the model for periods when the heating system is turned off or used more than expected, ensuring accurate energy use predictions.

Moreover, the project intends to continue its discussions with FIs to find an offering that would appeal to banks, whether this be PCAF reporting or the potential of a finance-backed guarantee.

Where to find out more

https://parityprojects.com/

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