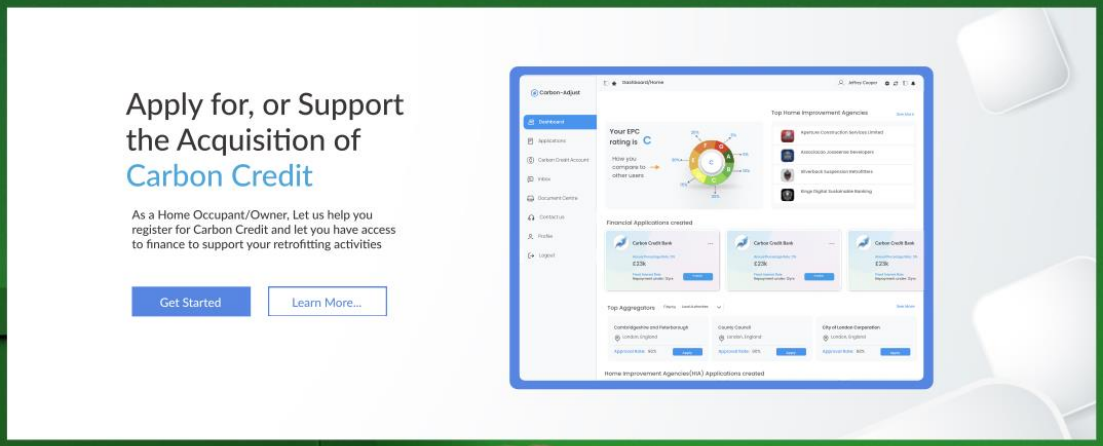
Carbon-Adjust

Escrow-Tech

Carbon-Adjust: Carbon-Offset Adjusted Loan Rate Settings for Financing Green Home Improvement Activities



GREEN HOME FINANCE ACCELERATOR (GHFA) DISCOVERY PHASE REPORT

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About Us

Escrow-Tech Limited is an innovative SME delivering bespoke solutions that leverage digital tools like artificial intelligence (AI), deep learning (DL), natural language processing (NLP) and image recognition in resolving climate finance problems. Our research areas span financial services with fiduciary responsibilities, infrastructure, energy, and supply chain. Our strengths include climate finance and business model development, climate risk analysis (physical, transition, regulatory), decarbonisation (residential, commercial, and industrial) and net zero research. We have a combined 40 years' worth of experience between staff in developing customer centric software solutions and data analytics systems at the enterprise level.

Escrow-Tech's role in informing policy and shaping its design especially on decarbonisation is two fold. On the one hand we develop innovative tools and software solutions that can enable end users in the residential, commercial and industrial space operationalise and manage the offsets their investments generate. At the same time, we are building innovative business models that can promote circularity within the local economy ensuring that the offsets generated can be part of a wider ecosystem that rewards all participants fairly. Beyond this we also have an advocacy role to play ensuring that we can continue to spot and raise awareness about perverse industry trends and practices that are set up to exploit and disenfranchise end users.

In ensuring we can continue to offer value to end users, we currently have a range of software products at different stages of production and all due to be fully licensed and operational by December 2024.

Contact us today at info@escrow-tech.co.uk or visit our website at: https://www.escrow-tech.co.uk/

Disclaimer

The views and opinions expressed in this report are those of the authors and do not necessarily reflect the official policy or position of the government. The information in this report is provided for informational purposes only and should not be construed as an independent review of the project.

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EXECUTIVE SUMMARY

The average energy efficiency rating for properties in England and Wales currently stands at a modest D rating, signalling the need for improvement. Most properties fall within bands D (24.5%), E (23.6%), and F (16.7%), which are considered less energy-efficient, with only a small percentage achieving the coveted band A rating (3.8%). The UK government has set an ambitious target to make all homes in England and Wales energy-efficient by 2050. The prevalence of government schemes like the Green Home Grant, the Boiler Upgrade Scheme, and the Domestic Renewable Energy Heat Incentive notwithstanding, there has been low interest and uptake by homeowners.

Our preliminary results from extensive desktop research prior to our Green Home Finance Accelerator (GHFA) Discovery Phase funding evidenced several issues as being instrumental in disincentivising interest from homeowners. Some of these include:

- bureaucracy,
- internal factors relating to the buildings (age, materials, insulation levels),
- the huge cost of retrofitting,
- the technical complexity,
- technical skill shortage,
- quality assurance, and
- the associated disruption and inconvenience retrofitting activities caused

Additionally, we also identified core issues of synergy between stakeholders in the domestic retrofit value chain and the difficult task of easily and cheaply decarbonising the huge stock of poorly insulated homes across the UK. Furthermore, we profiled existing schemes and identified their inability to offer any quantifiable and verifiable feedback benefits to homeowners that could incentivise interest, ease the process of retrofitting, and still achieve significant decarbonisation of both embodied and operational household emissions.

In our opinion, a digital scheme was needed that could leverage information communication technology (ICT) in facilitating the retrofit journey. This scheme needed to be seamless, agile and capable of onboarding all stakeholders (homeowners, aggregators, home improvement agencies, sub-contractors, finance institutions) involved in domestic retrofit. Additionally, such a scheme should be able to quantify and operationalise the carbon offset benefits for particular domestic retrofit activities. Such a scheme we argued must be able to fully exploit the potential benefits of onboarding domestic energy users on Ofgem's Market-wide Half Hourly Settlement Scheme (MHHS).

Carbon offsets result when our use of energy to achieve a task is done with a smaller carbon footprint. This could be through the use of more energy efficient devices (e.g. heat pumps instead of gas boilers), shifting of tasks (from periods with the electricity grid having high carbon intensity, to periods with lower carbon intensity), or better insulation that reduces heat loss which leads to the use of less energy (e.g. cavity wall insulation). When these carbon offsets are quantified, verified, validated and certified by a registry, they result in carbon credits.

The core aim of Carbon-Adjust in the Discovery Phase of the GHFA programme was to reduce the cost of decarbonising residential homes through the operationalisation of ensuing carbon credits. The target end users were the able-to-pay homeowners who will be impacted by future energy efficiency and/or carbon reduction targets. They were ideally those poorly served by the existing green financing market and those not eligible for support under government Help to Heat energy efficiency support schemes.

To achieve this core aim, Carbon-Adjust had three primary objectives.

- Objective 1: To create a minimum viable product (MVP) software platform to integrate all the stakeholders involved in domestic retrofitting. The software platform needed to intuitively progress homeowners from one implementing stakeholder (e.g. aggregator, home improvement agency, finance institution) to another seamlessly.
- Objective 2: To help homeowners extract and operationalise the carbon offset benefits that ensued from retrofit activities they invested in. For every voluntary investment made by homeowners in improving their home energy efficiency, there was a corresponding drop in the carbon footprint generated. With homeowners being unable to own carbon credits, aggregators were introduced to serve as middle-men in owning these credits and getting them verified on a voluntary carbon credit market like Verra.
- Objective 3: To create a business model that could leverage the operationalised carbon credits in offsetting a fraction of the interests being paid by the homeowners. Our project was targeted at homeowners accessing credit for home retrofit from lenders financed by Local Authorities. Our focus was to explore the development of a comprehensive business model that priced carbon credits fairly and used this valuation in reducing interest repayments for homeowners. Additionally, we were also interested in helping finance lenders build headwind risk hedging models for carbon prices. Lastly under this objective, we wanted to explore how the operationalised carbon credits could be "flipped" from the balance sheets of lenders to the accounts of Local Authorities and used in offsetting their carbon footprint. This objective was to protect lenders from exposure to lower valuation for carbon credits.

The total cost for the Discovery Phase of Carbon-Adjust was £198,800. Of this amount, grant contribution from the Department for Energy Security and Net Zero was £159,040 with match funding of £39,760 from the consortium.

Key barriers and challenges

Prior to the Discovery Phase, a major problem envisaged was helping homeowners generate significant carbon credit benefits from their investments in low-carbon energy technologies. This was of particular interest to us as we needed to demonstrate that in the event of a significant fall in carbon prices, homeowners were still able to generate significant financial benefits. Additionally, we were also limited in how we could price in headwind risks (like government policies) on carbon prices for finance lenders to ensure that their hedging strategies (to reduce their exposure to lower carbon prices) did not negatively price out the benefits for homeowners.

The Discovery Phase funding provided the needed investment to bootstrap our research into broadening our knowledge along these lines. Through the Discovery Phase funding we were able to successfully investigate that beyond the adoption of low-carbon energy technologies like heat pumps, homeowners could increase the carbon credits they generated through participation in demand response (DR) programmes. The ongoing plans of Ofgem to include domestic and small business energy consumers in the Market-wide Half Hourly Settlement Scheme (MHHS) facilitates this. Beyond this, we also devised a new business model that round-tripped carbon credits from the balance sheets of finance lenders (lending out council grants) through Carbonible (our carbon credit trading and settlement platform) and utilising them in displacing the carbon footprint of local councils. The implication of this arrangement meant that lenders could offer credit at lower interest rates to homeowners. Also, this arrangement meant that lenders did not have to hold these carbon credits long-term thus reducing their exposure to negative valuation risks.

Key findings from research

Our main Discovery Phase findings indicate that interest from homeowners scaled as their potential for higher levels of participation in flexible demand increased. Particularly, homeowners installing heat pumps were more eager to participate and utilise Carbon-Adjust when provisions were made for bundling electric vehicle (EV) chargers, and energy efficient dishwashers, washing machine and tumble dryers in flexible demand. Overall, we found that such participation was capable of generating over 86tCO2e[1] offsets worth £12,900 (at £150/tCO2e) in 20 years. For a typical 3-bedroom detached house, this represented a 23% reduction in energy cost.

Other findings relating to our webinar and focus group participants investigated the perception of end users to our software platform – Carbon-Adjust software as a service (SaaS). The software was rated excellent overall scoring high points for ease of use and navigation. Additionally, 80% of participants indicated their interest in receiving the Carbon-Adjust newsletter.

Key process learnings

[1] Carbon dioxide equivalent or CO2e means the number of metric tons of CO2 emissions with the same global warming potential as one metric ton of another greenhouse gas (https://www3.epa.gov/carbon-footprint-calculator/tool/definitions/co2e.html)

A major learning outcome for us has been the successful trial of agile methodology in successfully executing concurrent tasks in building Carbon-Adjust SaaS. The lessons have been invaluable as they enabled us to shorten the time to develop Carbon-Adjust SaaS to a MVP at technology readiness level (TRL) 4 (within 3 months) whilst also leveraging the ongoing webinar and focus group sessions that generated some useful inputs in improving the platform's functionality. The knock-on benefit of this process was that it allowed us to pitch Carbon-Adjust to stakeholders and generate the consortium members we needed for the Pilot Phase application. Another lesson from executing our agile methodology in building Carbon-Adjust SaaS was that it exposed a gap in our plans – the absence of any digital platform that could enable us to provide management operations for generated carbon credits for aggregators. This was picked up very early in the development of Carbon-Adjust SaaS and led to the development of Carbonible which was financed 100% by Escrow-Tech Limited. A final learning outcome for us was that the Discovery Phase funding period helped us identify our limitations in scaling our engagement above 100 homeowners. In attempting to reach out to homeowners that were best suited to trial our product, we discovered that traditional outreach methods were insufficient due to the absence of existing databases that collated their records. To mitigate this, we have now identified and secured partnership of a subcontractor with access to over 8,000 households and meeting our requirements.

Reflections on Key Outcomes Achieved

In hindsight, as we reflect on the outcomes of the Discovery Phase for Carbon-Adjust, we are very proud of our decisions to:

1. include aggregators in the value chain (to own on behalf of homeowners the carbon credits and offer them compensation either through direct cash payments or reduced interest rates) and,
2. bring forward the development of the Carbon-Adjust SaaS using the agile methodology.

These decisions have been pivotal in demonstrating to stakeholders the differentiating benefits of Carbon-Adjust and highlighting potential gaps (like our inability to reach the scale of our target homeowners and the absence of a carbon credit management platform) that we were able to correct during the Discovery Phase.

Additionally, the Carbon-Adjust SaaS MVP and the complimentary Carbonible platform were instrumental in securing interests and partnerships from Lendology CIC (a regional lender), Furbnow (a start-up retrofitting company), Energy Systems Catapult, Otaski Energy Solutions Limited, and Surrey City Council. These partnerships have now culminated into a Pilot Phase application made to advance the completion of Carbon-Adjust including securing Financial Conduct Authority (FCA) authorisation.

We can conclude that without the two pivotal decisions taken, we would have been unable to confidently put forward a Pilot Phase application. These partnerships will now be operationalised in the coming months to further the development of Carbon-Adjust. For instance, Energy Systems Catapult will in the Pilot Phase (if successfully funded) manage the stakeholder engagement onboarding up to 2,000 users for co-production purposes. Similarly, Modirect Limited, Otaski Energy Solutions, Furbnow Limited and Lendology CIC will be onboarded on Carbon-Adjust SaaS to both improve the process flow and provide guidance to homeowners on the retrofit journey.

EVIDENCE REPORT

1.0 PRODUCT INTRODUCTION

1.1 Product Information

Carbon-Adjust (see Figure 1 for flow chart) is an end-to-end one stop shop for domestic retrofit. Carbon-Adjust is the first practical platform that will see homeowners begin and end their home retrofit journey on a single account and web software. Additionally, the structure of Carbon-Adjust and its process flows facilitates greater interactions between implementing partners who need to be in constant communication while assessing and processing homeowners' applications. Carbon-Adjust facilitates and embeds these partnerships and opportunities. To ensure libertarianism[2] in its offering, Carbon-Adjust allows for homeowners to port from one aggregator to another after 2 years without impacting future carbon offsets their low-carbon energy investment generates.

[2] By libertarianism we imply a key index from the Energy Justice Framework in Sovacool and Dworkin (2015) and extend its definition to mean the ability of homeowners to within defined timelines change aggregators without hindrance or consequences.

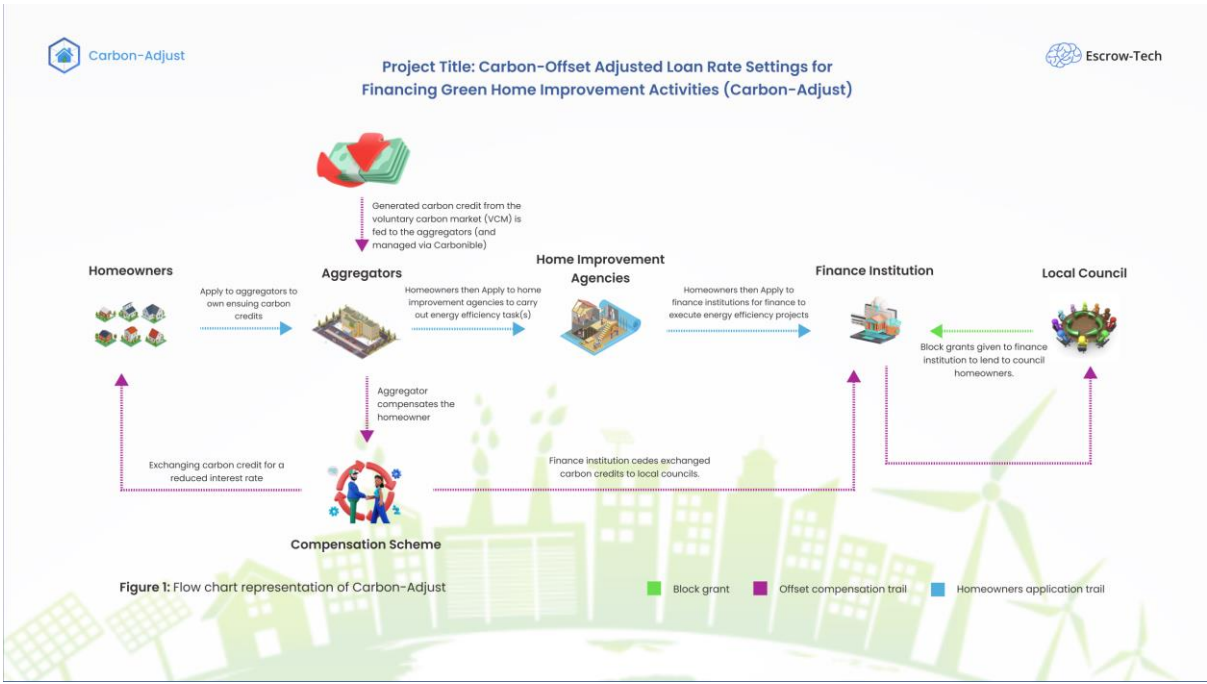

Figure 1: The Carbon-Adjust software as a service (SaaS) Flow Chart

1.2 Consumer value proposition

The value proposition of Carbon-Adjust to consumers is helping them extract and commercialise the carbon offsets of their investments in specific domestic retrofit activities. This is to be achieved through the operationalisation of carbon offsets from investments in low-carbon energy technologies like heat pumps or participation in flexibility (demand response).

1.3 Target customers

Carbon-Adjust focuses on the able-to-pay homeowners who are interested in specific retrofitting activities such as boiler upgrades, heat pump installation, and participation in demand side response (DSR) programmes. The reasons for focusing on these aspects of retrofitting are based on the following. First, is the ease of validating the offsets generated. Second, is the opportunity for homeowners to onboard select home equipment (e.g. heat pumps, dish washers, cloth washers, tumble dryer and EV chargers) for flexible dispatch. By participating in flexible dispatch, homeowners can take advantage of the arbitrage opportunities that exists from shifting demand due to the temporality of the grid's carbon intensity.

1.4 Business model

Our business model makes Carbon-Adjust free to use for all homeowners. Homeowners only pay the cost for services (costs associated with advising on retrofitting (assessors, coordinators) and processing their applications for loans) they receive from the home improvement agencies (HIAs) and the finance institutions (FIs) respectively. Other costs billed homeowners are outside of Carbon-Adjust (materials, sub-contractors and interest on loans). No direct payment is made by homeowners to aggregators as aggregators earn their income as a fraction of the operationalised carbon credits.

We charge a yearly flat fee for onboarding implementing partners and extract income through ads on the mediaspace[3] (to be hosted on Carbon-Adjust). The mediaspace is a social media plug-in platform that allows every account holder on Carbon-Adjust create video content on their experiences (for homeowners) or processes (for implementing partners). With such a unique audience, we are able to attract ads from product (e.g. heat pumps) manufacturers, and service providers (e.g. finance institutions, HIAs and aggregators) specific to home retrofit and location. Additionally, with AI, we are able to perform detailed analytics on our user base and utilise the insights gained in conducting market research for clients. Further trials are needed to validate the potential of our revenue model.

1.5 Approach to Retrofitting Advice

Our approach to the provision of retrofitting advice enabling customers to make the right product choices is a customer-centric approach and is embedded in our user design process of Carbon-Adjust. Particularly, our approach is built on the tripartite legs of: (1) qualification of the advisor, (2) the quality of the advice provided, and (3) the consumer's specific needs and circumstances. This approach has no perceived shortcomings as it ensures that homeowners are fully involved and guaranteed excellent delivery at each stage of the implementation plan.

1.6 Uniqueness of Carbon-Adjust

Carbon-Adjust's offerings are quite unique. First, Carbon-Adjust helps homeowners avoid the disruptions that traditional retrofit activities (e.g. insulation) cause. Second, Carbon-Adjust places no unnecessary requirements on homeowner's lifestyle. Homeowners continued use of heat pumps increases the offsets generated as well as their continued participation in flexible demand. Third, Carbon-Adjust provides immediate cost reduction benefits. Homeowners are guaranteed immediate cash payments or lower interest repayments on completion and validation of retrofit activity.

[3] To be licenced from Oaks Intelligence Limited

2.0 GENERAL SCOPING RESEAECH AND OTHER ACTIVITIES

2.1 Kick-off Research

Our underlying thesis on project start was that the decarbonisation of residential buildings will be better achieved using operational carbon offsets rather than physical retrofit. This was based on extensive desktop research we conducted that highlighted the issues plaguing physical retrofit activities and the difficulty in assessing and quantifying the carbon offset benefits they generate due to their susceptibility to behaviour change. Our very robust and detailed research examined the UK domestic housing statistics and distribution under sub-themes like housing ownership, energy efficiency, energy costs, cost of decarbonising, and the difficulties associated with decarbonisation.

The reason for this detailed review work was to help us hone in on our target customer base. To narrow our offering, we decided on very specific retrofit activities (boiler upgrade/heat pump installation, and participation in flexible dispatch). Considering the huge upfront costs needed in owning installations such as heat pumps, EV chargers and very efficient flexible dispatch loads, we were able to segment our market to the able to pay homeowners.

Our conviction in the specific choice and design of Carbon-Adjust's offerings was motivated by the focus of the Discovery Phase funding competition on consumers

poorly served by the existing green financing market and ineligible for support under government Help to Heat energy efficiency support schemes. Our extensive findings revealed that able-to-pay homeowners fit this segment perfectly and were desperately in need of interventions that could help them explore and exploit the benefits of improved home energy efficiency.

2.2 The Competition

Our very exhaustive and comprehensive search of potential competitors in this space has revealed only one across Europe – Arctica Partners. However, our offering differs from Arctica Partners' offering in many ways. First, Arctica Partners business model is focused on the extraction and sale of carbon credits with feedback to homeowners (i.e. homeowners spend first then get rewarded later). This differs from ours which discounts the initial loan required using the net present value of the carbon credit. Second, Arctica Partners has no software platform that engages the homeowner in the entire process of home retrofit. This means homeowners are totally excluded and thus are unable to have any sense of ownership since they have no say in how the derived carbon credits can be operationalised. Carbon-Adjust differs significantly from this as the software as a service (SaaS) platform empowers homeowners to own the process thus ensuring their inclusion in the process evolution and operationalisation of earned carbon credits.

Another differentiation in our offerings is in coverage. While Arctica Partners cover insulation (which we do not) as well as conventional home retrofit activities including boiler upgrades, heat pump installation, etc. we focus on all of their activities (excluding insulation) and include flexibility through demand response (DR). Our SaaS platform provides aggregators who can finance the installation of direct load control devices on specific appliances in homes (e.g. dishwashers, cloth washers, tumble dryers, EV Chargers, and heat pumps). These aggregators (or homeowners) can then shift the dispatch of these loads to periods of low carbon intensity without compromising on the homeowners minimum expected comfort level.

Another significant benefit of our platform is its one stop shop approach which differs from Arctica Partners manual process. Our platform has built in interoperability across implementing stakeholders ensuring that homeowners can complete their home retrofit journey from application to finance and execution via our platform. This offering simplifies the entire user experience.

2.3 Findings from our Scoping Research

As discussed above, our Discovery Phase findings indicate that interest from homeowners scaled as their potential for higher levels of participation in flexible demand increased. Particularly, homeowners installing heat pumps were more eager to participate and utilise Carbon-Adjust when provisions were made for bundling EV chargers, and energy efficient dishwashers, washing machine and tumble dryers in flexible demand.

As part of our reporting obligations, we conducted a simulation of a typical 3-bedoroom detached house with the following appliances – EV charger (11kW), dishwasher (1.2kW), washing machine (2.1kW), tumble dryer (5kW) and heat pump (11kW). The simulation involved various forms of flexible dispatch assuming direct load control (DLC) and user selecting preferential periods. Grid intensity was assumed at

265gCO2e/kWh. Overall, the results obtained showed that the household was capable of generating over 86tCO2e offsets worth £12,900 (at £150/tCO2e) in 20 years. For a typical 3-bedroom detached house, this represented a 23% reduction in energy cost. See Figures 2 and 3 detailing the carbon offset simulation and the realised monetary savings based on different carbon price scenarios.

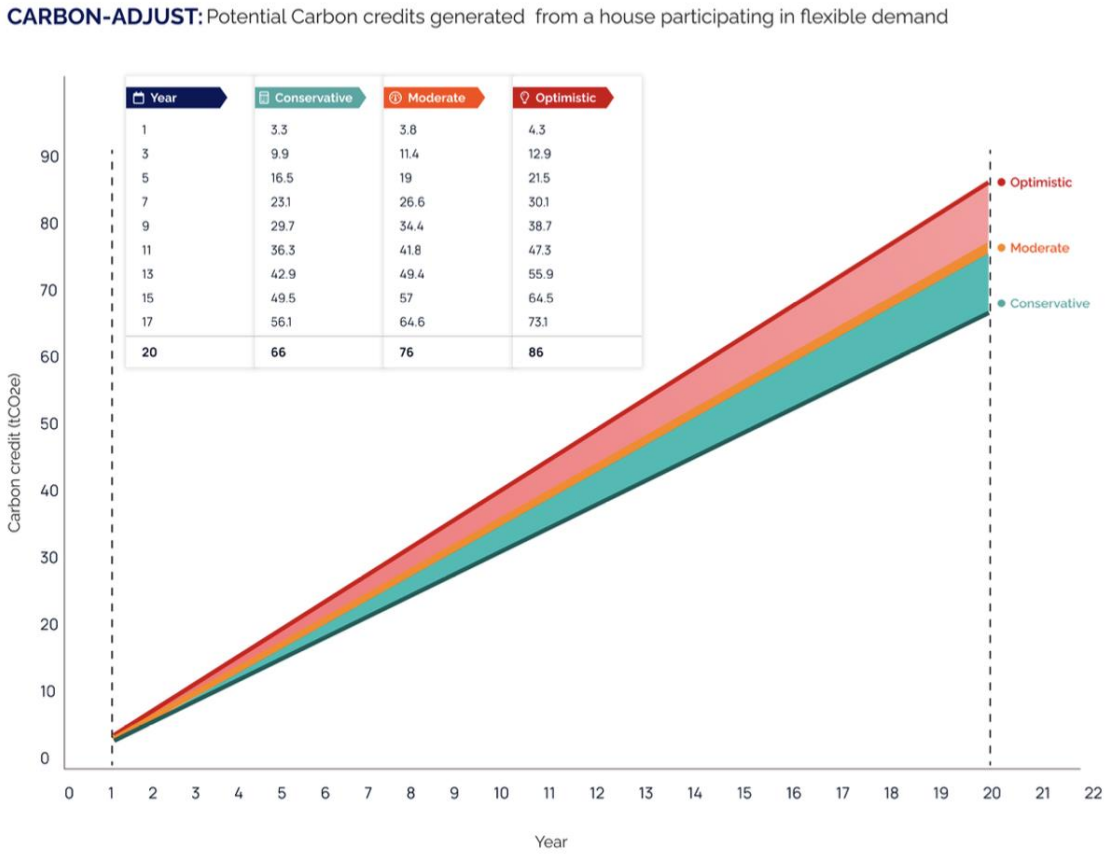

Figure 2: Carbon credit generated under different scenarios for a 3-bed detached house participating in flexible demand

CARBON-ADJUST: Potential revenue to a house participating in flexible demand.

Year	Conservative			Moderate			Optimistic		
	£70/tC02e	£100/tC02e	£150/tC02e	£70/tC02e	£100/tC02e	£150/tC02e	£70/tC02e	£100/tC02e	£150/tC02e
1	231	330	495	266	380	570	301	430	645
3	693	990	1485	798	1140	1710	903	1290	1935
5	1155	1650	2475	1330	1900	2850	1505	2150	3225
7	1617	2310	3465	1862	2660	3990	2107	3010	4515
9	2079	2970	4455	2394	3420	5130	2709	3870	5805
11	2541	3630	5445	2926	4180	6270	3311	4730	7095
13	3003	4290	6435	3458	4940	7410	3913	5590	8385
15	3465	4950	7425	3990	5700	8550	4515	6450	9675
17	3927	5610	8415	4522	6460	9690	5117	7310	10965
20	**4620**	**6600**	**9900**	**5320**	**7600**	**11400**	**6020**	**8600**	**12900**

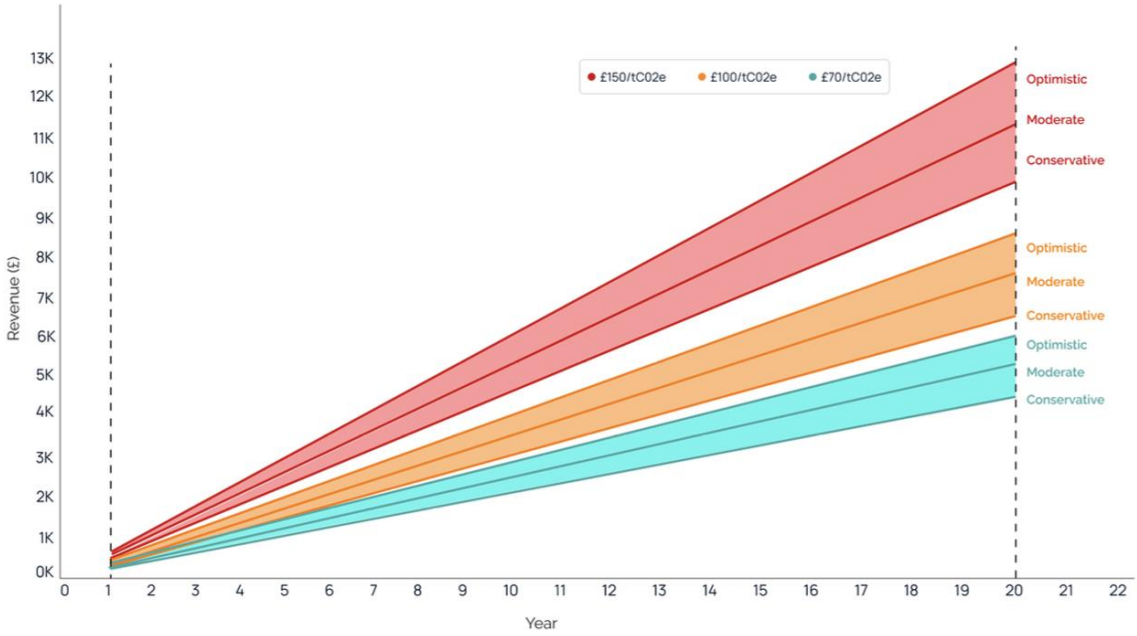

Figure 3: Potential revenue for a 3-bed detached house participating in flexible demand

Our scoping analysis of potential trigger points for homeowners taking up retrofitting highlighted the following:

1. carbon intensity of the electricity grid – We assume that if the carbon intensity of the UK grid remains elevated over 200gCO2e/kWh in the short to medium-term, our 13,022 initial target customers can averagely expect to have their yearly carbon offsets at 4tCO2e/year (+/- 10%) for a comprehensive domestic retrofit journey that includes heat pumps, and demand response. This we estimate generates 156,000tCO2e in permanent displacement over 3 years (baseline).
2. price of gas - Higher gas prices will increase adoption of heat pumps and participation in flexible markets. For each 10% rise in yearly gas bills, we assume a 5% increase in yearly adoption of heat pumps and participation in flexible markets. This implies an increase to 14,369 households (from 13,022) in three years producing 172,428tCO2e (11% increase).
3. cost of heat pumps - Lower cost of heat pumps will incentivise quicker and wider adoption. For instance, while Octopus' Cosy 6 will not be suitable for our target

clients (due to their homes being poorly insulated), we surmise that every 10% drop in heat pump prices will generate at least a 1% increase in yearly adoption.

4. government policies e.g. boiler upgrade grant scheme – For every 50% increase in government incentive, we assume a moderate 6% increase in yearly adoption due to the associated bureaucracy of accessing such grants. Overall, factors 1-4 combined will generate 196,860tCO2e from 16,405 households after 3 years, an increase of 26% in permanent carbon emissions displacement over baseline (156,000tCO2e).

2.4 Key Consumer Lessons Learnt

The overall target market for Carbon-Adjust within the UK is the residential sector covering owner occupied homes especially existing homes (pre-2011). Currently across England and Wales, there are over 26 million homes out of which 6.93 million are terraced, 6.27 million are semi-detached and 4.21 million are detached. According to the ONS[4], over 60% of owner-occupied buildings across England and Wales have Energy Performance Certificate (EPC) ratings under C which creates a huge incentive for Carbon-Adjust. Another differentiating feature of our overall customer segment is that they are either able to pay directly for home retrofit through their savings or can access loans easily since they have homes to put up as collateral. This pool of over 17 million homes creates an enormous opportunity for Carbon-Adjust since the barrier of cost has been overcome.

A deep dive into the overall owner occupied and able to pay customers leads to a further market segmentation of homes based on EPC rating, age of build, existing heating system, and energy burden of homes. The reason for this market segmentation is that while Carbon-Adjust can serve every household, our immediate focus will be on owner occupied homes with EPC ratings below C, pre-1990 built, utilising gas for heating, and with energy burdens of over 6%. Typically, this will include Georgian style houses, Victorian Terraced houses, Edwardian style houses, and the 1930/1960 semi-detached houses. Additionally, homeowners here will be middle to upper income earners, and potentially have invested in some form of low-carbon technology (e.g. EV cars). Energy bills for such houses will typically be upwards of £500 monthly and for a household with overall yearly income of £150K, their energy burden will be around 6%.

2.5 Method for factoring potential Price Fluctuations

Carbon-Adjust developed a comprehensive model that factored potential price fluctuations. Two of the main trigger points highlighted earlier included energy prices and price of carbon offsets. Both are factored into the computation of return on investment (RoI) for homeowners investing in home retrofit. As both prices rise, the payback period shrinks.

2.6 Scope for future expansion of Carbon-Adjust

The consortium while reviewing the findings from our Discovery Phase activities discovered that renters in social housing were a disenfranchised group. While Carbon-Adjust as a product is not compatible with this group of home residents, we hope to in the future explore the necessary modifications needed to target this group.

[4] Office for National Statistics (ONS), released 25 October 2022, ONS website, article, Energy efficiency of housing in England and Wales: 2022

3.0 RELATIONSHIP AND PARTNERSHIP BUILDING

3.1 Contribution of Carbon-Adjust to team knowledge base development

The Discovery Phase funding has enabled the consortium to expand its knowledge in helping homeowners reduce the cost of domestic retrofit by operationalising the carbon credits their low-carbon energy investments generate. We have also been able to expand our knowledge in understanding how to help finance institutions mitigate against forces that can lead to lower carbon prices.

For instance, through Discovery Phase funding, the consortium has been able to evidence those homeowners installing heat pumps and participating in flexible demand (being able to shift energy consumption) can generate more carbon offsets. Additionally, our development of Carbon-Adjust SaaS has helped us attract and solidify strategic partnerships that would be very useful in finalising the technical development, securing regulatory approval, and launching commercially. Such partnerships include local councils, home improvement agencies financial service providers, and stakeholder engagement partner.

3.2 Relationships built

We are pleased to have struck excellent partnerships with Lendology CiC (a local finance institution), FF Furbnow Limited (a home improvement agency), Otaski Energy Solutions Ltd (a manufacturer of bi-directional EV chargers), Energy Systems Catapult (a foremost energy research not for profit organisation), Modirect Limited (a software company), and Surrey City Council. These partnerships have been helpful in reviewing the processes and offerings of Carbon-Adjust and suggesting preliminary improvements. For instance, Otaski Energy Services Ltd was instrumental in our incorporation of flexibility into our aggregation offerings, whilst Lendology CiC offered advice in improving the user journey while applying for credit. Additionally, the support of these partners has been instrumental in the finalisation and submission of our Pilot Phase application. With these partnerships, we are on track to fully develop Carbon-Adjust, secure regulatory authorisation and commercially launch by end of Pilot Phase.

3.3 Management of knowledge sharing between partners

We have operated an open and instant dissemination process between consortium members. Updates, findings, etc. are curated and communicated with partners. This has been simplified using a shared drive platform ensuring that Discovery Phase partners can access information in real-time.

3.4 Additional identified knowledge gap for later inclusion

One additional knowledge gap we have identified has been in the area of property valuation especially when determining a loan cap for homeowners. The conventional approach does not include the use of earth observation (EO) data and the EPC rating of the house in stress testing headwind risks that can exacerbate fall in house prices beyond standard limits. We would be exploring partially how earth observation (EO) data[5] can be embedded in the credit risk assessment protocol of financial lenders to offer more robustness to their stress testing.

[5] Earth observation (EO) is the collection, analysis and presentation of data to better understand our planet. Earth observations can be taken at a local ground level or acquired from remote sensing platforms such as satellites (https://climatedetectives.esa.int/earth-observation-data/).

4.0 FINANCE PRODUCT RESEARCH

4.1 Key activities in Product Design and Development

In undertaking the design and development of Carbon-Adjust SaaS up to TRL 4 during the feasibility stage, a number of activities were undertaken. First, on project start, we conducted detailed research to understand the retrofit landscape and hone in on our target customers. For the feasibility stage, our focus was to translate our idea into an MVP and utilise that as a tool in demonstrating its potential and evidencing our capabilities to stakeholders. To achieve this, we had a series of coproduction activities with team members in evolving a user interface/user experience (UI/UX) that represented the full functioning of Carbon-Adjust. This was then followed with an intense period of web development and complimented with webinars that saw us present the ongoing development to home residents.

The completion of the MVP enabled us organise focus group sessions and trial the working of the Carbon-Adjust SaaS. Feedback from the focus group sessions was then analysed. Out of a combined audience of 35 participants (across our focus group and webinar), the software was rated by 63% of them rating the platform as excellent, while 34% rated the platform as good overall. The ease of navigating through the software platform was also evaluated, and 68% of the participants reported that the software was very easy to use and navigate, with 29% reporting that the software was easy to use and navigate. In comparison, only 3% reported some level of difficulty. We also asked the participants to indicate their interest in receiving the Carbon-Adjust newsletter to which 80% indicated willingness to subscribe to the newsletter when launched.

Beyond this, we also had targeted demonstration of Carbon-Adjust SaaS to other stakeholders like local authorities, financial institution, home improvement agencies, amongst others.

4.2 Key Finance Product related Lessons

A key lesson that has informed the design of Carbon-Adjust has been the need to introduce aggregators who can own ensuing carbon credits and based on user preference compensate them accordingly. This lesson stems from the fact that private individuals are not allowed to own carbon credits. To ensure that their voluntary investments in energy efficiency can be “rewarded”, aggregators are introduced to own these credits and compensate homeowners.

Another lesson is on the need to have buyers (off takers) ready to buy carbon credits that will be generated over the long-term. The benefit of this kind of arrangement is that they offer price stability to aggregators ensuring that they are protected from the fluctuations of carbon credits.

4.3 Alternative Finance options considered

For Carbon-Adjust, our preferred means of finance assumes the finance institution lending on behalf of a local council or local authority to homeowners within their jurisdiction. The reason for this consideration was that it allowed generated carbon credits being utilised by homeowners to reduce their loan repayments to be flipped over to offsetting the carbon footprint of local councils. This meant that lenders did not

need to hold these on their balance sheets and face potential headwind risks and book losses.

An alternative option to this would be for lenders to source for credit from the open market and lend at higher than market rates. This alternative option was rejected because of the high cost of borrowing which would lead to an aggressive under-pricing of carbon credits thus diminishing their utility for homeowners.

4.4 Key Regulatory Considerations to be addressed at the Development Stage

At the development stage of the Carbon-Adjust SaaS, there were no regulatory requirements to be met. However, as the project progresses to further development and large-scale trials, getting FCA approval becomes a key requirement. Without such approval, we would be unable to communicate or exchange protocols with lenders and local authorities who are FCA authorised and can only engage FCA authorised software. Already, we have begun preliminary engagement with the FCA to understand what services we offer and determine the right category under which we would be assessed.

5.0 ADVICE/INFORMATION RESEARCH

5.1 Approach to the provision of Retrofit Advice

Our customer-centric approach to retrofitting advice enables customers to make the right product choices for themselves. Particularly, our approach is built on the tripartite legs of: (1) qualification of the advisor, (2) the quality of the advice provided, and (3) the consumer's specific needs and circumstances.

The advice will always begin with a home visit by a qualified home PAS 2035 retrofit assessor to assess the options available to the homeowner to improve the energy efficiency of the home. Utilising modern techniques and insulation inspection, the homeowner's energy needs can be diagnosed. This will then be followed by a detailed breakdown outlining the range of improvements that can be undertaken. To complete the advice approach package, our partner home improvement agency (HIA) will provide homeowners with quotes of the various options along with a range of qualified and verified sub-contractors that can deliver each service.

Our partner HIA already has an established relationship with suggested sub-contractors to ensure that anyone selected by the homeowner delivers quality services in line with agreed upon minimum service level agreements (SLAs). An additional benefit of our advice scheme is the assessment offering that sees our partnering HIA assess homeowners to determine the range of government support schemes they qualify for.

5.2 Reason for choice of Approach

Our approach follows the waterfall methodology in that it is sequential with each stage feeding into the next. This approach has been selected because it offers homeowners consistency in the results obtained as well as a verifiable and repeatable process that allows for feedback from each completed stage into the homeowner's decision-making process. No other approach was considered.

5.3 Research Lessons on Consumers Preferences to advice and information

While our webinars and focus groups were more targeted at helping homeowners get acquainted with Carbon-Adjust, our experience gained from related research work and interviewing scores of homeowners evidences the fact that homeowners are becoming more cautious and hesitant in making energy efficiency investments. Consumers need to see consistent policy and long-term market signals from government. This helps to build and maintain trust and convince homeowners to commit to costly investments.

Another crucial learning experience for us was consumers preference for quantitative data. In evidencing the potential of Carbon-Adjust to stakeholders, they were more interested in results that showed how its contribution to reducing their energy burden, and their carbon footprint. This finding was instrumental in influencing our decision to include a carbon wallet (See Figure 4) for each homeowner that displayed how much offsets their investments were generating in real-time and the market value.

5.4 Research lessons on integrating advice/information with Carbon-Adjust

A crucial learning experience for us in demonstrating Carbon-Adjust and its potential to stakeholders is consumers wish to be made aware in real-time of how much carbon

credits they generate and the potential market value (see Figure 4). Reasons advanced for this bordered on the need to compare the value of compensation offered to them by their preferred aggregator and determine if there were other aggregators offering better deals. Another reason was that access to such data had the potential of incentivising more positive behaviour from them that could lead to the generation of more carbon offsets. This reason finds support in Iwafune et al (2017)[6] where households provided with their energy reports achieved a 3.4% reduction in energy consumption compared to the previous year. In our opinion, households when presented with this data become intentional in surpassing previous records.

These reasons were thus very instrumental in influencing our design of Carbon-Adjust, especially the introduction of a carbon wallet for every homeowner to visualise in real-time their generated offsets and market value. With regards to advice, we ensured that at the minimum homeowners had some clarity in articulating their demands and getting signposted to government websites that showed them what they qualified for.

5.5 Building our own bespoke advice platform or signposting to existing services

In offering advice to homeowners, we adopt a hybrid approach. For advice on the latest government initiatives and how to access them, homeowners will be signposted to the GOV.UK energy advice tool. However, for advice on the design of a retrofit plan for their houses, our partner HIA is well staffed with PAS 2035 qualified assessors to offer homeowners the best advice in deciding what options to access that meet with the objectives of the homeowners.

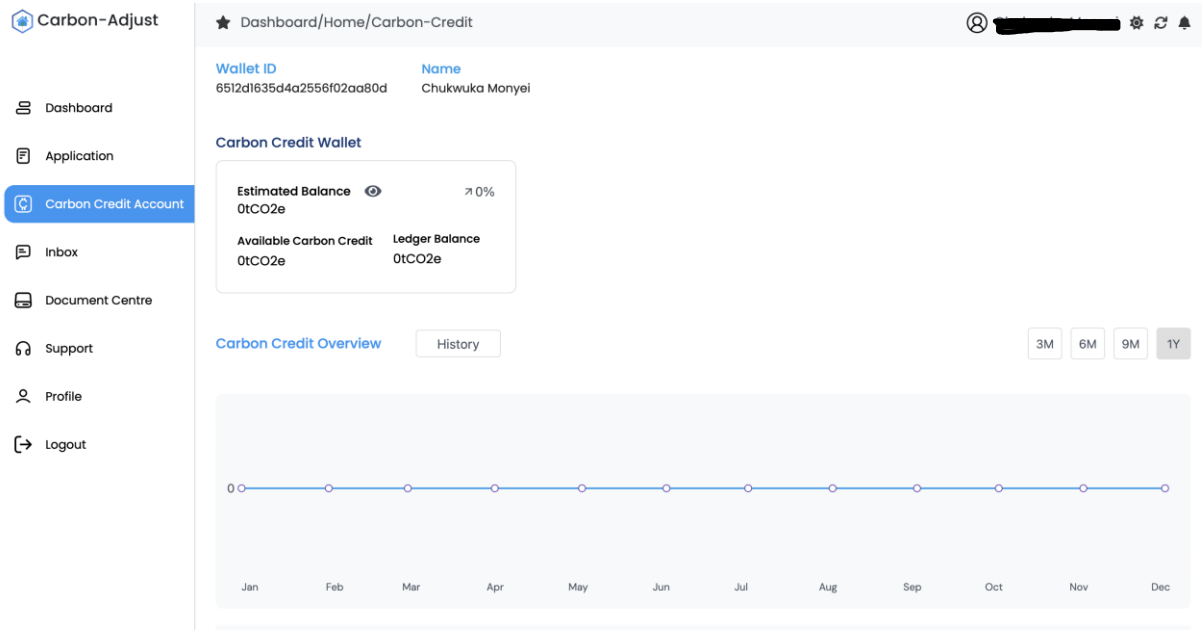

Figure 4: Homeowner carbon credit wallet account

[6] Iwafune, Y., Mori, Y., Kawai, T. and Yagita, Y. (2017), Energy-saving effect of automatic home energy report utilizing home energy management system data in Japan, Energy, 125, Pages 382-392, ISSN 0360-5442

6.0 VERIFICATION METHODOLOGY RESEARCH

6.1 Approach to Verification and Quality Assurance of Retrofit Installation

Our installation verification methodology is an agile approach which will involve a variety of methods to conduct real-time Quality Assurance of retrofitting activities implemented by associated sub-contractors to Furbnow. These include a blend of onsite and desktop audits. Furbnow along with aggregators (Modirect and Otaski) work in collaboration with the platform administrator in an agile manner to ensure that:

1. All participating sub-contractors are either TRUSTMARK registered or have compliance and staff competence levels at the levels expected by TRUSTMARK.
2. Completion of any phase of retrofitting work/activity is signed off by a qualified retrofit coordinator.
3. All completed retrofitting tasks are in line with PAS 2035 methodologies.
4. Strict quality control measures are followed during installation to ensure work is performed correctly.
5. Detailed records of all installation work including photographs, diagrams, and compliance documents are kept secure and tagged to each homeowner's account.
6. All required performance tests (e.g., blower door tests) are conducted and results documented.
7. There is an independent inspection or assessment of the completed installation to verify compliance with PAS 2035 standards.
8. There is a system for monitoring the post-retrofit energy performance of the property to ensure that it meets expected efficiency levels. Also important in our design process is a feedback mechanism that allows the homeowner to provide feedback on the quality of work and its delivery especially compared to pre-retrofit conditions.

6.2 Reason for choice of Retrofit Verification and Quality Assurance Approach

This approach was designed to specifically address the issue of benchmarking the delivery of subcontractors. To ensure we can achieve over 96% of measured retrofit offsets when compared to pre-retrofit projections, our verification process allows us to evaluate in-situ the quality of work being done to identify variations early on and provide adequate and appropriate mitigation. No other approaches were considered.

6.3 Research Evidence that informed Retrofit Design

In delivering Carbon-Adjust, we were very careful of avoiding the subjectivity that characterised assessing retrofit activities such as cavity wall and loft insulations. Our focus was on select retrofit activities that could easily have their carbon offset potentials validated with methods that were objective and reproducible. Additionally, we were also wary of retrofitting activities that depended on very complex supply chains and that had excessive exposure to risk factors we could not mitigate. These informed our design choices for verification and quality assurance methodologies adopted.

6.4 Research findings on the Integration of Verification Services/Activities

Our research has shown that homeowners are more aligned to a one stop solution that caters to their retrofit journey and provides them with a validation portal that ensures they can seek further clarification from sub-contractors before signing off on an aspect of a retrofit journey. We find that elderly homeowners want to have a sense of ownership of the retrofit journey as it “empowers” them to be better communicators especially among their peers.

6.5 Steps to minimise the risk of fraud/mischief

On completion of the Discovery Phase of Carbon-Adjust, our risk assessment shows that the risk of fraud/mischief by homeowners or installers is quite low due to the multiple checks and cross verification protocol we adopt. We also find that our focus on very specific sets of retrofit activities allow for remote monitoring. Overall, our approach to verification of retrofit activity and ability to remotely access and monitor installation utilisation are capable of minimising the risk of fraud/mischief.

7.0 MARKETING RELATED RESEARCH

7.1 Discovery Phase Research findings related to Consumer Marketing Preferences

During the Discovery Phase project, our primary focus was on getting an MVP of Carbon-Adjust and exploring the market reaction to it. There was no investigation into consumer preferences for this phase. However, further development of Carbon-Adjust will utilise a mediaspace plug-in[7] that allows us to embed a social media platform within the software. This allows all registered users on Carbon-Adjust to create content documenting their experience or process or product/service offered. Registered account holders on Carbon-Adjust who have indicated interest in receiving our Newsletter and/or commercial ads will get our periodic Newsletter and targeted ads both on the mediaspace and via their communication preference.

[7] To be licenced from Oaks Intelligence Limited

8.0 FUTURE PLANS FOR GREEN HOME FINANCE

8.1 Impact of Discovery Phase Lessons on further Development of Carbon-Adjust

The Discovery Phase has enabled us to fine tune the development of Carbon-Adjust. Particularly, we have been able to understand the basic homeowner retrofit experience and journey and provide a seamless process flow in the form of Carbon-Adjust. Additionally, we have been able to embed into this process aggregators as well as create a parallel carbon credit management platform called Carbonible ensuring that generated carbon credits can be fully operationalised.

These lessons have also been instrumental in helping us secure excellent partnerships and will now provide the foundations upon which subsequent development in the Pilot Phase (if successful) will be built on.

8.2 Application of Discovery Phase lessons in future development of green home finance products or services

As the project lead on Carbon-Adjust, one of our takeaways from the Discovery Phase is that adopting agile methodology to get software products to MVP level is the best option to get traction from stakeholders. Potential partners are able to trial the MVP and make useful inputs with end users able to validate if the process flow makes sense early on.

An MVP from our Discovery Phase experience offers better value than a UI/UX design on Figma as technical issues that may arise can be detected very early in the development phase and appropriately mitigated. Another important lesson is the need to have in place off takers in the value chain. This ensures that on product launch, end users are guaranteed certainty with regards to potential sale and at a guaranteed price. These lessons will help us advance our associated green finance products.

A major commercial learning for the consortium has been an exposure to the gaps that exist in the domestic retrofit space. Furthermore, we have been able to evolve a very agile pathway that can enable us to develop and bring to TRL 4 an MVP for software solutions within 3 months. These lessons will be deployed in advancing the development of Carbon-Adjust beyond the Discovery Phase, as well as modifying Carbon-Adjust to develop suitable products for renters in social housing.

8.3 Key challenges or barriers to the Future Development of Carbon-Adjust

For the consortium, the key barriers are access to cheap finance and uncertainties around future government policies. The knowledge required to build highly technical green finance software solutions like Carbon-Adjust that require digital technologies like artificial intelligence, and incorporate other technologies like earth observation data and climate risk modelling is quite expensive. Being able to access intervention funds like the GHFA Discovery Phase funding can ease the development of products like Carbon-Adjust.

Beyond finance, there is also the need for stability in government policies. When businesses invest in the development of products, they make such commitments expecting some level of stability in government policies in the short to medium-term. Uncertainties around stability of government policies can limit the risk appetite of

investors which makes the UK uncompetitive in attracting ambitious and transformative initiatives.

9.0 APPENDIX

9.1 Credits

Write up: Chukwuka Monyei, Ph.D.

9.2 For Citation Purposes

Escrow-Tech Limited (2023). Carbon-Adjust: Carbon-Offset Adjusted Loan Rate Settings for Financing Green Home Improvement Activities. Green Home Finance Accelerator Discovery Phase Report.

Thank You

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