Green Home Finance Accelerator Discovery Phase Evidence Report:

Integrated Solution for Residential Retrofit Financing

ELPS Energy Ltd

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Disclaimer

Executive Summary

1 Introduction, aims and objectives

The goal of our Discovery Phase project was the development of an Integrated Solution for Residential Retrofit Financing (ISRF). ISRF is a one-stop shop platform for energy efficiency works connecting vetted suppliers and consumers and providing innovative Pay-For-Performance (P4P) financing solutions. With this service, we aim to solve the biggest consumer problems related to implementing energy efficiency retrofits: big upfront investments; complicated customer journey; and lack of interest in using personal finances for energy efficiency retrofits. At the end of the Discovery Phase, we delivered the ISRF protype comprising key commercial, financial, and legal requirements and the fundamental technologies used for energy consumption/savings forecasting.

The ISRF technology building blocks comprise an online and mobile application for a customer interface and an intelligent decision-making engine. This leverages physics-based dynamic models and data-driven Artificial Intelligence (AI) models to compute energy consumption, predict retrofit energy savings and deliver a financial risk assessment with the monetisation potential of the retrofit.

Customer Journey: ISRF website collects home-related data. Customers input energy bill information and then our forecasting engine computes current energy consumption and future energy savings upon retrofit implementation. Using this data, we present a clear financing plan for the homeowner, with up to 100% of the upfront costs covered. Our network's partners install the retrofits to provide a 100% hassle free experience. ISRF automatically leverages public subsidies for the financing plan. Repayment terms are based on the homeowner energy savings. Therefore, guaranteeing high accuracy (>95% confidence level) of the savings prediction is paramount to bring the financial risk below the threshold to qualify the product as investment grade.

To achieve this Discovery Phase goal, we tested the commercial viability of ISRF, created the fundamental technologies for the predictive engine, and established the legal and investment framework.

The goal was achieved via the following objectives to:

- prototype the customer interface (web/mobile app)
- establish the legal framework
- create a financial model for P4P loans
- investigate financial partnerships to pilot the P4P solution
- test the commercial viability and key platform requirements with consumers and the supply chain
- develop a dynamic physics-based model and the fundamental technologies for the AI (data-driven) forecasting model

ISRF total project cost was £243,031.63 and Department for Energy Security and Net Zero grant contribution was £193,900.25.

2 Key barriers and/or challenges

In the Discovery Phase, we validated the key barriers and motivators to the uptake of energy efficiency, low-carbon heating and micro-generation retrofit via detailed social science investigations. We conducted interviews and focus groups with 55 consumers to identify the key barriers to the uptake of domestic energy efficiency. Additionally, we investigated barriers in the current supply chain that do not allow for smooth and efficient retrofit project planning and execution with multiple suppliers. The analysis of potential financial, cultural, and awareness-related barriers has led to the identification of the following three key barriers:

Big upfront investment. The cost of retrofitting the dwelling stock to 'an appropriate standard' in the least energy efficient homes is £25,800 (English Housing Survey). However, when shown loan offerings of £15k, £25k and £35k, participants indicated the most comfort with £15k loans. For some, a loan would not be possible at all.

Challenging customer/supplier journey. Customer barriers included the understanding of the process and retrofit technologies, securing government support, finding reliable suppliers, finding accessible and inclusive financial tools (e.g. Muslim communities not accepting interest-based loans). These are just a few of the homeowner's challenges. Overcoming these challenges is time-consuming, making the journey demotivating. Supplier barriers included understanding integration with different retrofit measures/technologies, uncertainties on existing building features, flawed Energy Performance Certificates, (EPCs), and time/cost consuming upfront planning (high project costs/risks).

Limited consumer interest/knowledge. Consumer interest in retrofitting is mainly driven by potential financial benefits. The consumer struggles to see the benefits of increased home energy efficiency (e.g. emission savings, increased home-value, improved health).

3 Key findings from research and other activities

The results of the two social science investigations conducted during the Discovery Phase have shown that ISRF is on the right path in terms of offering a P4P financing tool and/or loans between £15k and £25k since this has been identified as the major roadblock to the national uptake of domestic energy efficiency. The reader can refer to Section 2.3.2 for more details on the social science investigation performed.

We completed and tested the creation of a user-friendly interface and experience that brings together three main applications: consumers, suppliers, and finance providers.

We have assessed the lack of accuracy of standard EPCs and identified a potential path forward to increase EPC's accuracy. The lack of accuracy was found to be mainly correlated with strong biases and human errors in conducting the survey process; negative biases towards fundamental retrofit measures (e.g. heat pump); and limited accuracy of physics-based SAP (Standard Assessment Procedure) and RD-SAP (reduced data SAP) model calculation.

We have developed and deployed a dynamic physics-based model of house performance/consumption that has allowed us to successfully identify the house archetypes and features with the highest potential for retrofits energy savings. We have hence defined the ISRF entry market.

We developed an EPC data-driven AI algorithm that achieves 98% accuracy on energy consumption forecasting implemented on a web-based interface for fast energy consumption forecast generation. The web interface allows us to automatically retrieve information on the dwelling, modify the information if required via performing more accurate surveys and finally compute the expected EPC. The model has been then used and integrated with a database of retrofit measures to create a data-driven retrofit plan optimiser capable of delivering various retrofit packages, suitable to a certain house archetype in a matter of minutes. The packages are meant to optimise energy savings (increase EPC level) and balance the cost of the retrofit package. The data-driven optimiser allows us to de-risk retrofit project planning and execution. While the model was trained on EPC data, to achieve higher accuracy and abandon flawed EPC databases, training will need to be performed on smart meter data.

Finally, we have defined the full legal and financial requirements to enable the deployment of ISRF. This included the requirements of achieving Data Communications Company (DCC) licenses to gain access to smart meter data and the establishment of an appointed representative to enable the delivery of financial products.

4 Key process learnings

Conducting the ISRF Discovery Phase project provided valuable insights and learnings that can inform future projects of a similar nature. Key learnings include:

Customer-Centric Approach: The Discovery Phase emphasised the significance of understanding customer needs and preferences. Interviews and focus groups with 55 customers were instrumental in shaping the product design. In future projects, a strong customer-centric approach will be important to continually incorporate user feedback to de-risk product development cycles and reduce development costs.

Partnerships: Provisional partnerships with various stakeholders, including finance providers, installers, and technology providers, played a pivotal role in expanding the project's reach. These partnerships brought in expertise and resources that were invaluable. In future efforts, it will be essential to proactively identify and nourish these partnerships to maximise their impact.

Legal and Regulatory: The establishment of legal and regulatory frameworks was a crucial aspect of the project. Since ISRF works at the crossroad between finance, management of sensitive consumer-related data, and suppliers it was important to recognise the significance of these frameworks and ensure that all legal requirements are thoroughly addressed. This includes obtaining necessary licenses and permits, especially when dealing with sensitive data such as smart meter data. This should be always considered in future green home finance products.

Financial Viability Testing: Testing the commercial viability of ISRF during the Discovery Phase was a prudent step. In future projects, it will be important to conduct thorough financial viability

assessments early on to ensure that the proposed solution is economically sustainable. This includes analysing funding sources, repayment terms, and potential subsidies.

Flexibility and Adaptability: We found it important to keep a very flexible approach in determining ISRF feature development. The adoption of a Lean Startup method, which includes the development of several Minimum Viable Prototypes (MVPs), to continuously improve and integrate user-focused requirements has been instrumental to achieve that and should be adopted in future projects.

Data Quality: The project highlighted the importance of data quality in energy efficiency assessments. Flaws in existing EPCs were identified and steps were taken to improve accuracy. In future projects, ensuring data accuracy should be a priority and securing access to reliable data sources will be essential to the correct development of green finance products.

Taken together, the Discovery Phase offered valuable insights into the challenges of developing an innovative green home finance product. Moving forward, applying these learnings and insights to future projects will be essential to create innovative and sustainable solutions.

5 Reflection on key outcomes achieved

During the Discovery Phase, we achieved several significant milestones including the validation of key consumer and supplier barriers, the identification of the key requirements of ISRF financial and legal frameworks and the development of the Artificial Intelligence (AI) data-driven energy forecasting model. These have paved the way for the further development and refinement of our green finance products and services. Key product design decisions were made based on valuable insights gathered from interviews and focus group involving 55 customers. These insights have enabled us to tailor our offerings to better meet the needs and preferences of our target audience, ensuring that our green finance products are not only environmentally responsible, but also user-friendly and accessible.

The identified user interface and experience designs will be deployed in an app and web-based prototypes that will bring together finance, consumers, and suppliers in one single platform. We will also create an Energy Adviser, a key feature of our ISRF platform that will guide and inform the consumer of the process and benefits of domestic energy efficiency, low-carbon heating and micro-generation. Finally, the achievements obtained in the development of the fundamental features of our energy savings/consumptions forecasting tool will be further enhanced via enriched databases and data sources to achieve a higher grade of accuracy and applicability. We will also develop innovative survey methodologies to enable more accurate EPC data-driven determination.

In addition to product design, provisional partnerships were established during this phase. These included partnerships with finance providers, installers, retrofit technologies providers, and energy providers. These partnerships are instrumental in expanding our reach and impact within the green finance sector. They provide us with access to valuable resources, expertise, and networks that will be crucial as we move forward. These collaborations also reflect our commitment of ISRF to create a diversified and resilient supply chain with different partners coming together to deliver a hassle-free service to the customer and promote domestic energy efficiency at scale.

Looking ahead, these achievements will serve as the foundation for the further development and refinement of our green finance products and services. The customer insights will continue to inform our decision-making processes, ensuring that we remain aligned with the evolving needs of our audience. Our provisional partnerships will be formalised and expanded during potential follow-on fundings to pilot ISRF and create new avenues for growth.

Evidence Report

1 Product Overview

1.1 Introduction

The goal of our Discovery Phase project was the development of Integrated Solution for Residential Retrofit Financing (ISRF). ISRF is a one-stop shop platform for energy efficiency works connecting vetted suppliers and consumers and providing innovative Pay-For-Performance (P4P) financing solutions. With this service, we aim to solve the biggest consumer problems related to implementing energy efficiency retrofits: big upfront investments; complicated customer journey; and lack of interest in using personal finances for energy efficiency retrofits. At the end of the Discovery Phase, we delivered the ISRF protype comprising key commercial, financial, and legal requirements and the fundamental technologies used for energy consumption/savings forecasting.

The ISRF technology building blocks comprise an online and mobile application for customer interface and an intelligent decision-making engine leveraging physics-based dynamic models and data-driven Artificial Intelligence (AI) models to compute energy consumption, predict retrofit energy savings and deliver a financial risk assessment with the monetisation potential of the retrofit.

Main pillars of ISRF's retrofit advice:

1) Hassle-free customer journey

2) Hybrid AI-Human retrofit planning

3) Energy Adviser (including education, good practices)

The customer journey unfolds through the following steps:

Step 1. ISRF website collects home-related data.

Step 2. Customers input energy bill information and/or provide access to smart meter data.

Step 3. ISRF forecasting engine computes current energy consumption and future energy savings by proposing up to three different retrofit packages characterised by different execution times/costs/energy savings. This is to give to the customer customisable options (key highlight of the Discovery Phase) and unbiased advice since we do not focus on a single retrofit type/supplier).

Step 4. A call with an ELPS Energy Manager will follow to better understand the customer's needs and exposure to energy efficiency, low-carbon heating and micro-generation technologies and tailor their Energy Adviser services, including dispensing tips and knowledge on how to reduce the household energy consumption (gap identified in the Discovery Phase).

Step 5. Using the data of Step 3, we present a clear financing plan for the homeowner, with up to 100% of the upfront costs covered. Our network partners will install the retrofits to provide a 100% hassle free experience. ISRF will automatically leverage public subsidies for the financing plan. Repayment terms will be based on the homeowner's energy savings. Therefore, guaranteeing high accuracy (>95% confidence level) of the savings prediction is paramount to bring the financial risk below the threshold to qualify the product as investment grade. The hybrid AI-Human interaction allows for mitigation of the risks associated with project planning and implementation, it increases customer confidence, increases automation to reduce cost and increase project efficiency but maintain customer engagement via qualified human interaction and customer support.

Our product implementation delivers the creation of an extensive high-fidelity verification database, pre-installation and post-installation, including Smart-Meter Data (SMD), sensor data (e.g. heat-loss), photographic proof of the retrofit works and physical tests (e.g. air tightness, U-values). The latter will be mainly applied during the first year of commercialisation to independently measure the efficiency of each retrofit, individually. In addition to increasing future forecast accuracy, this will also allow us to de-risk and benchmark the integration of new technologies, thus, helping the ecosystem of technology providers to flourish.

During the Discovery Phase, we used data from national datasets on energy consumption to find characteristics of homes which appear to use more energy than is typical. These homes may offer the greatest returns for future green finance products which regain costs through energy savings. For this reason, we have identified as our initial target market a subset of residential dwellings (detached dwellings with EPC<D) which corresponds to £6.2 billion of value generation in retrofit works. This will then be scaled up to a much larger number of dwellings once our P4P value is deployed, targeting a market of £426.5 billion.

The P4P financing facilitates customers' payment for energy efficiency retrofits based on actual energy savings, removing the hurdle of substantial upfront costs, and aligning service providers' and customers' interests. Our projections indicate an average Internal Rate of Return (IRR) of 5% p.a. for our P4P loans with an average maturity of 25 years. By attaining investment grade classification, ISRF's risk return profile will attract core institutional investors, ensuring financial product profitability with this cost of capital. The one-stop shop platform offers a broad range of energy efficiency products/services, serving as a centralised hub for customers' energy efficiency needs. Revenue generation activities include introductory fees on retrofit works, brokerage/loan service fees from green home finance products, and a subscription model for suppliers seeking enhanced app features.

1.2   Consumer barriers addressed by ISRF

In the Discovery Phase, we validated the key barriers and motivators to the uptake of energy efficiency retrofits including low-carbon heating and micro-generation via detailed social science investigations. We have conducted interviews and focus groups with 55 consumers to identify the key barriers to the uptake of domestic energy efficiency. Additionally, we have investigated barriers in the current supply chain that do not allow for smooth and efficient retrofit project

planning and execution with multiple suppliers. The analysis of potential financial, cultural, and awareness-related barriers has led to the identification of the following three key barriers:

Big upfront investment. The cost of retrofitting the dwelling stock to 'an appropriate standard' in the least energy efficient homes is £25,800 (English Housing Survey). However, when shown loan offerings of £15k, £25k and £35k, participants indicated the most comfort with £15k loans. For some, a loan would not be possible at all. Potential solutions included the creation of a financing tool (P4P) not linked to the currently prohibitive cost of financing to cover up to 100% of the upfront cost, enabling home energy efficiency at scale.

Challenging customer/supplier journey. Customer barriers included understanding the process and retrofit technologies, securing government support, finding reliable suppliers, finding accessible and inclusive financial tools (e.g. Muslim communities not accepting interest-based loans). These are a few of the homeowner challenges. Overcoming these challenges is time-consuming, making the journey demotivating. Supplier barriers included understanding integration with different retrofit measures/technologies, uncertainties on existing building features (flawed EPCs), time/cost consuming upfront planning (high project costs/risks). Potential solutions include the creation of a one-stop shop delivering de-risked retrofit plans via high-accuracy (>95%) energy forecast with multi-technology integration, vetted suppliers' network, government grants adviser, and advice/education services.

Limited consumers' interest/knowledge. Consumers' interest in retrofitting is mainly driven by potential financial benefits. The consumer struggles to see the benefits of increased home energy efficiency (e.g. emission savings, increased home-value, improved health). Potential solutions included the creation of an Energy Adviser and marketing strategy to better deliver the added benefits of the retrofit implementation. These include increased comfort, removal of drafts, improved health from cleaner air, and increased property value via high-accuracy AI-driven EPC evaluation. This will make our product appealing to several consumer segments and increase our customer base.

2 General scoping research and other activities

2.1 Research Methodology

2.1.1 Entry market sizing

We used data from smart meters and data on building characteristics to identify subsets of the building stock which frequently use more energy than expected. In a subsequent piece of work, these subsets were modelled in dynamic simulation modelling software (DSM), to ascertain which retrofit products would be most suitable for these homes.

Identifying homes which use more energy than is typical requires information on a home's actual energy use, and information on what energy use would be typical for such a home. For the former,

data from the National Energy Efficiency Data Framework (NEED) was used. NEED records annual electricity and gas use for a representative sample of homes in England and Wales. The 2014 version of this dataset was taken, as this dataset includes the building characteristics required for later insights. This analysis focuses only on homes which use gas as their main heating source, as the data was not of sufficient detail to disentangle electricity use due to heating from other uses.

To estimate the expected energy use of a property, it was initially envisaged that modelled energy use from EPCs could be relied upon. However, recent work has shown that energy use predicted from EPCs differs greatly from that consumed by real homes in most cases[1]. This is particularly true on homes which are poorer performing, and which might therefore be more suitable for retrofit. Instead, this piece of work looked at the energy use suggested from the Smart Energy Research Lab (SERL) dataset. SERL collects detailed data on energy consumption alongside data on various occupant and building characteristics. The raw SERL dataset is considered highly sensitive, making it impractical to use for this project. However, SERL has released an aggregated dataset which contained typical energy use profiles. Leeds Beckett University (LBU) has taken this data and used it to build a model capable of predicting a building's energy use. The model took as input the building characteristics available in the NEED dataset, and as output the expected annual gas use for that property.

The difference between measured energy use and expected energy use was then calculated, such that a positive value suggests higher-than-expected energy use. The 90th percentile of these differences was then calculated. Properties with a difference greater than this percentile were then classed as "high energy users". A machine learning algorithm was then deployed to investigate if building characteristics can act as a strong predictor for if a home will be placed in this class of high energy users.

2.1.2 Market research and customer demand

We conducted two social science investigations to validate the barriers and drivers influencing the adoption of energy efficiency retrofits and to test consumer demand. We interviewed 55 participants living in diverse regions, housing types, life stages, and income levels. The insights gathered validated our hypotheses on barriers and informed the ISRF required improvements. We assessed our financial offerings, the choice between loan repayment and profit sharing (P4P), the necessity of third-party endorsements to establish trust, the one-stop-shop, the significance of environmental versus financial benefits, and retrofit technologies preferences.

ELPS Energy proposition is to develop a P4P scheme that would allow the customer to access retrofits without having to advance cash and/or in certain circumstances without having to directly re-pay the cost of the retrofit work. This model assumes that one of the main roadblocks to the widespread of energy efficiency retrofit is the relatively high upfront cost to implement the retrofits.

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[1] Few, Jessica, *et al*. "The over-prediction of energy use by EPCs in Great Britain: A comparison of EPC-modelled and metered primary energy use intensity." Energy and Buildings 288 (2023): 113024

In this experiment, we wanted to validate this hypothesis to make sure that this was in fact a key roadblock that the ELPS offering would have solved with its product. Therefore, we offered prototypes that would have required the customers to re-pay the retrofit work in a certain amount of time. These prototypes were designed such that ELPS Energy finances the retrofit and sources and arranges installation. Customers then repay the installation costs over ten years with no interest and ELPS Energy takes half their energy bill savings for a period of 25 years.

2.2   Competition landscaping

We have identified several offerings competing in the delivery of a one-stop-shop platform. We have identified our offering as in a unique position to overcome the several fundamental barriers to the nationwide uptake of domestic energy efficiency retrofits by offering a holistic product which is a blending of technology, finance, and energy. The lack of critical features in other one-stop-shop offerings, reduces the value add, enables biases, and limits the reachable customers (only "mortgage free inefficient" homes ~4.9m[2]). ISRF key features are set to reach a wider audience, go above the "mortgage-free" market, and serve the entire owner-occupied and private rented sector category (~12.3m[2]).

2.3   Key findings

2.3.1 Entry market sizing

The results of the methodology described in Section 2.1.1 showed that the homes which use more energy than expected tended to be:
- Over 151 m[2]
- Detached
- EPC of D, E, F, or G
- Built prior to 1930
- Be built in London
- Belong to the least deprived groups

Previous retrofit schemes have tended to focus on homes very different to those described above, often targeting smaller, social housing or those in the most deprived strata of society. The present work finds that green finance which regains investment through energy savings may encourage retrofit in a new subset of homes, which have historically not received much incentive.

We estimated this subset of residential dwellings to count 0.243[2] million homes. With an average intervention cost of £25,647[2] per dwelling (higher number as focus on most inefficient homes), the total cost for energy efficiency upgrades for this subset of homes in the UK amounts to £6.2 billion. This figure represents the Initial Target Market for ISRF.

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[2] English Housing Survey/Office for National Statistics/NRS Scotland/Department of Finance Northern Ireland

Via offering standard loan payments and with the support of government incentives, this initial entry market will ensure an initial revenue stream for ISRF. This will also allow us to complete the validation of the P4P technology, which requires a high accuracy >95% energy savings/forecasting tool (still being developed). Once this subsequent step will be completed, it will be possible to go above and beyond the initial entry market, targeting a total serviceable market of 28.455 million houses, corresponding to £426.5 billion value in retrofit works.

2.3.2 Market research and customer demand

We report here the key results of the methodology described in Section 2.1.2.

Financial Preferences

When shown loan offerings of £15k, £25k and £35k, participants indicated the most comfort with loan amounts around £15k. However, some participants suggested £15k may not be sufficient for the scope of work required, so the optimal pricing point likely lies between £15k and £25k. Some comments indicated that a loan would not be possible at all.

Role of Government Incentives

Participants expressed a desire for government incentives, indicating that if ELPS Energy were to collaborate with public programmes, this would enhance the appeal of their offering.

Profit-Sharing Acceptance

The proposal of profit-sharing for 25-years was seen as too long, especially considering the requirement to repay the retrofit loan. The idea of sharing energy bill savings with ELPS Energy was more palatable when confined to a 10-year period, coinciding with the loan repayment term. A longer profit-share period would be acceptable if no loan was required.

Trust and Credibility

The study revealed a strong consumer preference for third-party endorsements or guarantees, suggesting avenues for ELPS Energy to bolster its product's credibility.

Convenience vs. Customisation

While the one-stop-shop model was generally well-received for its convenience, some participants expressed interest in having the option to obtain their own installation quotes.

Technology Choices

Solar panels and loft insulation emerged as the most popular retrofit options, whereas heat pumps were met with reservations due to their novelty in the market. Many of the subjects were not aware of the many retrofit technologies available in the market hence leading them only to biased choices. Users demonstrated a deep lack of awareness on the several benefits of domestic energy efficiency, low-carbon heating and micro-generation.

Based on the social investigation outcome, ELPS initial hypothesis has been validated and this further underpins the importance of the development of the proposed ELPS product with a pay-per-performance model.

2.4   Energy price response

The project has not encountered any challenges/barriers relating to the cost of living and energy price crisis, nor any that translates into the consumer not willing to invest upfront for the execution of the retrofits. However, ISRF is set to mitigate energy price fluctuation via embedding micro-generation measures in retrofit packages and enhancing their impact onto energy savings by proposing an active control of energy management to the consumer. In addition to this, the return of investment and cash flow forecasting tool that will be developed and eventually deployed in the next phases of development will be able to account for energy price fluctuation and factor them in into the retrofit financial package creation.

3 Relationship and partnership building

ELPS was able to draw together some of the UK leading professionals in the fields of clean energy finance, energy/financial law, energy efficiency and user interface design and establish ISRF Consortium. The strong multi-disciplinary ISRF team is a clear testament to ELPS' standing and the quality of its members.

The Discovery Phase project partner was The Leeds Sustainability Institute (LSI) at Leeds Beckett University (LBU) which is one of the country's leading building research groups. The unique skillset within the LSI has been developed over 30 years and combines physics-based modelling of dwellings performance; execution and analysis of house performance measurement technologies, surveying, retrofit planning and good practices for monitoring of the retrofit execution, management and analysis of large datasets of housing stock and related energy consumption, and extensive knowledge of retrofit technology measures. These skills and expertise were essential to the development of the product as well as the development and execution of the social science investigations.

Additionally, the following subcontractors played a major role in delivering the project outcome:

Imperial College Consultants (ICON): experts in AI algorithm development/implementation, development of complex databases with multi-domain data sources for training of energy-related forecasting models, multi-variable optimisation algorithms, and back-end integration into cloud/software-based systems. The collaboration with ICON was fundamental to de-risk the AI and back-end technology development.

Together Holdings: award-winning firm for the design of creative and user-friendly user interface and product experiences. Contributed to the creation of the user interface/experience of the ISRF consumer and supplier apps.

Amberside Advisors: worked on over 10GW of investment in renewables and networks across heat networks, solar, wind, biomass, waste, and emerging tech to deliver technical and financial advice on the development of green financial products. Contributed to the identification of challenges and solutions to define the ISRF financial framework and requirements.

Lux Nova Partners: specialise in renewable and low-carbon energy projects. Lux Nova has advised financial and industrial sponsors, utilities, community groups, trade associations, start-ups, banks, governments, fund managers, developers, and contractors, on projects across the UK, continental Europe, the Middle East, and Africa. Lux Nova Partners contributed to identification of challenges and solutions to define the ISRF legal framework and requirements.

During the Discovery Phase we also engaged with and established key partnerships to onboard into the ISRF platform and foster a diversified and resilient supply chain. Due to confidentiality agreements and given the strategic role played by these partners in the initial development phase of ISRF we will keep the names confidential. We report a non-comprehensive list of supply chain players engaged in ISRF.

Technology providers/installers:

"Installer 1" develops intelligent tools to assess and maintain the health of buildings via cutting edge insulating materials targeting reduced house energy usage, reduced carbon emissions and enabling low-carbon heating.

"Installer 2" pioneers the design of intelligent ventilation systems to deliver fresh air at minimal energy cost while delivering optimal house heating.

"Installer 3" provides loft and cavity wall insulation, including extraction room in roof insulation, external and internal wall insulation; boiler replacement; central heating servicing and repairs; renewables installations; and home improvements and retrofits.

"Building performance measurement" expert in the creation of comprehensive pre-/post-installation measurements to quantify carbon accounting of the investment and enrich the training database for the training/refinement of ISRF energy consumption/savings forecasting tool and retrofit plan optimiser. The company is at the forefront of developing innovative technologies for accurate house-performance measurements and analysis (e.g. heat-loss coefficient).

Finance Providers: "Provider 1" and "2" will be providing the regulatory support and the capital to deploy conventional financing instruments via ISRF's one-stop-shop.

Taken together, the ISRF consortium and the supply chain organisations engaged in our project highlight how we have guaranteed all the required skills and market segment experience to enable the successful delivery of ISRF, including product and technology development, customer journey and retrofit projects deployment.

Knowledge sharing between supply chain partners has been secured via a robust control of confidential information (e.g. non-disclosure agreements in place) and via the creation of collaborative tools into the ISRF platform to promote the exchange of ideas and the development of future green home finance products. No specific challenges were encountered in the creation of

partnerships and the gaps that we have identified have been covered with the growth of ELPS team via talent acquisition campaigns and via the continuation of such a strong consortium in the delivery of the next product development phases.

4 Finance product research

4.1 ISRF finance offering

One of the key features of ISRF that will enable the nationwide uptake of domestic energy efficiency in the UK is the creation of financial tools that will allow to cover up to 100% of the retrofit package cost such as the pay-per-performance (P4P). According to our estimates, the average Internal Rate of Return (IRR) for our P4P loans will be 5% p.a. and the average maturity will be 25 years. This risk return profile will be appealing to core institutional investors if ISRF is classified as investment grade. This cost of capital will already ensure the profitability of our financial product. Additionally, at scale, we will be able to drive the cost of energy efficiency measures down by exploiting economies of scale in the procurement process, thus further increasing financial profitability. Furthermore, the business model behind ISRF considers the presence of alternative revenue streams such as introductory fees on retrofit works and a subscription to use enhanced features of our app for suppliers. This further consolidates our business viability.

Currently, green home investments are not investment grade. Without the ability to prove investment grade accuracy, the cost of capital required to invest in energy efficiency retrofits is higher than 5% p.a., render the proposition of a P4P not viable. ISRF will create investment grade products by delivering high accuracy energy consumptions/savings predictions with high confidence level (>95%). This will be the key to stimulate the creation of viable green home finance products at large scale.

The P4P solution is to be integrated with standard financial offering and with the support provided by subsidies and grants issued by the government. In this way, it will be possible to achieve a seamless launch of ISRF and obtain a quick turn around and technology validation that will enable the P4P model. In fact, by accessing the initial market of the "able to pay" it will be possible to gather data for training of the AI forecasting tool and achieve the high accuracy forecast prediction (>95%) that will enable the P4P model at scale.

4.2 ISRF finance offering consumer feedback

In the Discovery Phase, we validated the key barriers and motivators to the uptake of energy efficiency retrofits including low-carbon heating and micro-generation via detailed social science investigations. One of the key barriers is the big upfront investment currently required to execute a certain retrofit package. The cost of retrofitting the dwelling stock to an appropriate standard in the least energy efficient homes is £25,800 (English Housing Survey). However, when shown loan offerings of £15k, £25k and £35k, participants indicated the most comfort with £15k loans. For

some, a loan would not be possible at all. To this end, ISRF solution presented in Section 4.1, i.e. the P4P, offers an opportunity to overcome the currently prohibitive cost of financing and cover up to 100% of the upfront cost, enabling home energy efficiency at scale.

We report below the additional feedback provided by the users through the social science investigations conducted in the Discovery Phase.

- Participants were primarily focused on the financial aspects of the offer, rather than the comfort, environmental or convenience benefits. This was despite many talking about how their homes are often too cold in winter and too warm in summer. Most participants talked about how expensive their heating has become, and some described how they cannot afford to heat their home as much as they would like. This indicates that future versions of the product should strongly emphasise its cost-saving benefits, perhaps even providing case studies or calculators to help potential customers understand their return on investment.
- The concept of sharing energy bill savings with ELPS Energy was generally more palatable when confined to the 10-year loan repayment period. This feedback suggests that aligning the profit-sharing period with the loan repayment term could enhance the offer's attractiveness.
- Participants were hopeful that government subsidies or grants might become available for energy-efficient home improvements. This expectation could influence their willingness to invest in such measures now, suggesting that clear communication about any available subsidies or the lack thereof could be beneficial.
- The potential impact of energy efficiency measures on home value was a topic of discussion. While some participants felt that their home's value would increase, others were sceptical. A government-backed scheme was seen as potentially adding value to homes, indicating that partnerships with governmental bodies could enhance the product's appeal.

4.3   Regulatory considerations and other financial tools

We have engaged with Lux Nova Partners and Amberside Advisors to navigate the possible legal and regulatory framework required to the launch of ISRF and the realisation of the business model. As an overview, two key aspects were recognised: 1) the necessity of a DCC license to access and manage smart meter data; and 2) the formation of an appointed representative.

Financial Conduct Authority (FCA) regulations: ELPS will not be a finance provider requiring FCA approval. However, given that ELPS will be offering third-party conventional financial products to its customers at this stage, a credit brokerage FCA approval is required. To this end, ELPS is in the process of establishing a Principal / Appointed Representative relationship.

A DCC license is required to access smart meter data. These are critical to enable high accuracy (>95%) energy consumption/savings forecasting tools and to maximize energy savings/benefits of micro-generation. ELPS has already started the process of acquiring a DCC license.

5 Advice/information research

5.1 ISRF three advice pillars

Based on the outcomes of the social science investigations we identified three main pillars of ISRF's retrofit advice:

- Hassle-free customer journey
- Hybrid AI-Human retrofit planning
- Energy Adviser (including education, good practices)

Our customers will subscribe (free-of-charge) to the platform and will only have to fill out a short questionnaire on our website and provide either their past energy bills or access to smart meter data (if available). A call with an ELPS Energy Manager will follow to better understand customer's needs and exposure to energy efficiency, low-carbon heating and micro-generation technologies and tailor their Energy Adviser services, including dispensing tips and knowledge on how to reduce the household energy consumption (gap identified in the Discovery Phase). At the back end, our AI model will perform an energy profile analysis and deliver up to three different retrofit packages characterised by different execution times/costs/energy savings. This allows the customer customisable options (key highlight of the Discovery Phase) and unbiased advice since we do not focus on a single retrofit type/supplier. An ELPS Surveyor will then visit the property to record high-fidelity data and imaging of the property to feed into the AI forecasting model to provide the finalised retrofit plan with a >95% accuracy in energy savings. During and after implementation, each customer will be assigned to an ELPS Energy Manager.

The hybrid AI-Human interaction allows us to de-risk project planning and implementation, it increases customer confidence, increases automation to reduce cost and increase project efficiency but maintains customer engagement via qualified human interaction and customer support.

5.2 Benefits

Hassle-free customer journey:

Simplicity: This pillar minimises the complexity of engaging in energy efficiency retrofits, making it more accessible to a wider audience.

Personalisation: By tailoring services based on individual needs, customers are more likely to receive advice and retrofit plans that are beneficial to them.

Reduced Barriers: The simplified process lowers barriers such as lack of knowledge or uncertainty that often stop homeowners from pursuing energy efficiency upgrades.

Hybrid AI-Human retrofit planning:

Risk Mitigation: the AI-driven model relies on large amounts of historic data to provide ad-hoc retrofit packages in short lead time. This allows us to greatly de-risk project planning. The human validation and interaction further de-risk project plan and potential machine misreading. This enhances the overall success and reliability of retrofit projects.

Customer Confidence: The human element in the process provides customers with reassurance and confidence in the retrofit plan. They can trust that experienced professionals are overseeing the project.

Efficiency: Automation through AI speeds up the planning process, reduces costs, and improves the overall efficiency of retrofit planning and execution.

Energy Adviser:

Empowering Customers: By offering education and good practices, this pillar empowers customers to make informed decisions about energy efficiency retrofits and sustainable energy practices.

Long-Term Engagement: The ongoing support provided by an ELPS Energy Manager ensures that customers continue to receive guidance even after the retrofit is complete, fostering long-term energy efficiency habits. This could include tips on maintenance of the retrofit measures implemented, information on what to look for to evaluate any loss in performance in the measurements, positive habits to ensure maximization of energy savings, etc.

Alignment with Sustainability Goals: Educating customers about the benefits of energy efficiency and sustainability contributes to a broader societal goal of reducing carbon emissions and promoting green living.

5.3 Consumer feedback

The approach described in Section 5.1 was progressively developed as part of our Lean Startup method. In fact, the three main pillars followed the detailed customer feedback from the social science investigations which has eventually allowed us to shape advisory services with features tailored to our customer needs. Furthermore, in relation to advice and information preferences customer feedback included:

Participants indicated that some form of guarantee or third-party endorsement would increase their confidence in the offer. This suggests that securing certifications or partnerships with trusted organisations could be beneficial for the product's credibility.

Participants had mixed feelings about the one-stop-shop model. Some appreciated the convenience of having ELPS Energy source and oversee the work. They talked about the hassle of finding a trusted tradesperson, and about bad experiences they or their friends or family have had. Others were sceptical about the quality of contractors and assumed that ELPS Energy would profit from the arrangement. This suggests that offering a choice between a one-stop-shop and a more flexible approach, perhaps with the option for customers to obtain their own quotes, could cater to a broader range of customer preferences.

While participants acknowledged the importance of environmental sustainability, their primary focus remained on financial considerations. This suggests that while the environmental benefits of the service should be highlighted, they are unlikely to be the sole motivating factor for most customers.

Participants were hopeful that government subsidies or grants might become available for energy efficient home improvements. This expectation could influence their willingness to invest in such

measures now, suggesting that clear communication about any available subsidies or the lack thereof could be beneficial.

Overall, this feedback has been channelled into shaping our advisory services expressed above:

Government Collaboration: we will investigate potential partnerships with government programs to offer subsidised rates or additional incentives.

Building Credibility: we will seek third-party endorsements from reputable organisations like "Which" or "Money Saving Expert" to instil greater confidence in the product. Use customer testimonials to further build credibility.

Flexibility in Service: we will offer customers the option to obtain their own installation quotes, while also highlighting the benefits of the integrated one-stop-shop model.

Proactive Customer Education: we will develop a comprehensive Energy Adviser capable of dispensing knowledge and informing the consumer with tips and good practices to increase confidence, trust, and awareness in domestic energy efficiency, low-carbon heating and micro-generation.

6 Verification methodology research

ISRF delivers the creation of an extensive high-fidelity verification database pre-installation and post-installation. Our verification process include:

Sensor data: Locally positioned temperature data for a detailed analysis of the house performance (heat loss).

Smart-Meter Data (SMD): This provides the key verification data-source to monitor performance of the retrofits and schedule maintenance to maintain a high efficiency of the retrofit measures.

Photographic proof of the retrofit works: This will serve as an initial check for the confirmation that works have been carried out according to plan.

Physical tests (e.g. air tightness, U-values): Applied only during the initial phases of commercialisation to independently measure the efficiency of each retrofit, individually. In addition to increasing future forecast accuracy, this will also allow us to de-risk and benchmark the integration of new technologies, thus, helping the ecosystem of technology providers to flourish.

In addition to the above list of tests and verification methods, the onboarding procedure for installers and suppliers includes qualification and assurance reports that allows us to perform a background check on the quality of the suppliers' historical work. With this we de-risk further potential quality-related issues of the retrofit works. Additionally, the verification methods implemented allow the installers and technology providers to receive a direct measure of their work performance. This would be instrumental to ensure that the supplier enrolled into ISRF always deliver at the highest quality standards and to allow for detailed maintenance interventions in case of reduction of the retrofit performance. This also allows us to further de-risk potential fraud/mischief by the installers.

We have made ISRF technology agnostic by removing the bias associated with utilising only specific retrofit measures and we allow for the best synergies across technology to be exploited aiming at achieving maximum energy savings. Therefore, we have adopted a list of verification methods that allow us to span across multiple technologies including, solar, loft insulation, heat pump, etc. The selection of the measures above has been verified via the collaboration with Build Test Solutions (BTS) developed at the end of the Discovery Phase. BTS are expert in the creation of comprehensive pre-/post-installation measurements, and they are at the forefront of developing innovative technologies for accurate house-performance measurements and analysis (e.g. heat-loss coefficient).

The user research conducted has highlighted that non-invasive post-installation verification methods are greatly desired, and it gives them an additional insurance on the quality of the retrofit works and makes them feel that support is continuously provided even after the execution of the retrofit. This also enables us to assist our customer in scheduling maintenance intervention to overcome potential post-installation issues.

7 Marketing related research

We conducted six focus groups with a total of 34 participants to test our marketing tools. We included people living in different parts of the country, in different types of homes (mainly larger homes), at different life stages, and with different levels of available income. A quota was set for age, gender, ethnicity, and financial status. The focus on people living in larger homes was due to the findings from an earlier stage of the research, that these homes have greater potential for saving money.

Each focus group took place online and lasted an hour. During the groups we explored participants' perceptions of, and interest in, the ISRF green home finance offering. Participants first talked about their homes and any steps they have taken to reduce their energy use. They then read the ELPS Energy leaflet, which was developed by ELPS Energy for the purpose of the research. The leaflet describes the green home finance process and provides an example of how it works in practice. There were three versions of the leaflet. Four of the groups had a leaflet with an example of a £35k retrofit. However, initial findings were that this figure was too high, so for the remaining two groups, one had an example of £25k and one an example of £15k. Groups were semi-structured, with discussion topics varying between groups depending on the flow of conversation, and participants able to explore additional relevant topics should they arise. Groups were video recorded, and the discussions transcribed.

The leaflet was the tool investigated in the Discovery Phase for marketing purposes. We decided to use this approach as the leaflet restricted us to only show a limited set of information to better understand what key aspects of our offering we need to highlight in order to deliver a clear and compelling message to our customers. Key aspects of the marketing offer that were found important by the user research included:

1) Use of indicative example of customer journey to better explain the offer should appear early in the marketing material.
2) Strongly emphasise cost savings benefits and include calculators and/or case studies.
3) Use of third-party endorsement and testimonials.

4) Provide links and information to relevant retrofit technologies to allow the customer to better understand and have a clear vision of the product.
5) Highlight the impact on home value increase.
6) Add background information to build brand credibility and trust.
7) Ensure Government endorsement.
8) Use straightforward language.

Based on the consumer feedback we are now approaching different avenues for marketing of our offer which include social media marketing, email marketing, search engine marketing and search engine optimisation, public relations and media outreach, community engagement programs, workshops, tradeshows, and conferences.

8 Future plans for green home finance

8.1 ISRF next steps

Conducting the ISRF Discovery Phase project provided valuable insights and learnings that can inform future projects of a similar nature. Key learnings include:

Customer-Centric Approach: The Discovery Phase emphasised the significance of understanding customer needs and preferences. Interviews and focus groups with up to 55 customers were instrumental in shaping the product design. These have helped us to consolidate the fundamental barriers to domestic energy efficiency uptake and devise strategies and product features tailored to remove such barriers. In future projects, a strong customer-centric approach will be important to continually incorporate user feedback to de-risk product development cycles and reduce development costs. This will be central to future ELPS Energy product developments. Specifically, to enable continuous closed-loop feedback with our consumer base we will create an Energy Adviser, a key feature of our ISRF platform that will guide and inform the consumer in the process and benefits of domestic energy efficiency, low-carbon heating and micro-generation and it will allow us to gather feedback to further improve ISRF.

Partnerships: Provisional partnerships with various stakeholders, including finance providers, installers, and technology providers, played a pivotal role in expanding the project's reach. These partnerships brought in expertise and resources that were invaluable. Partnerships with suppliers and lenders are fundamental to ELPS business model and the realisation of ISRF. To this end, the partnerships initiated in the Discovery Phase are being finalised and new partners are being sought aiming at creating a highly diversified and resilient supply chain capable in a joint effort to deliver UK nationwide uptake of domestic energy efficiency. In future efforts, it will be essential to proactively identify and nourish these partnerships to maximise their impact.

Legal and Regulatory: The establishment of legal and regulatory frameworks was a crucial aspect of the project. Since ISRF works at the crossroad between finance, management of sensitive consumer-related data, and suppliers it was important to recognise the significance of these frameworks and ensure that all legal requirements are thoroughly addressed. This includes obtaining necessary licenses and permits, especially when dealing with sensitive data such as smart

meter data. As an example, ELPS is now in a process to become a DCC licensee in order to access and mange highly sensitive data such as smart meter measurements. Obtaining the suitable access right is fundamental not only to deliver a complete and powerful product development to overcome fundamental customer barriers (e.g. high upfront cost of retrofit) but also to guarantee that data storage and handling is performed with maximum security and in compliance with General Data Protection Regulation (GPDR) standards. This should be always considered in future green home finance products.

Financial Viability Testing: Testing the commercial viability of ISRF during the Discovery Phase was a prudent step. In future projects, it will be important to conduct thorough financial viability assessments early on to ensure that the proposed solution is economically sustainable. This includes analysing funding sources, repayment terms, and potential subsidies. A deep analysis of the ecosystem of technology providers, the requirements to overcome product development barriers as well as the variables that drive the cost of deploying retrofit and calculating return on investment (energy price, cost of technology, cost of IT infostructure, etc) are key to enable a reliable and robust framework for development of innovative financial products. This work that needs to be done early in the development stage to guarantee viability of the prototyped developed.

Flexibility and Adaptability: We found it to be important to keep a very flexible approach in determining ISRF feature development. The adoption of a Lean Startup method has been instrumental to achieve that and should be adopted in future projects. We have developed our Discovery Phase product feature and planned for the follow-on developments integrating the outcomes of all our research activities (marketing, user test, legal, technology). In fact, plans may need to be adjusted based on unexpected findings or changing circumstances and by developing our product in different sprints and closed loop feedback cycles has provided us with the agility to continuously shape our product to consumer needs and the supply chain challenges.

Data Quality: The project highlighted the importance of data quality in energy efficiency assessments. Flaws in existing EPCs were identified, and steps were taken to improve accuracy. In future projects, ensuring data accuracy should be a priority and securing access to reliable data sources will be essential to the correct development of green finance products.

Looking ahead, these achievements will serve as the foundation for the further development and refinement of our green finance products. The customer insights will continue to inform our decision-making processes, ensuring that we remain aligned with the evolving needs of our audience. Our provisional partnerships will be formalised and expanded during potential follow-on fundings to pilot ISRF and create new avenues for growth.

The lesson learnt from the activities of the Discovery phase has allowed us to also understand the necessary skillset that is required by ELPS in order to have a successful product launch. To this end the successful achievements of the Discovery Phase have been channelled into supporting a fundraising campaign that will allow for the ELPS team growth and the creation of new jobs and skills which are fundamental to enable the development of green home finance products. In the future, we plan to increase the impact of ISRF developments via embarking in numerous dissemination activities that will help to attract new customers/partners and build brand recognition:

- Online presentations/webinars reporting major project outcomes and regular news updates, showcasing demo and success stories.
- Creation of a Supply Chain Workshop. We will invite up to 6 external representatives from industry and academia. The workshop exposes the attendees to disruptive ideas generated through the program with high potential for the development of future green finance propositions.
- Conferences and fairs participation including The Retrofit Challenge Summit 2024 and Futurebuild 2024.
- Training programs development.

These dissemination activities will stimulate discussion and awareness to enhance lender/supply chain integration and stimulate the market for the development of future green finance proposition.

8.2 Green finance product challenges

In addition to the ISRF development achieved in the Discovery Phase, there are still external challenges that would need to be addressed to ease the growth of sustainable finance products. These include:

Changing Regulations: Regulatory landscapes related to energy efficiency and green initiatives may change over time. Staying up to date with and adapting to evolving regulations is essential.

Economic Uncertainty: Economic conditions and uncertainties can impact the demand for green home finance products. Economic downturns may affect homeowners' willingness to invest in energy efficiency retrofits.

Consumer Education: Providing homeowners with the knowledge and resources to make informed decisions about energy efficiency retrofits is a continuous challenge. Education and outreach efforts are necessary to promote understanding and adoption.

Partnership Building: Establishing and maintaining partnerships with stakeholders, including finance providers, installers, technology providers, and utilities, requires ongoing effort. Ensuring that these partnerships remain productive and contribute to the success of the proposition is crucial.

Data Quality and Accuracy: Relying on accurate data for energy efficiency assessments and predictions is vital. Overcoming issues related to data accuracy, such as flaws in existing Energy Performance Certificates (EPCs), is a barrier to providing reliable retrofit recommendations.

Customer Awareness and Interest: Increasing homeowners' awareness and interest in energy efficiency and green home improvements is essential. Many consumers are not fully aware of the benefits, including energy savings, reduced carbon emissions, improved home value, and better health.

Addressing these challenges and barriers will require a holistic and multidisciplinary approach that involves collaboration among government agencies, financial institutions, technology providers, and

homeowners. Continuous innovation, education, and a commitment to sustainability will be essential for the successful development of green home finance propositions.