

EcRoFit

A summative evaluation for
Birmingham City University
Final Report, July 2023

Trihelica



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PAUL JEFFREY ASSOCIATES

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Executive Summary

1 Project Context

1.1 Project objectives

Housing accounts for some 40% of carbon emissions and poses a major challenge to the UK's net zero targets. EcRoFit sought to improve the quality and accuracy of energy assessment, particularly in the context of housing retrofit as well as new homes, by providing improved tools for assessors to use and by raising awareness, knowledge and understanding among assessors and users of energy assessment. It sought to draw on AI and machine learning expertise and to apply these to the simulation of the energy performance of homes.

1.2 Economic and policy context at the time the project was designed

The project context as set out in the logic model reflected a major regional housing need coupled with an imperative to improve the energy performance of new and existing housing stock and a requirement for knowledge development associated with energy assessment and its application through a 'relatively easy to use' tool. Both national and regional and national policy have recognised the importance of energy consumption, though this aim was not well supported by the regulatory structure at the time or by the tools and techniques available for measurement.

1.3 Market failure

Market failures have arisen from a combination of high costs of developing new and more accurate measurements - than current generic tools such as SAP - and a lack of regulatory pressure to promote and enforce the development and use of more effective tools that will have a greater impact on the reduction of carbon emissions.

1.4 Project design

The project design was ambitious but sound, and the delivery approach appropriate in that it combined rigorous work on modelling and assessment – as the basis for better tools – with outreach to the assessor/user community through information sharing, awareness raising and demonstration via practical collaborative projects. Targets were also ambitious but, in the context of circumstances when the project was conceived, realistic.

1.5 Impact of the changing context

Since then, the need for a project such as this has radically increased. The current context is one of massively increased energy costs, major concerns over energy security partly for geopolitical reasons, and strong policy pressures to reduce energy use and greenhouse gas generation both at national and at regional level. UK policy priorities in respect of energy consumption are reflected in policy papers including the 'Powering up Britain'¹ policy papers and at regional level the WMCA has identified Clean Teach as one of 2 innovation priorities.

1.6 Expectations of delivery

Delivery was compromised by the COVID-19 pandemic and lockdowns, and only by the end of 2022 was it possible to ramp up delivery to overcome the impacts of the pandemic by which time there was a limited

¹ <https://www.gov.uk/government/publications/powering-up-britain>

period to deliver the project to its targets. The project team used this period to advantage and made up considerable ground in the last six months (January-June 2023) to achieve output targets (see below)

2. Project Progress

2.1 Delivery against spend and outputs

The most upto date records (June 2023) show project spend of £1,287,405 against the budget of £1,434,173.

Two sets of outputs serve as indicators of project progress and achievement: business support in the form of completion of CPD workshops by eligible firms (target 80 C1 outputs) and the completion of collaborative applied research projects involving eligible businesses (target 10 C26 outputs) The project has achieved some 90% of the former, and 120% of the latter, as at the end of the project. This only proved possible as a result of strenuous efforts by the project team in early to mid 2023, which enabled the team to make up a significant proportion of the ground previously lost as a consequence of several factors.

2.2 Factors explaining performance

These were:

- Principally and obviously, the COVID-19 pandemic – resulting in very limited ability to progress or engage with users during lockdown, absence of staff, a shift in attention by assessors, users and other from energy efficiency and innovation to survival, and overall social and economic disruption.
- The temporary indisposition and unavailability of the project manager.
- Loss of a key software developer and difficulty in their replacement. Some difficulty was inevitable given the demand for, and cost of, people with the requisite skills; but this was significantly exacerbated by slow University approval, recruitment and appointment processes.
- Delays in procurement of a software licence, again a result in part of university procurement. These delays, and the consequences in compromising timely project delivery, and were not conducive to the fast delivery required by time expired projects.

2.3 Achievement of output targets

The project is on target to achieve and exceed its C26 targets (12 against 10). There will be a shortfall against C1 targets (70 against 80) but we understand this falls within the tolerance level set by the GDT on the basis of C1 outputs also hitting targets in respect of sector relevance and geography (at least 60% from or operating in the GBSLEP area) as set out in the offer letter and clarified in the email of Anna Vinsen (Head of the Midlands Programme Delivery Team) of 6th April 2023.

3 Project delivery and management

3.1 Management and governance structures

A more proactive and visible approach to project management would have avoided a lack of clarity as to the responsibilities of project contributors and a lack of urgency in chasing up actions. Delegation was insufficient to cope with the combination of project delays and the indisposition of the project manager.

That the PI had management responsibilities for members of the team – based on the organogram – that might normally be managed by a project manager was not an effective arrangement.

Insufficient use was made of the Industrial Advisory Board (IAB) and the expertise and experience of its members. Greater consultation during the planning and scoping stage of the project would have brought about a better focus on user needs, while linkages to other built environment work at BCU and elsewhere could have been more fully utilised.

The delivery of outputs was severely affected by the factors noted above, some – but not all – outside the control of the University. Wisely, the team responded to delays to development of the iRet energy assessment tool by a change in approach to business support, in the form of the creation of CPD workshops. Overall, and with additional resources, project delivery was much improved in the final six months.

3.2 Improvements to project delivery

Delivery could have been improved by more systematic marketing of the CPD workshops earlier in the project. When implemented in the later stages, this brought about a marked improvement and by the final months of the project, interest greatly exceeded the number of places available.

3.3 Procedures in place to ensure the project focused on the right beneficiaries

CPD provision focused correctly on practitioners and users of energy assessment, providing valuable insights into the potential of AI and machine learning. The iRet tool, once available in a sufficiently user-friendly form, would meet a market need and offer a means of conducting assessments complementary to the Standard Assessment Procedure. The Smart Sketcher tool for 3D visualisation is a valuable complement to iRet as well as allowing use independently.

Feedback from participants in CPD workshops, and from firms engaged in collaborative projects, was positive and encouraging. Excellent relationships between industrial and academic participants were developed and consolidated. For one company the data obtained were so significant that they would feed into the company's forward strategy for development and use of modern methods of construction (MMC).

3.4 The perceptions of beneficiaries?

Evidence has been drawn from the CPD feedback forms, an online survey of CPD participants and case studies of five of the C26 collaborations. The general feedback has been very positive on all accounts and both in terms of the delivery of C1 and C26 support and the benefits arising. Although it is early to claim too much in respect of the application of new knowledge there is qualitative evidence from participating businesses of improved profitability and access to new markets.

3.5 The application of horizontal principles

No major issues have been reported in respect of equal opportunities. In respect of sustainability the entire EcRoFit project is devised in the context of environmental sustainability.

4 Project Outcomes and Impact

4.1 Progress against the outcomes and impacts set out in the logic model

Inevitably for a project of this nature, the major benefits are likely to accrue in future phases of activity in the medium to longer term after conclusion of the project itself. Benefits perceived are more about anticipating the future of energy assessment and having an early awareness of the role of sophisticated data analytics than about tools and techniques for short term application.

That said, the strong business interest and the positive reactions from beneficiaries point to future impacts in respect of logic model outcomes. These focus on long term GHG reduction, increased market demand for GHG reduction interventions, and the growth of a more competitive, resilient, innovative and technically capable business base to advise upon and implement the necessary measures – leading in turn to a stronger and upskilled construction sector in the region.

4.2 Changes in outcomes and impacts attributable to the project

The full impact of EcRoFit and the iRet tool in particular is likely to be evidenced after the ERDF period. In fairness to the project designers the approach taken to tool development was deliberately cautious with the planned activity to 'develop, test and validate existing building simulation and optimisation software (iRet)'.

The project has achieved minimum viable product (MVP) with iRet but not to the stage of being fully available for practitioner use. (by the end of the project the iRet software is available through an open source license) The project design did not make claims for employment or GVA impacts at the time of the application, nor GHG reduction at this stage.

4.3 Gross and net additional economic, environmental and social benefits of the project

There is insufficient evidence to quantify net benefits. From the survey two businesses attending CPD workshops reported an improvement in profitability and two stated that they were accessing new markets (from 16 responses). The industry-business collaborations have the potential to deliver significant impacts but that will take time to manifest.

There was a high level of interest in CPD workshops from businesses within and outside the GBSLEP area, a promising indicator of the potential for future business and employment growth in the field of energy assessment. The iRet tool one fully developed and 'rolled out' has the potential to make a significant contribution to GHG reduction. In one of the industry-business collaborations new evidence of the superior environmental performance of timber framed housing (over steel) could make a dramatic impact if adopted by the construction sector. In another collaboration the development of a portal to provide independently assessed thermal junction details that comply with part I of the building regulations, has been accelerated and improved².

4.4 Quantification of benefits in a statistically robust way

There is limited data on impacts and that would be expected given the time lag between business engagement and support activity, university-business collaborations and evidence of net additional benefits. The evidence at this stage is therefore largely qualitative and partial.

4.5 Contribution to ERDF result indicators

The potential impact on GHG targets would follow the full development and adoption of the iRet tool by the energy assessment sector. That will depend in part on changes in regulation that encourage the use of bespoke and more accurate measurement tools than standard generic tools.

For the construction sector the project has identified AI pathways specific to the sector, developed potential further CPD provision, and by raising awareness with a 'window on the future' enhanced the prospects of regional construction and other businesses being among early adopters of AI innovations for economic benefit. Regionally, in addition to improving skills in energy assessment and construction, the project contributes to increasing digital skills in general – a significant need both in the West Midlands and on a UK level.

4.6 Strategic Added Value

EcRoFit was the winner of the West Midlands Tech Award 2022, marking recognition by the region's fast-growing tech sector, with potential to "bring more digital players in the built environment sector, which is far behind compared to other sectors such as finance." Academic impact is already evident, with one paper already submitted and six more in progress. The ability of BCU and regional SMEs to collaborate has been enhanced, further aided by the STEAMHouse facility. The CPD workshop provides an insight into the power of data analytics and AI. For BCU it has created opportunities to drive uptake of AI across non-STEM disciplines, including for business school students: it has also laid a foundation for strong CPD offerings for business and industry. Moreover, EcRoFit contributes to the evolution of a regional, indeed national, centre of excellence in the built environment with particular emphasis on housing, in the form of the Centre for Future Homes.

² See www.recognisedconstructiondetails.co.uk

5 Project Value for Money

BCU has calculated VFM for the project showing that for the C1 and C26 outputs VFM forecasts have largely been met. This is as follows:

- C1 – average cost per output £2,099 (forecast £1,706)
Note: If the 105 businesses, who applied for the CPD had completed the business assist, that value would have been £1,160.
- C26 – average cost per output is £13,099 (forecast £13,087)
- iRet tool development – actual £126,626 (forecast £331,227) – due to additional software outputs
- Marketing and dissemination – actual £103,499 (forecast £127,565)

6 Conclusions and Lessons Learned

6.1 General lessons

- EcRoFit was a well-intentioned project, rightly targeted on energy assessors and allied users. It was aligned closely with national and regional priorities, under the overarching need to accelerate progress towards net zero in the built environment. It also sought to bring together digital expertise, which in the West Midlands is both strong and fast growing, with a sector hitherto lagging in application of digital and AI techniques.
- The project was timely and relevant at the outset: given the change in climate in regard to energy costs and energy security since then, it is now immeasurably more so given the climate change crisis and the energy supply and security issues exacerbated by the war in Ukraine.
- However, progress was handicapped both by external factors neither entirely predictable nor controllable – the consequences of the pandemic – and by factors that could be addressed in future projects. These include staff changes, delays in recruitment and procurement and a slow start to uptake of project activities by beneficiary firms. Greater clarity as to responsibilities of contributors (including a greater role for built environment academics alongside computer scientists), and more proactive project management, could have mitigated some, but not all of the factors noted above.
- There does not appear to have been a strong relationship with the Growth Delivery Team and interactions have focused on outputs and finances. A more regular series of exchanges might have improved progress at critical times in the project.
- In hindsight, this was a research and development project rather than applied technology and therefore was probably better suited to Innovate UK funding than to ERDF. To some extent, the pressure to chase outputs came at the expense of some of the original aims.
- That said, the potential for future impact and for further research, development and application, building on the foundation of EcRoFit is considerable. Experience suggests significant appetite for participation by industry including, importantly, SMEs. The project would be a good candidate for future national and/or regional funding.
- There is considerable potential to build on the EcRoFit CPD experience to develop further education and training material for BCU degree workshops across a range of disciplines and for CPD provision for industry. This can directly help to address a widespread digital skills shortage.
- Key to a further phase of the project is the progression of the iRet tool. This needs further investment and development, and a forward plan should be developed to maximise the potential both of iRet and of the overall EcRoFit project.

6.2 Specific lessons for Grant Recipient/ project delivery body

- For future projects, the alignment between the expertise of academic staff involved and the needs of the project should be more fully explored. The project would have benefited from more involvement of experts in the built environment as distinct from experts in advanced AI.
- The procurement and recruitment processes used, while typical for a large and complex university, are far too protracted for a project such as this where time is critical. The grant recipient should put in place

faster, while still robust, processes such that (for example) approval to recruit rests with the project director provided that budget constraints are met.

- The introduction of the Cyber Essentials IT security standard is a cause of serious problems where communication to and from outside the university network is required, even where this communication is with team members and key collaborators. To avoid continuing wastage of time and hence cost, modified cybersecurity measures must ensure that such communication remains straightforward and efficient.
- Undue restrictions that prevent project team members from drawing on the expertise and experience of administrative colleagues within the university should be removed.

6.3 Specific lessons for those designing and implementing similar interventions

- There should be more engagement activity with relevant firms and individual assessors in the very early stages of such a project: industry, especially SME, interest should be encouraged by early and energetic marketing activity.
- A cross-faculty or cross-discipline scoping exercise at the outset of a project such as EcRoFit can help to avoid duplication, securing multi-disciplinary input and maximising internal impact.
- Strong, proactive, highly visible project leadership and management are essential where contributors are many but where most allocate only a small fraction of time to the project.
- For projects developing open-source innovation the dissemination of results to a wider audience is important. BCU should prepare a forward plan showing how the work will be carried forward.

6.4 Specific lessons for policymakers

- Further R&D and outreach should be designed and funded in order to encourage application of advanced digital, AI and machine learning techniques to the built environment.
- Changes to regulations, in order to drive the use of improved or more accurate energy assessment techniques would increase the uptake of the learning from the EcRoFit project.
- Measures to facilitate engagement of academics with SMEs are key. In this case, the presence of STEAMHouse proved a valuable mechanism to this end.

6.5 Other specific lessons

- Companies in the built environment should engage actively with the 'tech sector' on a regional level, with a view to taking advantage of digital methods to improve energy assessment and performance, and building design.
- Increased industry involvement in the scoping and planning of built environment research should be encouraged, so that it can be aligned with emerging needs and realistic, though ambitious, expectations can be set.

1 Introduction and project context

1.1 Objectives of EcRoFit

The **objectives** of the EcRoFit project (see Box 1) were to improve the quality and accuracy of energy assessment, particularly in the context of housing retrofit, by providing improved tools for assessors to use and by promoting their use among assessors and users of energy assessment. It has evolved to draw on AI and machine learning expertise and apply these to tool development. In parallel, the project has sought to raise awareness and understanding of AI-enabled energy assessment among relevant firms and practitioners, and to increase appetite to make use of novel tools through a combination of continuing professional development (CPD) workshops and a set of short-term R&D projects.

At the heart of the project was the development of new, user-friendly, energy assessment software – the iRet tool (see Box 2) - to be piloted with a view for wider application in the building sector. Training in the tool was built into the project but given the delays in the development of iRet (detailed below) there was a conscious uncoupling of the C1 and C26 outputs (see Box 3).

Box 1- Original Ecrofit Objectives

PO 1: To provide a new type of energy assessment software (iRet) that incorporates the use of building simulation and multi-objective optimisation with the following innovation and benefits.

PO 2: To improve energy assessments, retrofit plans and implementation, and new building design in Greater Birmingham and Solihull Local Enterprise Partnership (GBSLEP) and beyond, through 80 business assists (C1) and research collaborations with 10 eligible industry partners (C26).

Box 2 - iRet

New software designed to produce a bespoke and more accurate assessment of energy, free and easy to use (it is designed to be accessed via a tablet or smart phone). The aim is to add functionality to the industry's standard assessment procedure and to broaden usage to non-experts, while offering both energy assessment and recommendations for retrofit packages. iRet was to be tested on a number of houses installed with sensors to capture temperature, lighting, humidity and energy as part of the validation process. Delays in the development of iRet (summarised below) have meant that by the end of the ERDF project (June 2023) iRet will have reached the minimum viable product (MVP) stage but will require further development, testing and accreditation before it can be used extensively. The project team is looking at alternative funding options for the next stage of development including opportunities within the university (e.g. an AI Pathways module with the Business School).

Box 3 - Original EcRoFit Delivery Targets

EcRoFit will develop an online tool (iRet app and portal) that supports building assessments and recommendations for energy efficiency interventions in retrofit or design. It aims to familiarise companies with the software tool and encourage in building energy efficiency through:

Free training, provided to 80 companies to better understand, and design or recommend energy efficiency measures for buildings (C1 outputs).

Research projects will be developed between 10 companies and BCU academics (C26 outputs).

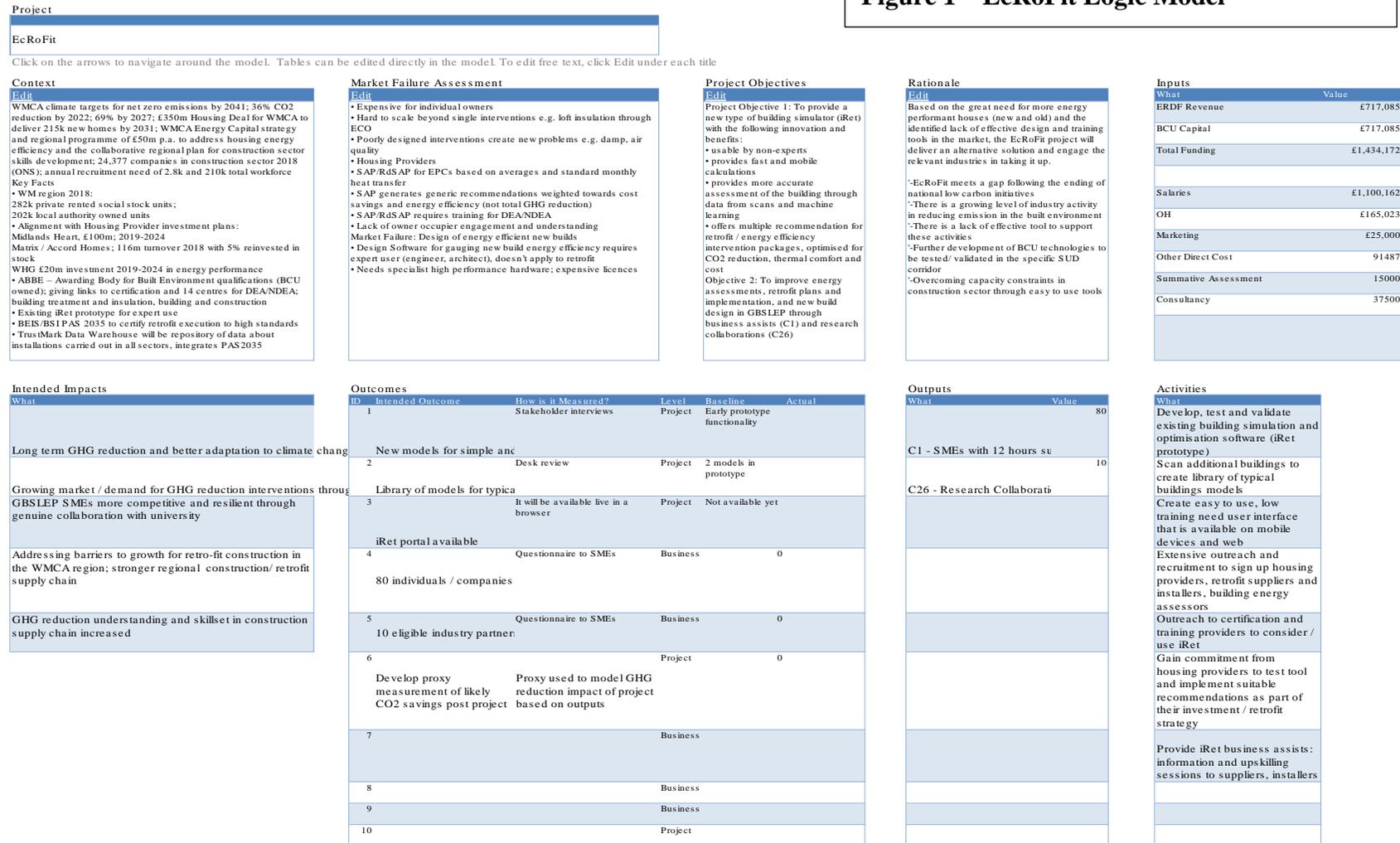
Online iRet portal will be available to participating companies during the project and made available post project to a wider audience.

Develop proxy measurement of likely CO2 savings linked to the adoption of the iRet tool by companies.

1.2 Logic Model

With the objectives noted above, EcRoFit falls under Priority Axis 4 of the ERDF – supporting the shift towards a low carbon economy in all sectors, and the logic model reflects that overall aim. The EcRoFit logic model envisaged the impacts tabulated below:

Figure 1 – EcRoFit Logic Model



Source: ERDF application, project reference 12R19A03429

Market failures arose from a combination of high costs and lack of understanding on the part of owner occupiers, along with the limited capability of existing assessment techniques (e.g. SAP indicating cost savings through energy efficiency, but not overall greenhouse gas reductions). The twin objectives of the project were an appropriate response to these concerns.

In addition, developing new software can be prohibitively expensive and unless legislation demands more accurate measurements there is limited incentive to use new tools. That was the case at the start of the ERDF project and remains so at the end. However, given the commitments of government to Net Zero and the need to tackle the existing housing stock³ through retrofit improvements, the imperative for effective and relatively cost-effective and easy to use tools will increase (the policy context detailed below).

The project has pointed to the skills deficit in AI – greater than the general digital skills deficit - and the need to democratize AI so that it can be applied by non-experts. However, this was not anticipated at the time of the logic model.

The **project design** was ambitious but sound, and the delivery approach appropriate in that it combined rigorous work on modelling and assessment – as the basis for better tools – with outreach to the assessor/user community through information sharing, awareness raising and demonstration via a number of practical collaborative projects. Targets were similarly ambitious but, in the context of circumstances when the project was conceived, realistic. However, delivery was inevitably compromised by the COVID-19 pandemic and lockdowns, and only in late 2022 was it possible to ramp up delivery to overcome the impacts of the pandemic.

1.3 National context

The UK's commitment to Net Zero by 2050 forms the backdrop to the project. In the UK, with some of the least energy efficient housing in Europe, reducing energy usage is a particularly pressing concern. The Committee on Climate Change reported some six years ago that 40% of UK emissions come from households. Achieving Net Zero therefore demands a significant reduction in the emissions from this source. New build to high standards – including for example, PassivHaus⁴ standards – is essential but since existing housing stock will be in use for many years, the need for retrofit is inescapable. For it to be effective, the availability of accurate tools for assessment of energy consumption and of the impact on energy use of diverse improvement measures is a key requirement. Moreover, the tools must be in a form that can be readily and competently used by energy assessors, without requiring very extensive training. We understand that there is an appetite in industry for tools to complement or provide alternatives to the Standard Assessment Procedure (SAP) calculators. SAP is the methodology used by the government to assess and compare the energy and environmental performance of dwellings⁵, currently managed by BRE Group and licensed to companies offering assessment, such as Stroma and Elmhurst (two companies that have recently merged).

Moreover, since the outset of the project and for obvious reasons, the importance of energy efficiency and energy costs has greatly increased. The context is now one of massively increased energy costs, major concerns over energy security partly for geopolitical reasons (Russia/Ukraine),

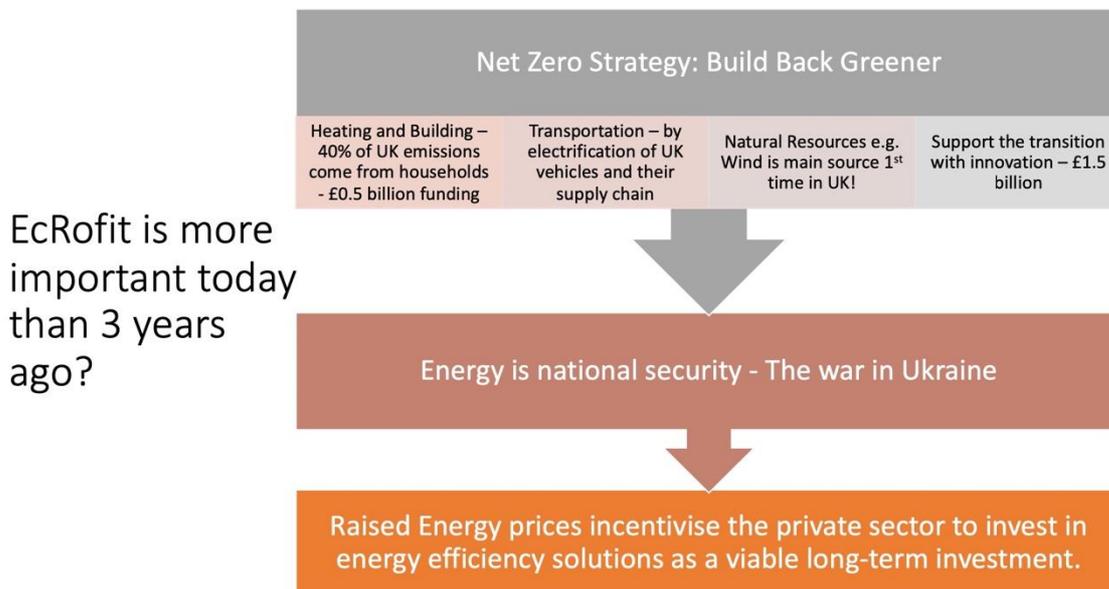
³ In the ERDF application BCU cited 484,000 housing units in the private and public rented sector in the region (WM region, 2018)

⁴ https://www.passivhaustrust.org.uk/what_is_passivhaus.php

⁵ <https://www.gov.uk/guidance/standard-assessment-procedure>

and strong policy pressures to reduce energy use and GHG generation both at national (as reflected in the recent 'Powering Up Britain' policy papers⁶) and regional level.

Figure 2 – EcRoFit Rationale (courtesy of Dr Shadi Bassura)



1.4 Regional context

The West Midlands is a region with a major housing need, coupled with a strong desire to improve the energy performance of existing housing stock and a requirement for skills development associated with energy assessment. These issues have been recognised by the West Midlands Combined Authority, which has selected Cleantech, along with Healthtech, as one of the two priority areas in which it wishes to back innovation and business growth. Digitally enabled tools for energy assessment thus fit squarely with a regional innovation priority⁷.

The local authority with the largest housing stock in the country, Birmingham City Council, also recognises the importance of retrofit, and in 2022 announced a £27m programme to retrofit 300 properties, using the programme to test approaches to improve thermal efficiency, reduce carbon emissions, provide energy savings for tenants and address fuel poverty.

“BCC’s housing stock is a large net contributor to the city’s carbon emissions, accounting for 26% of the city’s total. Tackling these heat emissions and achieving a ‘net zero’ position is key to us achieving our route to zero commitment. We need to improve the thermal efficiency of our housing stock to reduce carbon emissions, reduce energy bills, address fuel poverty and support a just transition to a zero carbon city”.

Councillor Sharon Thompson, Cabinet Member for Housing & Homelessness, Birmingham City Council

⁶ See <https://www.gov.uk/government/publications/powering-up-britain>

⁷ WMCA set climate targets for 2014 with a 36% reduction in CO2 as a key target.

Housing developer Midland Heart's 'Project 80' programme, in conjunction with BCU, is a timely demonstrator for improved standards of energy efficiency. Houses on two development sites are designed to achieve 80% reduction of energy consumption in use compared to typical previous performance, and to meet 2025 building standards. Two EcRoFit projects utilise Project 80 properties for research, in conjunction with companies.

1.5 This evaluation

This report presents the summative evaluation of the EcRoFit project as required under ERDF rules. It is designed to supplement the summary information provided in a spreadsheet to the managing authority, and to provide guidance and recommendations to the project partners and others wishing to design and implement similar programmes. Importantly, it provides observations and recommendations as to how the achievements of the project might be built upon in the future to support retrofit practitioners and academic researchers.

Box 4 - Method Statement

The summative assessment was undertaken by independent evaluators, Paul Jeffrey Associates. The assessment has been undertaken in close collaboration with Birmingham City University (BCU) through regular meetings who have also provided the monitoring data that informs this report, In addition:

A report to BCU on suggested steps to improve project performance was completed in December 2022 (**Annex A** – sets out the recommendations of that report as written at the time).

Interviews have been conducted with selected stakeholders and five completed C26 industry-BCU collaborations from the perspective of the academics and beneficiary businesses.

Survey Monkey was used to collect perceptions from beneficiaries of the continuing professional development (CPD) workshops that have been used to count C1 outputs. A summary of the survey results is included as **Annex B**.

Background research on the project context including the latest developments and legislation concerning the energy efficiency of the housing stock.

Attendance at the Ecrofit event hosted by BCU on 12th May, 2023.

Workshop participation with the overall project management team and with the CPD team on 1st June, 2023.

2 Activities and outputs – project progress

2.1 Project structure

Central to the project was the development of a tool, iRet, for conducting energy assessments of buildings with a primary focus on retrofit. Such a tool should be of benefit to companies and individual professionals in producing reliable and practically useful assessments which would in turn enable building owners and residents to achieve improved energy efficiency and hence reduced carbon emissions.

The project outputs fell into 2 categories - C1 (80 enterprises receiving support, in the form of free-to-attend CPD workshops which provided business insights on AI and machine learning, and their use to improve business performance) and C26 (10 enterprises cooperating with research entities). Both categories of output, it was envisaged, would entail trialling and use of the iRet tool – at least in a ‘minimal viable product’ (MVP) version – by enterprises and researchers: this would then provide guidance for the further development of the tool, extending beyond the current project timescale and with the inclusion of a range of refinements. Numerous potential refinements and ‘nice-to-have’ features have already been identified.

Box 5 – Four Work Packages

The project has been structured into four work packages:

WP 1- The iRet tool: a new ‘easy to use’ energy building simulation tool designed to be tailored to individual building and taking into account future weather conditions. It aims to be more sophisticated than simple SAP tools but not overly complex, so as to avoid the need for specific operational skills.

WP2 – Smart Sketcher – 2D to 3D models: allowing for 3D modelling of buildings, distinct from the 2D models currently in use.

WP3 – 10 R&D projects: university-business collaborations using AI, data analytics and advanced software engineering for new business solutions.

WP4 - Offering CPD to businesses: based on AI for the built environment and designed to spread awareness of how digital techniques can support the construction sector.

The iRet tool uses artificial intelligence and building simulation to simulate the energy performance of a building, taking into account current and future weather conditions. It is designed to be inexpensive, to run on mobile devices, and to occupy the “middle ground” between complex simulation tools and relatively simple Standard Assessment Procedure (SAP) calculators. SAP is the methodology used by the government to assess and compare the energy and environmental performance of dwellings⁸.

Each work package had a nominated lead, in most cases an academic, together with a small team responsible for delivery of continuing professional development (CPD) workshops.

⁸ <https://www.gov.uk/guidance/standard-assessment-procedure>

The AI/machine learning group explored the use and impact of AI and examined appropriate use cases, looked at the impact in relation to national AI strategy and Government objectives, and scoped out pathways for expanding the use of AI across construction as well as by users with business and finance rather than technical backgrounds.

The software engineering group developed the iRet tool itself to MVP stage, while the Built Environment team established user requirements, identified companies to work with and potential collaborations, drawing both on existing BCU industry relationships and new contacts.

2.2 Project progress

In terms of outputs, project delivery initially fell short of expectations, but a marked increase in assessor/user interest in the late stages of the work, coupled with strenuous efforts by the project team, was able to make up a significant proportion of the lost ground.

Several factors, largely though not entirely outside the control of BCU, contributed to this underperformance:

- Principally and obviously, the COVID-19 pandemic, with several consequences:
 - very limited ability to progress the project, access university facilities or engage with users during lockdowns
 - absence of staff
 - Diversion of attention by the funders
 - An inevitable shift in attention by assessors, users and other from energy efficiency and innovation to survival
 - overall social and economic disruption
 - difficulties in project kick-off and onboarding of project staff during lock-down, which severely impacted on team building and creation of a common project spirit.
- The late start of the project: the start date was July 2020, necessitated by the need to provide for a three-year period leading up to the end of ERDF programmes at end June 2023, but key staff were not in place until well into 2021. The project manager started in February 2021 and software developers in April and June 2021.
- Difficulty in recruiting and retaining staff, especially software developers, a major reason being that university salaries are not competitive. In addition, React Native, the software platform selected for tool development, though selected for good reasons (advantages in device-agnostic display and future proofing the software), was one with which relatively few developers are familiar. These factors, combined with the pandemic, exacerbated the shortage of relevant skills already created by Brexit.
- Delays in procurement – disruption to supply chains, again partly a consequence of the pandemic, meant that necessary computers were simply not available.
- Problems in project management, including the lengthy indisposition and unavailability of the project manager; too little face-to-face team interaction as a team or 1:1 (in part, because contributors were located remotely from BCU, including in Italy and later Jordan); patchy maintenance of an issues and risks log; and uncertainty over the degree of autonomy given to and to be exercised by the project manager.

- The duration of the CPD workshop, requiring three days to complete: this led to drop-outs due to competing company commitments or illness.
- Inappropriate balance between academic AI/computer science expertise and built environment expertise (i.e. too little weighting on the latter), with insufficient clarity as to who should take the lead in the design and implementation of projects (e.g. the interaction between computer science and built environment experts in scoping projects).
- Inability to access expertise within BCU. Although academics outside the project team willingly assisted with the creation and delivery of CPD workshops, the ring-fenced nature of the project impacted on the ability of project team to access the expertise and assistance of administrative staff within BCU.
- The introduction of new IT security standards (the Cyber Essentials standard). This led to the server being used for iRet development being blocked from accepting input from outside the university network – including from remote members of the project team working on key software – and made important progress impossible⁹.
- The protracted nature of procurement and (especially) recruitment processes within BCU. We understand that when a software developer left at the end of July 2022, a prospective replacement had already been identified by the PI, but that administrative processes resulted in a delay of almost six months before the individual was able to commence work in January 2023.

2.3 The iRet tool

The development of the iRet tool has proved significantly slower and more challenging than anticipated, for reasons among those outlined above. Particularly significant were the late project start with developers not in place until mid-2021, almost a year after project start, and the slow recruitment of a replacement for a developer who left in late 2022.

In response to this rate of progress, the project team took steps to decouple the C1 and C26 outputs from dependence on the tool. This proved a sensible move. The team also increased the number of CPD workshops, made changes to the workshop material in response to early feedback, developed a self-paced learning platform to complement the workshop, and increased the amount and diversity of marketing efforts.

The Government's Growth Delivery Team (GDT) recognised the need for limited changes in order for a successful conclusion of the ERDF project, and accepted a target of 85% compliance with the original output totals, with at least 60% of CPD workshop participants to be based or doing business in the GBSLEP area while others could be in other More Developed Regions.

2.4 CPD workshops

C1 outputs took the form of continuing professional development workshops introducing data analytics and machine learning in the context of applications including energy assessment. To increase participation, an online version of the CPD workshop was made available and was utilised by a minority of participants.

⁹ In fairness to BCU, it is not alone: this is the third university in quick succession where one of the writers has encountered difficulties and wastage of time resulting from the introduction of the Cyber Essentials standard, where communication to and from outside the university network is essential.

Over time, the workshop was revised and improved based on teacher and learner feedback and observations from workshop coordinators. The content was fairly demanding, covering material that in a regular MSc course would be delivered over a substantially longer period. Workshop materials remained available to participants online after completion of the workshop (although this was to end on 30th June).

Early uptake was disappointingly low, in part because potential users were still recovering from the effects of COVID, but participant feedback was extremely positive. Participants were especially engaged during practical sessions where they could try using AI tools using sample datasets, including data relating to energy assessment.

Wisely, additional marketing resources were put in place, and from early 2023 a marked increase in interest and uptake was evident. By the final months of the project the workshop was generating a high level of interest, well exceeding capacity. Considerable interest was generated from firms either outside the geographical scope of the project¹⁰ or too large in size to qualify as SMEs. This underlines the importance and relevance of the topic, and is promising in terms of future wider impacts of the work undertaken for EcRoFit and the learning generated in doing it.

The evaluators held a workshop with CPD team and were singularly impressed by the levels of commitment backed up by evidence of increasing interest and take up as the project entered its final phase. Indeed, the CPD approach on iRet could be adopted more widely across BCU.

Analysis undertaken by BCU using Eventbrite data – the mechanism for expressing interest in and registering for CPD – demonstrates an impressive level of interest in CPD reflecting the strong relevance of the topic to the construction and built environment sector. In addition to companies eligible for ERDF support, many other organisations have been made aware of the project and alerted to the potential of AI and machine learning. This should have a positive effect on their appetite to upskill in the area and to take advantage of new IT tools such as iRet as they become available.

Table 1 Organisations registering in connection with the EcRoFit project

| | |
|---|------------|
| Organisations registering | |
| Total number of delegates registered | 355 |
| Companies invited to apply through the ERDF application form | 204 |
| Not eligible to apply as from ineligible organisations (education, public and third sector, outside of England) | 151 |
| Total | 355 |

The mix of delegates from companies involved showed a broad diversity in terms of gender and of job roles, with technical staff positions, commercial positions and senior leadership roles well represented.

¹⁰ In addition to companies within the GBS LEP area, interest came from companies elsewhere in the West Midlands and in some cases further afield.

Table 2 Diversity: delegate gender

Of the delegates registered for companies:

| Total delegates registered for the 204 companies; NOTE: only a single delegate was allowed per company | female | male | other | not given |
|--|--------|------|-------|-----------|
| 293 | 78 | 145 | 2 | 68 |

Table 3 Diversity: delegate job roles

| Job titles attracted | |
|--|-----|
| Advisors / Consultants | 20 |
| Analysts, Business Analyst and Business Insight, Data and Research roles | 64 |
| Architects | 2 |
| Engineering roles | 27 |
| Sustainability, Environment, Carbon, Retrofit coordinator roles | 9 |
| IT and Software roles | 25 |
| Director, MD, CEO, CTO, COO roles | 43 |
| Commercial roles (sales, marketing, account mgt, finance) | 22 |
| Other job titles | 81 |
| Total | 293 |

These results point to a considerable potential for BCU to build on the learning from EcRoFit to develop and deliver support to firms and individual practitioners in the West Midlands and beyond, and in doing so to help advance the use of AI and machine learning based techniques and tools in housing retrofit and in other parts of the build environment sector, such as new build and commercial premises. Lasting value should accrue, over and above the reportable outputs from the EcRoFit project itself.

2.5 Collaborative research projects

C26 outputs took the form of short, applied research collaborations between BCU, led by a nominated academic in each case, and SMEs based in, or with business activity in, the GBSLEP area. Five such collaborations were sufficiently advanced to be covered in the evaluation and feedback from both beneficiary firms and academic participants was positive.

2.6 Expenditure and output indicators

The data, from BCU, is accurate as of 29th June 2023. It shows there will be an under spend on the project, that C1 output targets will be met (to 85% of the original target) and that C26 targets will be exceeded (120% against the original agreement). No variations were made during the project period.

Table 4 - Spend and output data

| Indicators/ Expenditure | Original Funding Agreement | Amount in most recent Funding Agreement (*) | Total achieved at the time of the evaluation | % of Funding Agreement | Expected Indicators/ Expenditure at close of project | % of Funding Agreement |
|---|----------------------------------|---|--|------------------------------|--|------------------------------|
| Expenditure | | | | | | |
| ERDF Revenue (£m) | £1,434,172. | £1,434,172. | £1,287,405 | 89.5% | £1,278.491 | 89.14% |
| Indicators | | | | | | |
| (C1) Number of enterprises receiving financial support other than grants | 80 | 80 | 55 rising to 70** | 69% | 70*** | 87.5% |
| (C26) Number of enterprises cooperating with research entities | 10 | 10 | 12 | 120% | 12 | 120% |

Source: BCU ((*) there have been no amendments to the budgets or indicator targets). (**) the figure stood at 55 as the SA was being drafted but increased to 70 as we included updated figures. All financial and output figures are as provided by BCU and subject to internal audit by the university). (***) the 70 is made up of 58 individual businesses and attending the CPD courses plus the 12 C26 outputs where business partners have received the equivalent of C1 support.¹¹

¹¹ The output guidance states that under 'relationship to other indicators' – the enterprise may also be reported under indicator C1 where the ERDF support is given directly to the enterprise and the support meets the definition criteria and count of C1.

3 Project delivery and management

3.1 Project Management and Governance

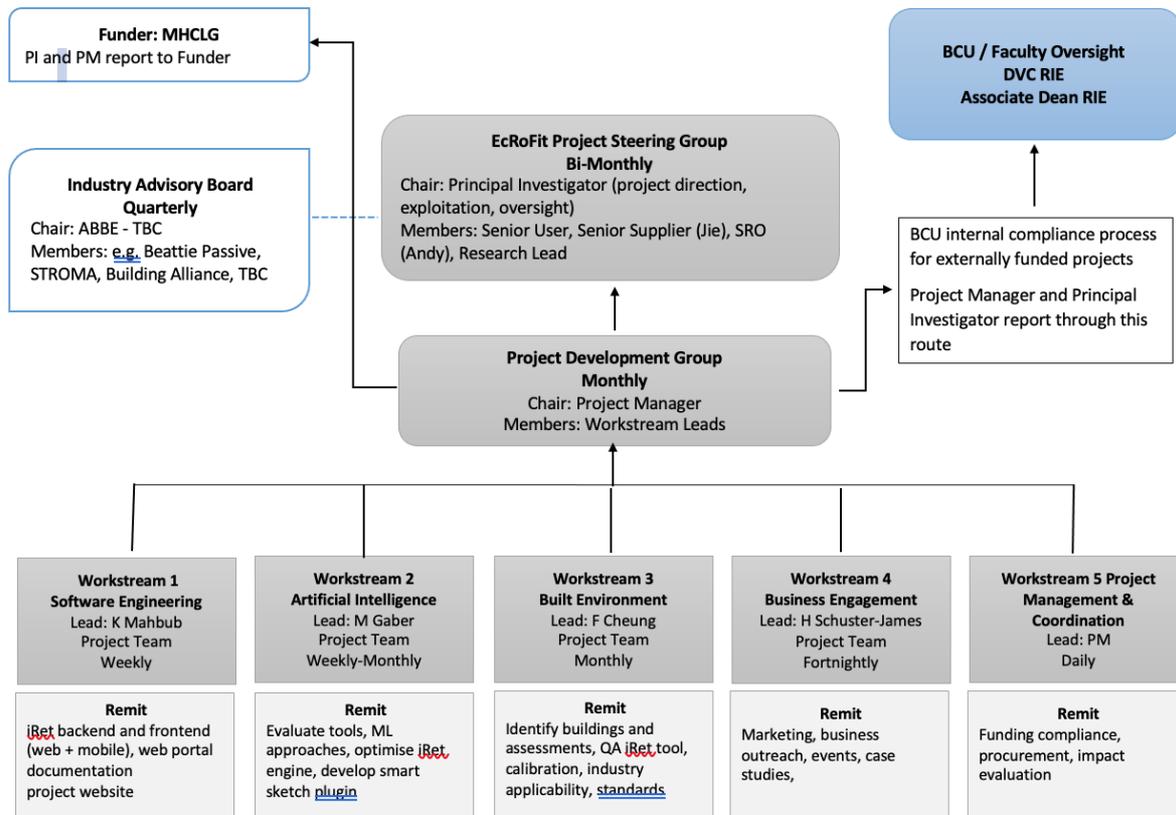
From the outset, the project was essentially 'AI-led' rather than pitched as a built environment project with machine learning and data analytics as tools to be marshalled in support of building assessors and assessments. A greater industry involvement in scoping and planning at the outset could have improved the direction of the project and helped set expectations.

We examined the action log for the project, which was well structured and a valuable management tool. However, we noted that it appeared to have been used intensively at some stages, particularly early in the project, but much less so at other times. For example, it appears that over 20 action points were recorded in May 2021 but only three between January and April 2022, with another eight at the start of May.

Staffing for the project involved a relatively large number of individuals across different parts of the University, often allocated small portions of time (e.g., 0.1 or 0.2 FTE). We reviewed an organisation chart (see Figure 3) which indicates that some 30 individuals are involved, along with a listing of staff from the proposal where some 22 individuals had time allocated from the project budget. In the absence of a time recording system, it is difficult to determine where contributions may have been delayed or holdups encountered. This hampered effective project management and left the principal investigator rather exposed when overall progress was behind schedule.

Given this situation, project management was less proactive and visible than was necessary, resulting in a lack of clarity as to the responsibilities of project contributors and a lack of urgency in chasing up actions.

Figure 3 – EcRoFit Organisation chart



3.2 Delivery

3.2.1 Has the project delivered its intended activities to a high standard?

Progress has been severely affected by a combination of factors some – but not all – outside the control of the University. These include:

- The impact of COVID-19 and the associated closures and restrictions
- Effective restriction to 2.5 rather than 3 years project duration that many other ERDF projects have enjoyed, due to the ‘hard closure’ of ERDF projects in June 2023, although this was known by BCU at the time that agreements were signed.
- Use of protracted University HR, procurement and approval processes which, while common for regular university business, could be deemed inappropriate for a project of this nature and duration and can prevent the optimal and timely delivery of outputs.

In particular, delays in the replacement of a key software developer heavily impacted progress. Delays in procuring software licences created extra difficulty. These delays, and the consequences in compromising timely project delivery, have put the University’s reputation at risk.

The delays to development of the iRet tool necessitated a change in approach to business support, in the form of the creation of CPD workshops. This change made sense. The workshop provided was focused on AI and data analytics with some reference to building energy assessment and was demanding in content and scope. As many of the participants were new to AI and machine learning, it is likely to be some time before it is easy to demonstrate a connection to Priority 4 ERDF outputs and subsequent impacts.

3.2.2 *Could the delivery of the project have been improved in any way?*

It appears that delegation from the project manager to other staff was insufficient to cope with the combination of project delays and the indisposition of the project manager. That the PI had management responsibilities for members of the team – based on the organogram - that might normally be managed by a project manager does not seem to be an effective arrangement.

Insufficient use was made of the Industrial Advisory Board (IAB) and the expertise and experience represented by its members. Greater consultation during the planning and scoping stage of the project would have brought about a better focus on user needs. Interaction with the IAB during the project has been at a low level and as noted above, largely limited to the business development workstream leader. We were surprised to learn that the project manager had not met with the chair of the advisory board.

Potential linkages to other built environment work at BCU and elsewhere have not been explored as fully as they could have been, resulting in a lower profile for the project. That said, C26 projects were used to co-deliver outputs for the Project 80 collaboration with housing association Midland Heart and property developers, while members of the EcRoFit team from the Built Environment discipline are also part of BCU's Centre for Future Homes¹², with members of the EcRoFit industry advisory board also involved. This linkage created some difficulty in that two 'brands' – EcRoFit and Project 80 – could not easily be promoted at the same time.

In addition, systematic marketing of the CPD workshops appears to have been insufficient until a late stage, with several individuals 'doing their bit' rather than – as was eventually done – appointing a full-time staff member, assisted by a placement student, to market and administer the workshops. This brought about a notable improvement and by the final months of the project, interest greatly exceeded the number of places available even when drop-outs and ineligible applications are taken into considerations (the CPD Team estimates that some 50% of all businesses contacted and processed continue to become C1 outputs).

3.2.3 *Were procedures in place to ensure the project focused on the right beneficiaries?*

The iRet tool, if developed and made available in a sufficiently user-friendly form, would meet a market need and offer a means of conducting assessments which would be complementary to the Standard Assessment Procedure SAP¹³. The project correctly focused on assessors and allied professionals who would make use of such a tool.

At the outset of the project there was no evidence available that parallel developments elsewhere might make iRet redundant once it had been brought to fruition. We have had no indication from our initial analysis and consultations that this situation has changed, and so the case for creating the iRet tool remains strong.

The Smart Sketcher tool for 3D visualisation complements EcRoFit, and should make its use by beneficiaries much faster and more user friendly. Smart Sketcher can be used as a standalone solution and has a value as a plug-in in different contexts beyond iRet.

¹² <https://www.bcu.ac.uk/business/partnerships-and-projects/projects/the-centre-for-future-homes>

¹³ <https://www.gov.uk/guidance/standard-assessment-procedure>

3.2.4 How were project activities perceived by stakeholders and beneficiaries?

Delegate feedback on CPD workshops has been positive and encouraging (see Box 6). This is supported by feedback from the survey of beneficiaries (see Box 7).

Box 6 - CPD Delegate Review Forms

We have been able to review 5 anonymised forms from businesses attending CPD workshops. They are all very positive. Businesses were asked to rank session content, venue and administration on the following basis: very poor; poor; fair; good and very good. The majority of responses were marked as good or very good. Fair was highlighted in 3 of the 5 forms in relation to the relevance of workshop content to the business's own specialisms. This reflects the point made that not all businesses supported were engaged in building or construction activities although this improved in the later part of the CPD programme.

However, even where 'fair' was applied to the relevance of workshop content businesses were positive about the experience (as can be seen below) – learning new concepts and applications, making useful business connections and networking opportunities. The organisation of the workshops was singled out for praise in all cases.

'very enlightening in terms of the potential of 'big data''.

'I would recommend to any EPC advisor'.

'It gave a good idea of the potential of machine learning in real life projects'.

'very enjoyable ... good presentation and knowledge of the presenters'.

'the insight offered is invaluable'.

The indications are that the workshop provides an insight into the power of data analytics and AI, and an expectation that tools based on them will be both a potent and a necessary addition to the energy assessor's armoury if targets for progress towards Net Zero in the built environment are to be achieved. Hence, the benefits perceived are more about anticipating the future of energy assessment and having an early awareness of the role of sophisticated data analytics than about tools and techniques for short term application.

In the future, the workshop could be augmented by further examples illustrating the use of data manipulation specifically in the built environment and especially in relation to retrofit, and in due course by introducing the iRet tool. If so, it should prove an attractive CPD offering beyond the timescale of the EcRoFit project and an asset to the built environment sector in the region.

The twelve-hour duration of the CPD workshop, spread over three days, was determined by ERDF requirements in relation to business assists but was arguably less well suited to business users than, for instance, one 8 hour 'long day'. For an SME or individual operator, taking time out over three days will represent a significant loss of revenue potential, and we think it probable that this has limited uptake of an otherwise attractive workshop. The team explored a two-day option but found this even harder for businesses to accommodate. Some business requested extensions and the ability to complete the workshop in their own time but this approach has been rejected by the CPD team on the basis that the intensity of the workshop requires a focused period of learning.

'the 12-hour CPD [workshop] is equivalent in content to a 12-week module on an MSc course'
BCU CPD team

Box 7 - Survey of beneficiaries

An e-survey of beneficiaries was undertaken between May and June 2023 using Survey Monkey. All recipients of C1 CPD workshops were mailed with a link to a short survey and a mix of prescribed and open questions. Reminders were sent out by BCU to increase the response rate. Sixteen (16) responses were received plus one from a participant not deemed as eligible for support that would count as an ERDF C1 output. The analysis is therefore based on the 16 responses which equates to a response rate of 23%. As with the feedback forms – completed on the day – the responses in respect of the delivery and value of the CPD workshop – were generally positive.

A full set of graphs is given as Annex 1 but the key findings are summarised as follows:

10 of the respondents were employees, 1 was a student and 5 business owner/director/sole trader. 8 of the respondents (50%) had the West Midlands (including the GBSLEP area) as their main working base. The remainder answered 'elsewhere in England to this question).

The majority of respondents were working in construction, energy/sustainability sectors with the remainder primarily engaged in IT/software and data analysis. 5 were involved in providing energy assessments with 1 as a customer for energy assessment. Of the remainder 4 (25%) would like to be involved in energy assessments but were not currently so.

BCU employed various means to enrol participants to the CPD workshops and this is reflected in the responses. Six had received a mail shot from university/EcRoFit team and 5 had joined as a result of word of mouth from a colleague or business associate, a good sign of a positive reaction among those who had attended previously. 12 respondents had visited the EcRoFit website on at least one occasion.

Respondents rated the delivery of the CPD workshops and in most cases the rating was good or excellent with the highest 'excellent' rating being for the quality of experts (10 out of 16). There was positive feedback for the online format and the delivery of information and 'poor' was only mentioned twice, 1 respondent in workshop timing and 1 for the relevance of content.

There was very positive feedback in respect of new knowledge and information gained (15 out of 16 completely (14) or somewhat (1) agreed with the statement).

There was also positive feedback in respect of the application of new knowledge and information (where a delay would be expected before knowledge and information can be applied). 13 out of 16 completely (2) or somewhat agreed (11) that new information had already been applied in their work. In respect of awareness of the possibility to apply new knowledge and information to energy efficiency in buildings 12 completely (6) or somewhat (6) agreed that they were more aware having completed a CPD workshop.

In respect of the principal benefits that followed participation the single most mentioned benefit (mentioned by 8 or 50%) was greater access to expert advice (from the university and other experts) with a further 6 citing economic benefits (3 stating increased profitability and 3 stating access to new markets) as the main benefit (respondents were allowed to choose one benefit from a list).

C26 project participants also expressed high levels of satisfaction. For one participant (see Box 8), the data obtained were so significant that they would feed into the company's forward strategy for development and use of modern methods of construction (MMC). An excellent relationship between industrial and academic participants had been consolidated.

Box 8: Walsall Housing Group Ltd: Life cycle analysis for embodied carbon

Embodied carbon in the structure of a dwelling can be the equivalent of more than 40 years of typical annual emissions while the building is in use – potentially more, as retrofit reduces the latter. Choosing a construction method that minimise embodied carbon is therefore important, and the project between Walsall Housing Group Ltd (WHG) and BCU developed a technique for comparing several alternative methods.

Building on an established relationship between academic and industry partners and on previous work supported by Innovate UK, the project exceeded expectations with many fruitful discussions. The company would be more than ready to engage in further development work with the University, given the necessary resources and time, and to employ former BCU research students when openings arise.

“It’s been a fabulous journey.....it was brilliant” – Company participant

Results favoured timber construction over the currently-favoured light gauge steel frame method. The comparative data obtained will influence WHG’s future development strategy and choice of construction methods, and will support the company’s aim of securing EMAS (EU Eco-Management and Audit Scheme) accreditation.

Box 9: Vergroot Ltd: information on renewable energy choices for residents

This project was the result of good timing with the company planning its next steps in developing a portal targeted primarily at residents to help them make informed choices (and investment decisions) on the use of renewable energy and other methods to reduce energy costs and emissions. The software is tailored to specific housing, climate conditions and renewable energy types (e.g. solar v wind turbine). EcRoFit has funded a BCU developer and in the view of the business has reduced R&D time by some six months.

‘very pleasantly surprised by how much work got done in a short space of time’ – Company participant

The EcRoFit intervention is claimed to have brought forward the research and testing process to the level of API (application programming interface) and according to the beneficiary company means that a web-based platform can be piloted by September 2023. The company is looking at a further stage – post-ERDF – collaboration with the university. The one negative comment centred on university and ERDF processes and the bureaucracy and time taken from project idea to implementation.

Box 10: Tricas Construction Ltd: understanding the indoor environment

The Project 80 housing development by Tricas for housing association Midlands Heart aims to create homes that are 80% more carbon-efficient than typical earlier housing. To achieve this aim in practice, creating an indoor environment that offers occupant comfort while achieving reduced energy usage is essential.

This project involved installing sensors in several properties, retrieving and analysing data and interviewing occupants to understand their experience. Problems in sensor connectivity and loss of internet connection were addressed and monitoring continues.

Midland Heart have maintained a close interest in the project, which will inform new build and avoid future homes needing retrofit early in their service life.

Box 11: Covatic Ltd: digital home information for tenants

As part of the Project 80 development, the BCU team developed a set of user guides for tenants of three properties constructed with different systems and materials. The aim is that by providing users with information in a readily accessible digital form, behaviour will change in such a way as to reduce energy usage while maintaining a comfortable environment and producing savings on householders' energy bills. Midland Heart, the housing association managing the properties, have worked with the BCU team to gather information from a fragmented array of sources.

User guides are being drafted for sharing with a resident focus group and refinement to be as user-friendly as possible. The project builds on a PhD project already under way at the university with Covatic support, aiming to create a phone app – 'I am zero' – for resident use. The user guides could then be made accessible via the app, which could also draw on data from, for example, air quality sensors, heat pumps and solar panel information to 'nudge' occupants towards behaviour change.

The project team are already discussing future collaborative funding opportunities, offering the potential for a practical and valuable tool benefiting householders and the environment alike.

Box 12: My Global Home

A collaboration that was concluded in 2022. BCU worked with My Global Home to develop floor plans using AI technologies that cut the research time required to estimate the carbon footprint of homes significantly as part of a Smart Homes project. BCU provided consultancy support (at least 50 hours and involving at least 3 members of staff) and My Global Home – we understand – would have liked to have advanced the collaboration further, but this will require funding. For BCU it provided a useful practical platform to develop Smart Sketcher. The project also provides BCU with material for research papers that can show the benefits of applied research through open-source publications and journals.

The objectives and content of the project are wholly in line with the principles of sustainable development and over time could deliver significant CO₂ savings. In respect of equal opportunities, the creation of a user-friendly energy assessment app such as iRet should be affordable, facilitate use by a wide variety of individuals, and help developers ensure that energy efficient and hence more affordable dwellings can be provided.

4 Outcomes and impact

4.1 Defining impact targets

The EcRoFit logic model target impacts were as follows:

| |
|--|
| 1. Long term greenhouse gas (GHG) reduction and better adaptation to climate change in retrofitted buildings |
| 2. Growing market / demand for GHG reduction interventions through increased occupier comfort and affordability for housing providers and owners |
| 3. GBSLEP SMEs more competitive and resilient through genuine collaboration with university |
| 4. Addressing barriers to growth for retrofit construction in the WMCA region; stronger regional construction/ retrofit supply chain |
| 5. GHG reduction understanding and skillset in construction supply chain increased |

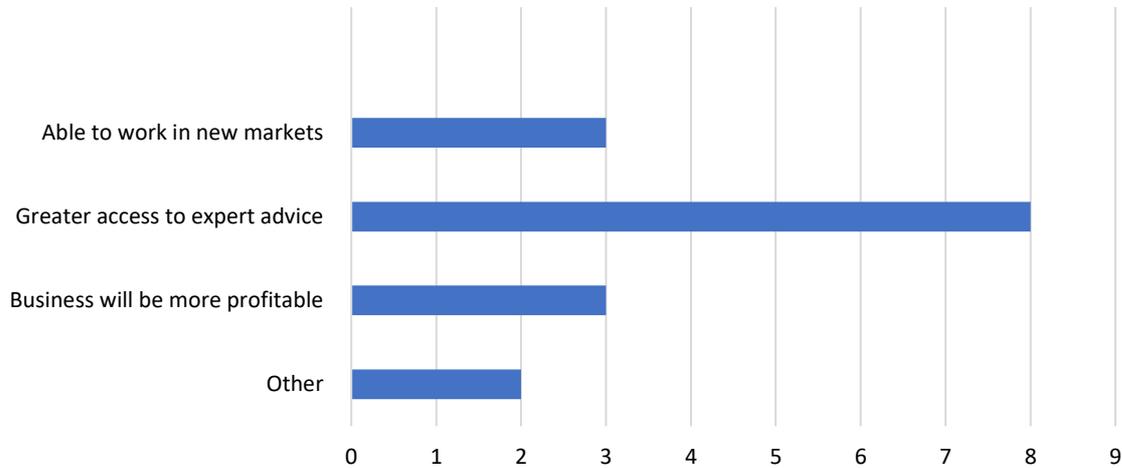
The major benefits of the work are likely to accrue in future phases of activity in the medium to longer term after conclusion of the EcRoFit project itself. A successful iRet tool, coupled with appropriate CPD and close business-university collaboration, should be a significant asset in energy assessment and by extension, in reduction in CO₂ emissions through retrofit and indeed new build. Further work under the auspices of BCU's Centre for Future Homes should provide ways of extending and building on the learning gained from EcRoFit.

4.2 Measuring Impact

Given the developmental nature of EcRoFit which has involved engaging and involving businesses in collaboration, either as part of C1 CPD workshops or 'deeper dive' C26 collaborations it would be unrealistic to expect immediate economic, environmental or social benefits and in fairness to BCU the logic model makes no reference to traditional economic indicators (such as jobs and GVA) in the context of the ERDF targets and timescales, whilst GHG reductions would follow later. The data that can be gathered from survey or other means is not sufficient to allow for reliable and robust quantification.

From the survey 2 (out of 16) businesses that attended CPD workshops cited increased profitability and a further 2 highlighted access to new markets, but these are relatively small numbers for quantitative analysis. Perhaps more importantly, were the 8 (50% of those surveyed) who mentioned access to expert advice as their prime benefit.

Table 5 - For yourself and your business what are the principal benefits following participation in the CPD workshop?



Source: C1 beneficiary survey

Other = (1) ability to offer new services (2) a better understanding of what I am doing

The more in-depth industry-university collaborations have the potential to deliver economic, environmental and social benefits, but over time and in some cases through subsequent collaborations and investment funding. Nevertheless, there is anecdotal evidence of the potential for significant benefits stemming from new research including new evidence of the superior low carbon performance of timber framed buildings from sustainable sources when compared to other forms of construction. Knowledge such as this, fully disseminated, has the potential to lead to longer term impacts.

4.3 Dissemination and Recognition

Academic impact is already evident, with one paper already submitted and six more in progress. EcRoFit has potential to be a REF 28 impact case study and the basis for further KTPs. Significantly, the ability of BCU and regional SMEs to collaborate has been enhanced: STEAMHouse was credited for making it easier to contact SMEs and build networks.

Key research outputs in progress include the following papers:

- An Active Learning Approach to Floorplan Image Annotation for Energy Assessment
- Data Analytics for Air Quality Monitoring
- iRet Tool Comparison Study with Building Simulation Tools and SAP
- Bridge AI Funding - iRet Tool Plug-in – Deep Learning to detect home appliance models for building simulation
- KTP – Neural Network-based Computer Vision System for Quality Control of Coatings in Recess Punch Manufacturing

- NLP approach to analyse building models and applications

Proposals for further funded research are in hand building on EcRoFit experience, with two bids awaiting results at the time of writing and external partners identified for future project proposals.

The CPD aspect of the project offers further promise for future impact. For BCU it has created opportunities to drive uptake of AI across non-STEM disciplines, including for business school students: it has also laid a foundation for strong CPD offerings for business and industry.

EcRoFit was the winner of the West Midlands Tech Award 2022, marking recognition by the region's fast-growing tech sector, now worth over £15 billion to the economy¹⁴. It had the potential to "bring more digital players in the built environment sector, which is far behind compared to other sectors such as finance." If so, this greater involvement is likely to create valuable impact in the construction and property industry, with an improvement in the energy performance of buildings.

4.4 The Awarding Body for the Built Environment

The project benefited from the involvement of ABBE (the Awarding Body for the Built Environment), a fully owned subsidiary company of BCU. ABBE assisted with introductions to several of its partners (companies and training providers delivering ABBE-accredited programmes), reviewing the content of the EcRoFit project, and encouraging partner involvement. As part of the project, ABBE developed a suite of qualifications for retrofit (<https://www.abbega.co.uk/retrofit-2/>). It now enables partners to offer retrofit practitioners qualifications at levels 3 and 5, in line with the PAS 2035 standard covering how to assess dwellings for retrofit, identify improvement options, design and specify energy efficiency measures.

Notwithstanding some delays due to internal payment processes within BCU and the retirement, towards the end of the project, of a closely-involved staff member, from ABBE's perspective the project has been successful. The EcRoFit team were very approachable and the principal investigator's detailed knowledge was especially commended. As for iRet, the ABBE view was that if in general usage it would be a very useful tool.

"Having people that really know their project is really valuable" – ABBE interviewee

1.5 Centre for Future Homes

For BCU, EcRoFit contributes to the evolution of a regional, indeed national, centre of excellence in the built environment with particular emphasis on housing, in the form of the Centre for Future Homes – formed during the workshop of the EcRoFit project. This will assist BCU in differentiating itself within the 'market' of higher education, research and knowledge exchange, while on a regional level leading to well-informed adoption of appropriate retrofit measures.

1.6 Construction Sector Benefits

For the construction sector the project has identified AI pathways specific to the sector, developed potential further CPD provision, and by raising awareness with a 'window on the future' enhanced the prospects of regional construction and other businesses being among early adopters of AI innovations for economic benefit.

¹⁴ <https://techwm.com/press-release-west-midlands-tech-sector-growth/>

Regionally, in addition to improving skills in energy assessment and construction, the project contributes to increasing digital skills in general – a significant need both in the West Midlands and on a UK level.

4.7 Value for Money

Table 3 provides an analysis of VFM based on project monitoring data. The average cost of a C1 (£2,099)¹⁵ and a C26 (£13,099) are within the range that might be expected.

Table 6 – Value for Money

| C1: SME engagement, marketing and CPD delivery | Forecast | Actual |
|---|-----------------|---------------|
| Sub-total | 136,510 | 121,756 |
| Total number of C1 | 80 | 58 |
| Average cost per C1 | 1,706 | 2,099 |

| C 26 Delivery | Forecast | Actual |
|-----------------------------|-----------------|---------------|
| Sub-total | 130,867 | 157,190 |
| Total number of C26 | 10 | 12 |
| Average cost per C26 | 13,087 | 13,099 |

| Cost of iRet tool development | Forecast | Actual |
|---|-----------------|---------------|
| Sub-total | 662,454 | 506,505 |
| Total number of software outputs | 2 | 4 |
| Average cost per output | 331,227 | 126,626 |

| Marketing and Dissemination | Forecast | Actual |
|------------------------------------|-----------------|---------------|
| Sub-total | 127,565 | 103,432 |

| Management Acitivity | Forecast | Actual |
|-----------------------------|-----------------|---------------|
| Sub-total | 376,777 | 389,542 |

| | | |
|----------------------|------------------|------------------|
| Total Project | 1,434,173 | 1,278,491 |
|----------------------|------------------|------------------|

¹⁵ Excluding the 12 businesses also in receipt of C26 support

5 Conclusions and lessons learned

5.1 Overall conclusions

- EcRoFit was a well-intentioned project, rightly targeted on energy assessors and allied users. It was aligned closely with national and regional priorities, under the overarching need to accelerate progress towards net zero in the built environment sector. It also sought to bring together digital expertise, which in the West Midlands is both strong and fast growing, with a sector hitherto lagging in application of digital and AI techniques.
- The project was timely and relevant at the outset: given the change in climate in regard to energy costs and energy security since then, it is now immeasurably more so given the climate change crisis and the energy supply and security issues exacerbated by the war in Ukraine.
- However, progress was handicapped both by external factors neither predictable nor controllable – the many consequences of the pandemic – and by factors that could be addressed in future projects of this nature. The latter include staff changes, severe delays in recruitment and procurement, arguably over-optimistic expectations as to the rate of progress in tool development, and a slow start to uptake of project activities by beneficiary firms. The fixed term of the project – and less than many ERDF projects have enjoyed, given the ‘hard ending’ of June 2023 has served to concentrate minds but a further period - of 3-6 months – might have made a significant difference. In the words of the PI *‘more progress was made January-June 2023 than in preceding periods’*. This sentiment was reinforced by the project management team and the CPD team.
- Greater clarity as to responsibilities of contributors (including a greater role for the built environment academics alongside computer scientists), and more proactive project management, could have mitigated some, but not all of the factors noted above.
- There does not appear to have been a strong relationship with the Growth Delivery Team and interactions have focused on outputs and finances. Appreciating that the GDT has resource limitations and has experienced staff changes a more regular series of exchanges might have influenced progress. This conclusion draws from discussions with the project – the GDT declined to be interviewed.
- In hindsight, this was a research and development project rather than applied technology and therefore was probably better suited to Innovate UK funding than to ERDF. To some extent, the pressure to chase outputs came at the expense of some of the original aims. Given the state of play at the ERDF project end the normal measures of impact ‘jobs’ and ‘GVA’ will only follow after the ERDF project and assuming additional medium- and longer-term funding can be secured by BCU.
- That said, the potential for future impact and for further research, development and application, building on the foundation of EcRoFit is very considerable. Experience with C26 participants suggests significant appetite for participation by industry including, importantly, SMEs. In the view of the evaluators and based on the assembled evidence the project would be a good candidate for future national and/or regional (WMCA) funding to maximise the added value of the ERDF investment.

- There is considerable potential to build on the EcRoFit CPD experience to develop further education and training material for BCU degree courses across a range of disciplines and for CPD provision for industry. This can directly help to address the digital skills shortage that is of high concern both nationally and regionally.
- Key to a further phase of the project is the progression of the iRet tool. This needs further investment and development post-ERDF if it is to be fit for purpose and a practical tool for experts and non-experts. Overall, there is an urgent requirement for a forward plan to maximise the potential not just of iRet but the overall EcRoFit project.

5.2 Specific lessons for Grant Recipient/ project delivery body:

- For future projects, the alignment between the expertise of academic staff involved and the needs of the project should be more fully explored. In this instance, the project would have benefited from more involvement of experts in the built environment as distinct from experts in advanced AI.
- The procurement and recruitment processes used, while typical for a large and complex university, are far too protracted for a project such as this where time is critical. The grant recipient should put in place faster, while still robust, processes such that (for example) approval to recruit rests with the project director provided that budget constraints are met.
- The introduction of the Cyber Essentials IT security standard is a cause of serious problems where communication to and from outside the university network is required, even where this communication is with team members and key collaborators. To avoid continuing wastage of time and hence cost, modified cybersecurity measures must ensure that such communication remains straightforward and efficient.
- Undue restrictions that prevent project team members from drawing on the expertise and experience of administrative colleagues within the university should be removed.

5.3 Specific lessons for those designing and implementing similar interventions

- There should be more engagement activity with relevant firms and individual assessors in the very early stages of such a project.
- Industry, especially SME, interest should be encouraged by energetic marketing activity at an early stage.
- A cross-faculty or cross-discipline scoping exercise at the outset of a project such as EcroFit can be helpful in avoiding duplication, securing valuable multi-disciplinary input and maximising internal impact.
- Strong, proactive and highly visible project leadership and management are essential, especially where contributors are many in number but where most allocate only a small fraction of time to the project.
- For projects developing open-source innovation the dissemination of results to a wider audience is important. The May 2023 industry event – attended by the evaluators – was

useful but we have recommended that the project prepares a forward plan showing how the work will be carried forward.

5.4 Specific lessons for policymakers

- Further R&D and outreach should be designed and funded in order to encourage application of advanced digital, AI and machine learning techniques to the built environment, especially in regard to energy performance.
- Measures to facilitate engagement of academics with SMEs are key. In this case, the presence of STEAMHouse proved a valuable mechanism to this end.

5.5 Other specific lessons

- Companies in the built environment should engage actively with the 'tech sector' on a regional level, with a view to taking advantage of digital methods to improve energy assessment and performance, and building design.
- Increased industry involvement in the scoping and planning of built environment research should be encouraged, so that it can be aligned with emerging needs and realistic, though ambitious, expectations can be set.

Appendix 1: Evaluator recommendations at interim report stage

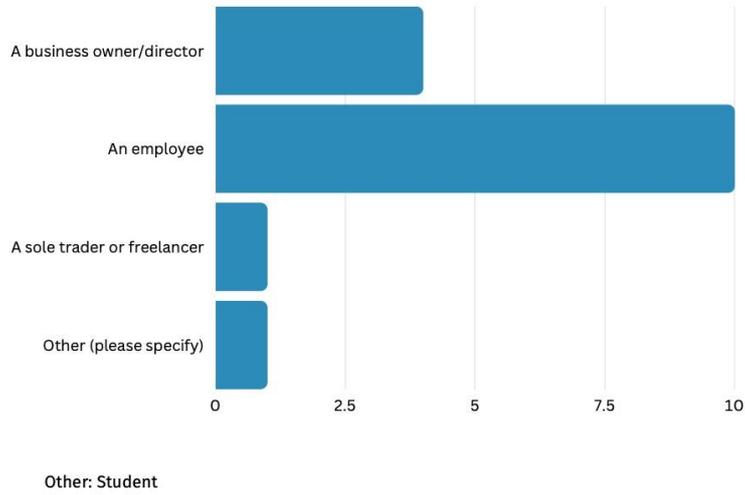
1. It is essential that delays due to standard University procedures are minimised. While we are pleased to learn that the proposed new front-end software developer has now been contracted albeit following a lengthy delay, the cooperation of BCU senior management should be urgently sought in order to (a) enable the PI to purchase software, licences or other items for which there is provision in the project budget without procurement process delays (e.g. issue of a purchase order on a same-day basis) (a) avoid any further delays of a similar nature in recruitment, procurement or otherwise.
2. A more robust and ‘hands-on’ approach to project management should be adopted for the remainder of the project. The project manager should review the contributions of each staff member with time allocated to the project, establish ‘who has done what’, and together with the PI ensure that any outstanding contributions are delivered as soon as is consistent with overall progress of the project (in particular, the iRet tool). A clear system of delegation should be put in place at once, minimising delays due to illness or other cause.
3. Regular team meetings, virtual and where possible physical, should be held with honest and open discussion and with all involved encouraged to flag up problems and issues – and suggestions for improvement – promptly, regardless of seniority.
4. The PI should secure firm assurance as to an adequate and defined amount of time that the back-end software developer will devote to the project from the start of January.
5. The team should convene a physical meeting of the Industrial Advisory Board (IAB) as soon as possible to seek their advice on promotion of CPD workshops and research collaboration, on the further development of the iRet tool and on any other measures to accelerate achievement of project outcomes. This meeting should be attended by the PI, project manager, and the workstream leads or suitable deputies should any workstream leads be unavailable.
6. The IAB should then be kept fully informed during the remainder of the project, with opportunities for regular contact with the principal investigator and project manager as well as the business development workstream leader (and indeed other workstream leads as appropriate).
7. We welcome the recent appointment of a dedicated person responsible for promotion and administration of the CPD workshops. They should make maximum use of existing networks, including members of the IAB and their contacts, the Innovation Alliance’s Low Carbon Working Group, Sustainability West Midlands and the National Housing Federation.
8. The team should also explore closer links with other projects at BCU connected with energy usage and the built environment, with a view to raising the profile of the project and identifying further ways in which the iRet tool, when sufficiently developed, might be tested and feedback on its use obtained. For example, a project involving several occupied houses in Handsworth has been suggested as an opportunity to try out the iRet tool. There is also another ERDF funded project in East Birmingham where homes are being retrofitted to high energy efficiency standards¹⁶.

¹⁶ Gressel Lane. Birmingham Municipal Housing Trust

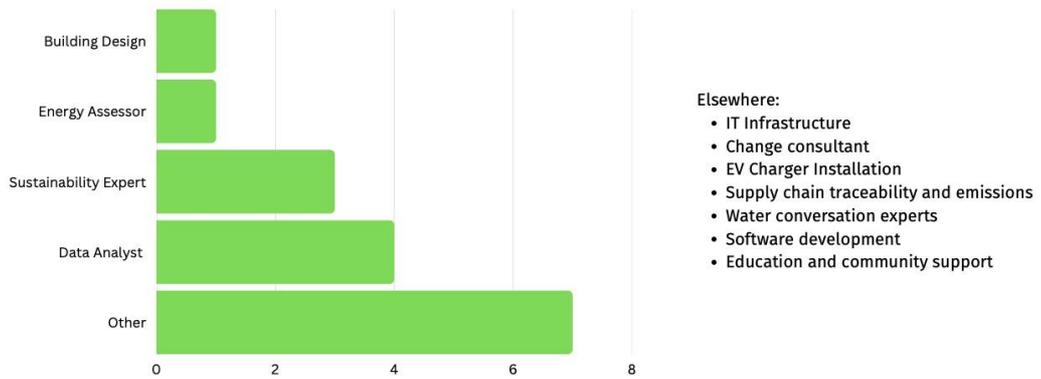
9. In the medium term, possible links to the built environment and low carbon projects and initiatives elsewhere, especially across the West Midlands, should be explored with the aid of regional networks and cluster organisations.
10. Completion of a working 'minimal viable product' version of iRet, in a form that can be tested in use, by the project end point is essential, and should be a higher priority than incorporating any refinements. The team are to be commended however for identifying a variety of potential features which could enhance the power, utility, and user-friendliness of the tool, and this should form a basis for its possible future development beyond the timescale of the current project.
11. As soon as a version of the iRet tool suitable for user demonstration is available, a 'launch event' should be arranged to raise awareness of the project and its outputs in industry and especially among companies and individual operators undertaking energy assessments.
12. Initial feedback on the CPD workshops indicates that participants find them both interesting and valuable, and momentum in running the CPD workshops must be maintained. The workshop could be enhanced further through a review of the content with a view to adjustments to make it more directly relevant to personnel conducting building energy assessments, and more accessible in terms of the level of 'IT fluency' required.
13. In parallel with the above, promotion of the workshops e.g., via the project website should place greater stress on the use of the material to be covered, in the context of practical energy assessments, as opposed to AI and data analytics per se.
14. In addition, 1:1 discussions should be considered with key organisations in the built environment such as the BRE Group, in part to understand more fully how iRet would complement existing tools as well as to gain views on the tool itself.
15. University management should be invited to consider what changes can be made to standard procedures for recruitment, procurement, delegation of purchasing authority, etc., or what alternative and more streamlined processes could be employed, in order that future fixed-term projects do not experience the lengthy delays that have hindered progress during EcRoFit.
16. Other ERDF projects we are familiar with and ending in 2023 are actively looking towards continuation funding, despite ongoing uncertainty over future public funding. BCU is generally very active in this area but some proactive work may be required to ensure that development funding is in place to move the iRet tool from the MPV status.

Appendix 2: C1 Participant Survey

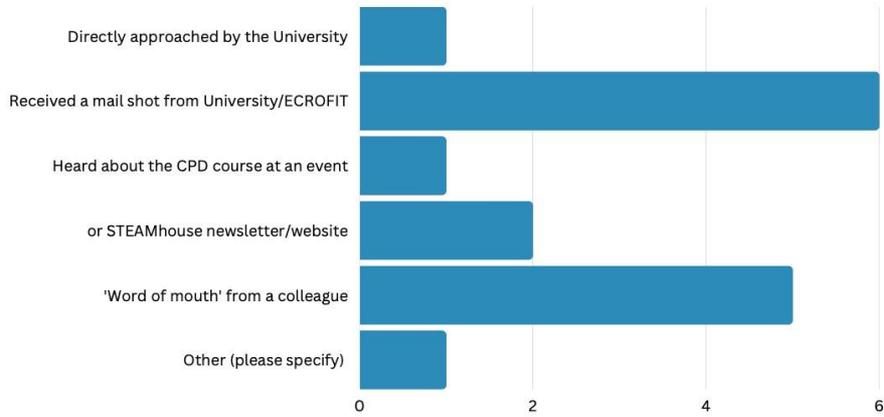
Which term best describes you?



Which of the following best describes your main area of business/work?

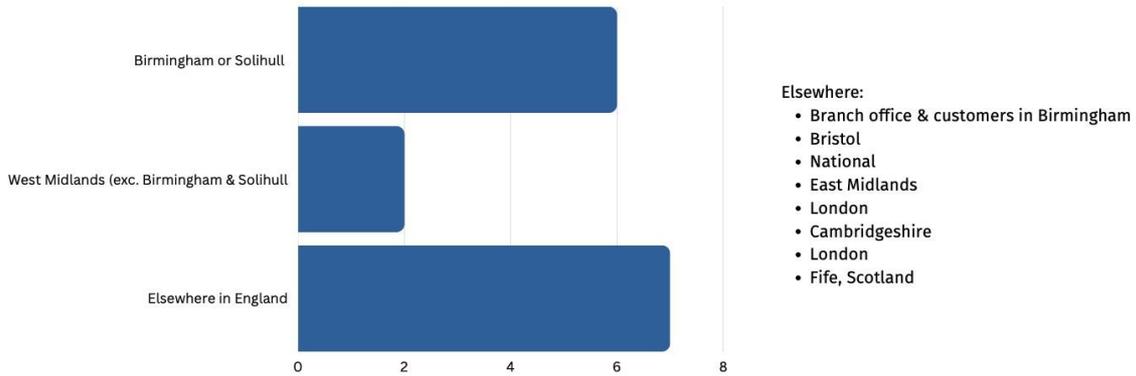


How did you (or your business) hear about the CPD course? (main source of information)

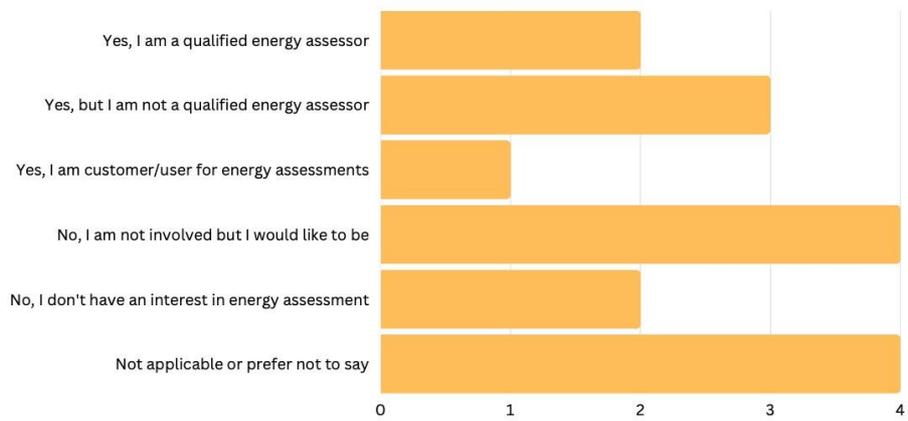


Other: My HR suggested not sure where she got the information from.

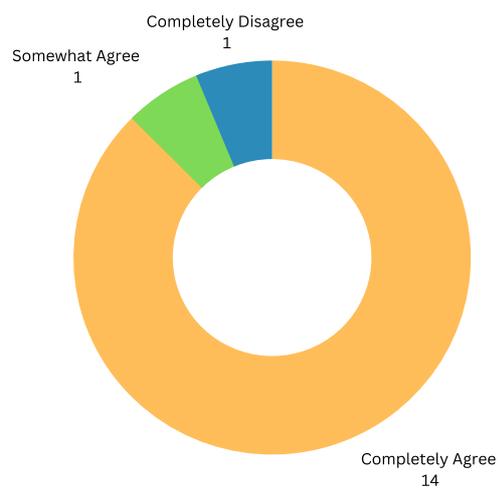
Which of the following best describes your normal working base?



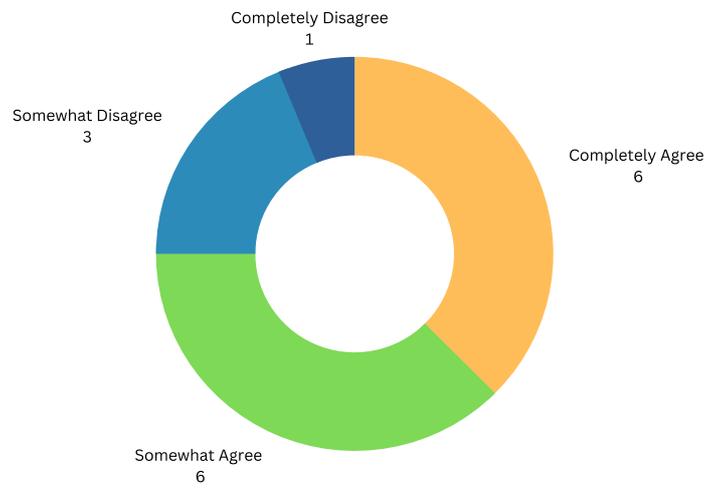
Are you currently involved in the energy assessment of buildings?



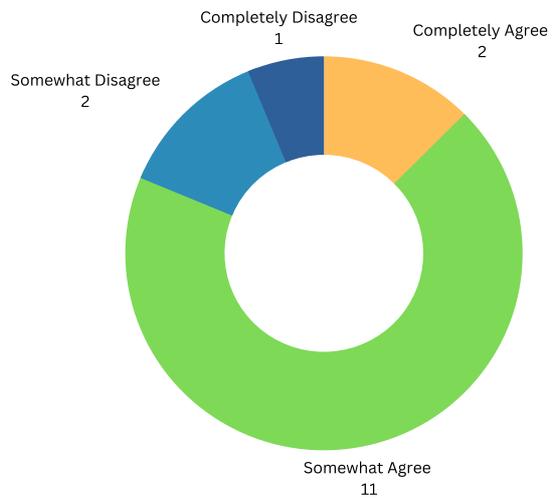
I have learnt from the experience (new knowledge gained, new information and applications)



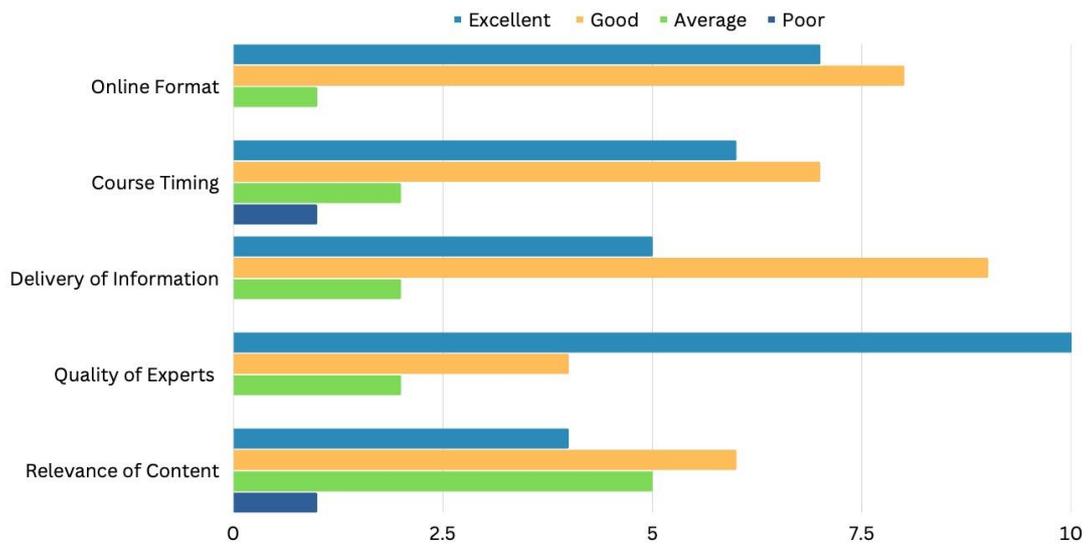
I am more aware of the possibilities to apply new skills and knowledge to energy efficiency of buildings



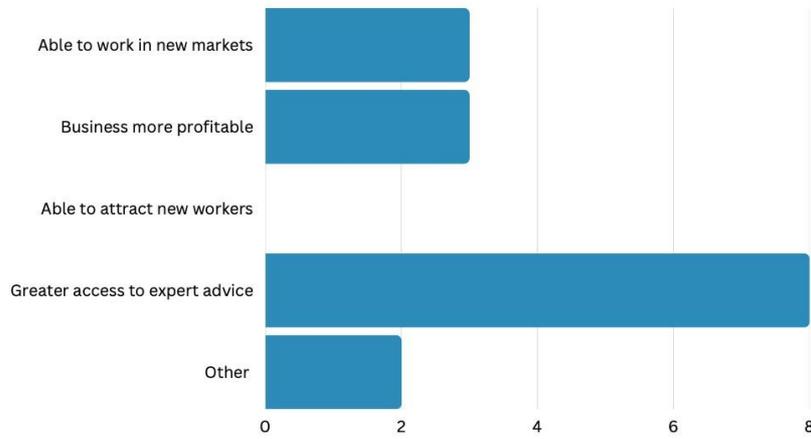
I have already applied new skills and information in my work (the work of the business)



Thinking about the delivery of the ECROFIT CPD course please rate the following.



For yourself and your business what are the principal benefits following participation in the CPD course (tick all that apply)



Other: No benefits other than me having a better understanding of what others are doing.
We will be able to offer new services