Department for
Energy Security
& Net Zero

Evaluation of the Energy Entrepreneurs Fund

Final Report

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One page summary

Ipsos MORI, in association with Technopolis Group, were commissioned by the Department for Energy Security & Net Zero (DESNZ) to undertake an evaluation of the Energy Entrepreneurs Fund (EEF) Phases 1-7. The findings from the research are presented below:

Process evaluation

- Promotion of the scheme has generated high levels of interest and led to a large number of high quality applications. The assessment process appears broadly fit for purpose and was proportionate. The scheme generated high levels of additionality (as few projects would have moved forward in the absence of public funding).
- Incubation support[1] was positively received by applicants and considered useful when it tailored to specific details of the participating firm. Providers of incubation support were considered to offer the breadth of expertise to deliver outputs of the level of specificity needed and no gaps in the package were highlighted.

Impact

- The EEF has been largely successful in delivering its intended short-term outcomes of increased R&D activity (an increase of between £329m to £580m by 2020 in R&D spending and between 140 and 320 R&D jobs), increased technical progress (more rapid development of technology and acquisition of technological and project management skills), and commercial advancement, with the incubation support generally considered to be an important driver of progress.
- The EEF had a substantial positive impact on the ability of participants to raise follow-on funding both from private markets and publicly funded grants. Each grant awarded through the programme was estimated to increase the equity investment raised by firms by £0.7m to £2.1m on average by 2020 (from an average grant value of £462,000).
- The programme had smaller impacts on commercialisation at the time of the research, due to the time elapsing since support was awarded. As few projects had resulted in widespread adoption, there was limited evidence that EEF participation has led to significant economic benefits (in terms of productivity effects) or environmental benefits (although many technologies have the potential to do so).

Value for money

- The EEF has proven cost-effective as an instrument for leveraging private R&D investment into novel clean technologies. The level of additionality associated with the R&D grants is high and indicates that the programme has addressed shortages in the availability of funding for R&D.

[1] Incubation support is the provision of support for SMEs through business advice, market insights and commercialisation support.

- The impacts of the EEF are substantially larger than those observed from comparable grants provided without accompanying incubation support. This could suggest that the incubation support provided through the programme has had a significant amplificatory effect and increased the value for money associated with the programme.

Executive summary

Ipsos MORI, in association with Technopolis Group, were commissioned by the Department for Energy Security & Net Zero (DESNZ) to undertake a process, impact and economic evaluation of the Energy Entrepreneurs Fund (EEF) programme Phases 1-7 in November 2019. This document presents the findings from the evaluation.

Description of the programme

The EEF programme provides grant funding and incubation support to enterprises (mainly small and medium enterprises, SMEs) to help them develop and commercialise low carbon technologies, products, and processes. The programme has been delivered in a competitive format with resources allocated over seven funding rounds.

The programme committed £72m in grant funding to 156 projects to support their proposed R&D project. Applicants needed to match the grant with additional funding of at least 10 percent of the overall cost of the project. The grants awarded are expected to lead to increased levels of R&D spending and acceleration of the project through the development pathway, and lead to improvements in the commercial readiness of firms through the provision of tailored incubation support.

Most projects receiving EEF support were in the buildings or the energy networks and storage technology areas (based on programme management data). This aligns with the profile of applications received for the EEF. On average, the largest grants were awarded to projects in the Carbon Capture area (£638,000). The average starting Technology Readiness Level (TRL)[2] for the projects awarded funding were broadly comparable across technology areas.

[2] Technology Readiness Levels (TRL) are a type of measurement system used to assess the maturity level of a particular technology. The measurement system runs from one to nine, with nine being the highest level of maturity. A description of the TRLs is provided in the Technical Annex.

Table ES.1: EEF projects supported by technology area

Technology area	No. of funded projects	% of funded projects	% of applications	Average starting TRL
Buildings	48	31%	26%	4.9
Carbon Capture	8	5%	2%	4.2
Clean Industry	16	10%	7%	4.6
Clean Power	20	13%	22%	4.3
Energy Networks and Storage	38	24%	23%	4.3
Waste, Biomass and Water	18	12%	9%	5.4
Transportation	8	5%	8%	4.9
Other			2%	
Total	156			

Source: EEF programme Management Information; Figures may not sum to 100 percent due to rounding

Effectiveness of processes used by the programme

Phases 1 to 7 of the EEF have been largely administered effectively and efficiently:

- Promotion of the scheme has generated high levels of interest and given DESNZ many options to allocate funding to projects meeting its quality thresholds. 894 applications were received in total across the seven phases, and 156 grants were awarded, so 5.7 applications were received for each grant awarded. The assessment process appears broadly fit for purpose and was considered proportionate. Few projects failed to progress because the technology did not meet expectations, and a high level of additionality was demonstrated (as few would have moved forward in the absence of public funding).
- The contractual framework used to award funding to applicants was considered robust and gives DESNZ flexibility to discontinue projects if they fail on technical grounds.
- Incubation support was positively received by applicants and considered useful when it provided specific details supporting the development of their commercialisation strategy. Providers of incubation support were considered to offer the breadth of expertise to deliver outputs of the level of specificity needed and no gaps in the package were highlighted. However, questions were raised as to how far the smallest or least mature businesses benefitted from incubation support.
- Some stakeholders raised concerns that projects encountering difficulties were given too much support by DESNZ. There may have been opportunities to increase value for money by withdrawing funding from projects that proved not to be technically or

commercially viable. However, there was also a view that arrangements were too inflexible in cases where projects needed to 'pivot' to alternative objectives.

The main factors inhibiting the progress of applicants beyond the tenure of the grant stemmed from failures to advance the R&D project sufficiently to attract investment or issues with commercial viability. DESNZ could consider the following steps to improve value for money:

- Strengthening scrutiny of how far the proposed R&D project would need to progress in order to be likely to attract follow-on funding during the assessment stage under the policy implemented by the Government at the time of the appraisal.
- Adjusting the design of programme to require applicants to complete market validation to confirm commercial viability before it is permitted to progress the R&D project. This could give an opportunity to applicants to pivot to new objectives as well as identify cases where public investment in the R&D project may not lead to the desired results.
- Creating more flexibility to discontinue projects where changes in external commercial factors limit the likely future exploitation of the technology. This could involve adopting a 'stage-gate' review process that allows for go/no-go decisions based on external parameters as well as the achievement of technical milestones. This could also facilitate adaptation and re-prioritisation to changing external circumstances where appropriate.
- Developing a knowledge management function within the programme to codify the learning from projects. This could provide a resource that could be communicated to policy teams as well as assessors when appraising future applications for funding through the EEF (or other relevant programmes).

Impact of the programme

The EEF has been largely successful in achieving its intended shorter-term outcomes:

- EEF enabled participants to increase their R&D activity. The overall impact of the programme on R&D spending was estimated at between £328m to £580m by 2020, compared to grant spending of £67m. It was estimated that the EEF led to the creation of between 140 and 320 R&D jobs in the companies benefitting from the grant.
- The additionality of the R&D activity supported by the programme was high. Most declined applicants struggled to raise significant alternative funding for their projects and have only progressed them in a relatively piecemeal way.
- The R&D activity supported by the grants enabled firms to accelerate the development of their technologies. Firms awarded grants achieved more rapid development of their technology than declined applicants (an average increase of 2.4 TRL levels, compared to 1.5 for declined applicants). Delivering the project also had additional benefits, such as acquiring technological and project management skills.
- Most projects were viewed as technical successes by applicants and there were few examples of technologies that did not perform in line with expectations. However, technical success is not synonymous with commercial success and there were a variety

of examples of projects where the applicant pursued alternative directions at the end of the project because there was no market for the technology. This reinforces the recommendation made in Section 4 that some projects may benefit from more thorough market validation and business model development before progressing with R&D.

- EEF participants also advanced more rapidly in developing their business models and making commercial progress. The incubation support was generally considered by applicants an important factor in enabling this progression, who highlighted numerous benefits arising from the support. Those making the most significant progress tended to receive 'business development and sales support' activities.

The key findings from the analysis of the longer-term outcomes of the EEF indicate that:

- The EEF programme had a substantial positive impact on the ability of participants to raise follow-on funding both from private markets and publicly funded grants. Firms benefitting from the programme raised an average of £4.3m in equity funding by 2020, whereas declined applicants raised an average of £0.6m over the same period. Economic analysis indicated that each grant awarded through the programme was estimated to increase the equity investment raised by firms by £0.7m to £2.1m on average by 2020 (from an average grant value of £462,000).
- A large proportion of EEF participants have not yet secured follow-on funding to support follow-on R&D and scale-up (around 70 percent of participants). This is partly due to timing and some projects were still on-going at the time of the research. These firms tended to explore public funding options as they had not progressed to the point at which they could attract private investors. Firms often reported they needed to complete a commercial demonstration trial to attract follow-on investors. This can require substantial funding and clean technology firms face funding constraints at later stages, therefore there may be value in considering the possible benefits of additional public sector support for follow-on R&D for the most promising projects.
- There was also evidence that start-ups at very early stages of development were less able to benefit from the programme. The EEF did not appear to have a substantial effect on fundraising amongst those that had not already attracted financial backing from the private sector. This could imply firms need to reach a minimum level of development for EEF to have a positive effect in leveraging follow-on funding.
- As highlighted in Section 4, it may be worthwhile for DESNZ to consider the value of funding firms with less evolved business models to validate the proposed route to market and explore issues of commercial viability. This could take the form of a precursor programme to the EEF to help build readiness for the programme. Existing financial backing could be used as an indicator of whether a firm is 'ready' to participate in the programme.
- The programme had achieved relatively modest impacts on commercialisation at the time of the research, and the scale of the impact on commercialisation was much lower than the impact on fund raising. This is also a function of the time elapsing since grants were awarded (insufficient time had elapsed for many participants to commercialise their technology), and most participants had not abandoned their commercialisation of

their technology. However, commercial viability (partly arising from the direction of government policy) was often reported as a barrier to commercialisation. This highlights the importance of establishing the commercial viability of the proposed technology before committing funding to more costly R&D projects.

- As few projects have resulted in widespread adoption to date (due to insufficient time elapsing to commercialise technologies), there was limited evidence at this stage that EEF participation has led to significant economic benefits (in terms of productivity effects) or environmental benefits (although many technologies have the potential to do so).
- There was also limited evidence at this stage that the EEF programme has had any significant spill-over impacts outside of some isolated examples of policy influence. As highlighted in Section 4, it is recommended that DESNZ develop a knowledge management function to reveal barriers to commercialisation originating in policy.

Value for money

- The EEF has proven cost-effective as an instrument for leveraging private R&D investment into novel clean technologies. The level of additionality associated with the R&D grants is high and indicates that the programme has addressed shortages in the availability of funding for R&D.
- The EEF has been moderately cost-effective in delivering downstream outcomes such as leverage of follow-on investment and increasing the underlying value of the firms benefitting from the programme. This reflects the challenges encountered by firms in developing commercially viable technologies and in some cases the failure of expected markets to emerge.
- The impacts of the EEF are substantially larger than those observed from comparable grants provided without accompanying incubation support.. This could suggest that the incubation support provided through the programme has had a significant amplificatory effect and increased the value for money associated with the programme. While there are competing explanations for this finding, there is no evidence to suggest that major changes should be made to the fundamental design of the programme.
- An indicative cost-benefit analysis indicates that the programme is likely to deliver net benefits up to 2021 that exceed its net costs. However, the central benefit-cost ratio only just exceeds the hurdle rate of return applied in the economic appraisal of these types of programme by the Government.
- The evaluation highlighted that firms have faced a variety of constraints in commercialising their technologies. Some of these constraints have originated from there not currently being a conducive government policy to create the appropriate incentives for the market to adopt the technologies emerging from the programme. This

is reflected in some of the patterns observed, including the relatively low returns generated by projects in the 'energy demand' sector grouping.[3]

- However, an analysis of ex-ante modelling of the environmental benefits undertaken by applicants suggests that around one third would not be expected to deliver emissions reductions that exceed the value of grants awarded over a ten-year time horizon (even under the most optimistic assumptions)[4]. However, this is based on a small sample of projects which provided sufficient evidence to undertake an analysis of the environmental effects. Assuming projects will primarily generate future profits from the attractiveness of their commercial proposition (which the emissions reduction potential may significantly contribute towards), these projects were never likely to be commercially viable. This raises a question as to whether there may be value in integrating a formal, independent verification of the potential environmental benefits of the programme as part of the project selection process.

[3] Energy Demand is a Clean Technology category, which includes technologies which aim to reduce demand for energy.

[4] Guidance on the valuation of greenhouse gases published by DESNZ (then BEIS) in September 2021 provides updated values for carbon (this analysis was conducted in February 2021). Using these values, increased positive return on investment are observed per project but around one third of projects are still not be expected to deliver emissions reductions that exceed the value of grants awarded over a ten-year time horizon.

1 Introduction

Ipsos MORI, in association with Technopolis Group, were commissioned by the Department for Energy Security & Net Zero (DESNZ) to undertake a process, impact and economic evaluation of the Energy Entrepreneurs Fund (EEF) programme Phases 1-7 in November 2019. This document presents the findings from the evaluation. A Technical Annex, providing a detailed description of the EEF, the data and the analysis used is presented alongside this report.

1.1 Aims and objectives

As set out in the Invitation to Tender (ITT), this study aims to evaluate the delivery of the EEF, its reach, and the success of funded projects. The specific aims of the evaluation are to:

- Identify the overall benefits and impacts of the scheme,
- Assess the extent to which the scheme has achieved its objectives,
- Assess the cost effectiveness of the scheme and whether it has delivered value for money, and,
- Understand how implementation could be modified to optimise impacts, benefits and efficiency, including lessons learnt that can be applied to future innovation funding schemes and identifying whether the process was appropriate and proportionate.

A detailed set of evaluation questions are presented in the Technical Annex.

1.2 Data collection

A detailed description of the information and data used in the evaluation is presented in the Technical Annex. A summary of the evidence gathered is provided below:

- **Analysis of Management Information:** The evaluation was underpinned by an analysis of Management Information describing the delivery of the programme and outcomes achieved by funded projects. These included project application forms, technical and commercial assessment scores, monitoring information, Commercial Progress Reports (CPRs, completed by projects at the end of the EEF supported project), details of the incubation support activities delivered and the results of a survey undertaken by the incubation support provider in 2018. The quality of the Management Information was high, with the data collected for many of the key expected outcomes of the EEF programme being accurately recorded (based on validation via depth interviews and secondary sources). The coverage of the information was also high for Phases 5 to 7 of the programme. Some application forms and assessment records were missing for earlier Phases of the programme and CPRs were not compulsory on completion of the EEF project in Phases 1 to 4, meaning that not all projects had

completed a CPR. Additionally, DESNZ could not provide an annual breakdown of the public sector costs of delivering the programme.[5]

- **Energy Innovation Portfolio KPIs:** Further information collected by the DESNZ ThirdS contract provided data on the Energy Innovation Portfolio KPIs. This data only covered EEF projects in phases 5 to 7 of the programme.
- **Depth interviews with EEF applicants:** The evaluation involved a comprehensive programme of depth interviews with applicants to the EEF to collect evidence on their experiences of the programme and results achieved during and beyond the completion of the grant. 167 depth interviews were completed. 101 interviews were completed with successful applicants (from a population of 133 and a response rate of 76 percent) and 66 with applicants that scored highly in the technical assessment but did not receive funding (a technical assessment score higher than 60 out of 100). Written feedback was received from three applicants that declined to be interviewed. Interviews were undertaken using Microsoft Teams or Webex and recordings were transcribed to support detailed thematic coding using the NVIVO qualitative analysis software. Interviewees did not always have a perfect recall of applications submitted and projects delivered in earlier rounds of the programme. Some applicants did not provide consent to take part in the research (and were subsequently not interviewed).
- **Case studies:** Case studies involved follow-up interviews with seven firms benefitting from the EEF to collect further information about the commercialisation of technologies under development and associated environmental outcomes. These projects were selected in collaboration with DESNZ, with the aim of selecting case study companies that have achieved outlying commercial success or had identified a significant impact from the incubation support. The main challenge was securing engagement from applicants who had been selected as case study participants.
- **Depth interviews with stakeholders:** Depth interviews with nineteen stakeholders involved with the delivery of the EEF and the wider clean technology area were completed to obtain a broader perspective on the impact of the programme and its delivery. Stakeholder groups included DESNZ officials involved in the design of the programme, the technical assessment process, and monitoring of projects, external contractors (including providers of incubation support and monitoring services), and members of the commercial assessment panel. Interviews were undertaken over the phone, via MS Teams or Webex and transcribed for detailed thematic analysis.
- **Analysis of secondary datasets:** Multiple secondary data sources were also used to collect data for the EEF applicants. These included:
    - Data from the Office for National Statistics (ONS) Secure Research Service (SRS).[6] These data sources were the Business Structure Database (BSD) and the Business Enterprise Research and Development (BERD) dataset.

[5] An estimate of the public sector costs was provided by DESNZ, but no records were available which showed the amount of time spent by internal DESNZ staff on the EEF programme. Additionally, no records of the proportion of grant funding which had been claimed so far was provided.
[6] DRAFT NOTE: Copyright and acknowledge of ONS SRS data to be included in the final draft

- Online platforms providing real time information on disclosed investments in UK high growth companies and start-ups. The primary research using this type of data used data extracted from the Beauhurst database, but data on participants was also extracted from the PitchBook platform[7], and analysis was undertaken using both datasets separately.
- Data was also extracted from Innovate UK Transparency Data, which provided details of whether EEF applicants had secured funding from Innovate UK.

1.3 Overview of methodological approach

A detailed description of the methodologies used to analyse the information collected for the evaluation is presented in the Technical Annex. A summary of the methodological approach is presented in the table below.

Table 1.1: Methodological approach to EEF evaluation

Methodological approach	Areas of evaluation applied
Thematic and descriptive analysis: Examining qualitative and quantitative data to identify commonalities and patterns.	Process and impact evaluation
Qualitative Comparative Analysis: A method of analysing the causal contributions of different conditions to a given outcome variable.	Impact evaluation
Logistic regression analysis: A statistical analysis of binary outcome measures to explore which factors have a statistically significant effect on the outcomes the EEF is expected to contribute towards.	Impact evaluation
Econometric analysis: A series of statistical analyses exploring the impact of the programme on a series of economic indicators, such as employment, turnover, productivity and R&D activity.	Impact and economic evaluation
Cost Benefit and Cost Effectiveness Analysis: Comparing the outcomes and impacts achieved by the programme (and their monetary value) to the cost of delivering the EEF programme.	Economic evaluation

1.4 Structure of the report

The remainder of this report is structured as follows:

- Section 2 provides a brief description of the Energy Entrepreneurs Programme
- Section 3 provides an overview of the context for the programme
- Section 4 sets out the findings from the process evaluation
- Section 5 provides an assessment of the short-term outcomes of the EEF

[7] Pitchbook is a “Software as a Service” company that delivers data, research and technology covering private capital markets, including venture capital and private equity.

- Section 6 examines the medium-term outcomes associated with the EEF
- Section 7 provides an economic evaluation of the EEF programme
- Section 8 gives the conclusions and recommendations from the research

2 The Energy Entrepreneurs Fund

This section provides a brief description of the EEF programme and its intended outputs, outcomes, and impacts, and the hypotheses this evaluation is aiming to test. A more detailed description of the programme is provided in the Technical Annex.

2.1 Aims and objectives

The Energy Entrepreneurs Fund was launched in 2012 with the following aims and objectives:

- Produce disruptive/lower cost technologies that improve energy security, lower carbon emissions, or improve energy efficiency.
- Support SMEs and early-stage innovators to develop innovative technologies and processes.
- Leverage private sector funding into pre-commercial technologies and processes.
- Produce technologies that are market ready with businesses capable of achieving sales in the five years after grant.
- Produce projects and technologies that are ready for a large-scale demonstration or pilot.
- Support SMEs with technologies or products that are suitable for follow on private investment.

2.2 Programme overview

The EEF programme provides grant funding and incubation support to firms (mainly small and medium enterprises, SMEs) to help them develop and commercialise low carbon technologies, products, and processes. The programme has been delivered in a competitive format with resources allocated over seven funding rounds. These first seven rounds constituted part of the £505m DESNZ (then BEIS) Energy Innovation programme (EIP), which ran from 2015 to 2021; the EEF is continuing (from round eight onwards) as part of the £1bn Net Zero Innovation Portfolio, which will run from 2021 to 2025; the NZIP EEF rounds will be evaluated separately.

The programme was technology agnostic and delivered in response mode.[8] Specific technology areas were highlighted in the competition documents including building technologies, power generation, power storage, carbon capture and storage, manufacturing systems, and installation processes.

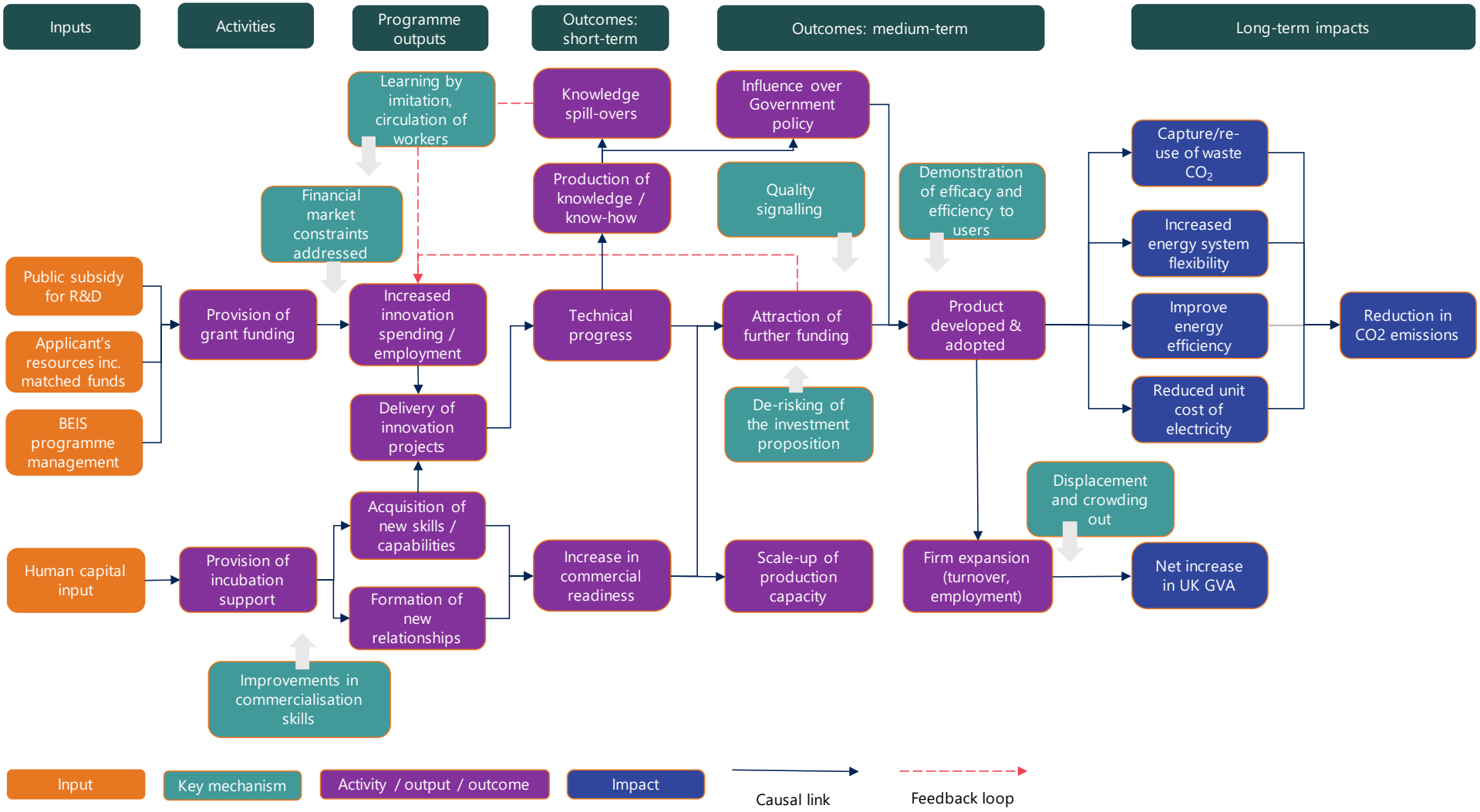
[8] Support is awarded to proposals in any area which is considered relevant to the overall aims and objectives of the EEF programme.

A detailed overview of the expected outcomes and impacts of the EEF is provided in the Technical Annex. A brief overview of the key pathways to impact is presented below:

- **Programme inputs:** The programme committed £72m in grant funding to 156 projects to support their proposed R&D project. Applicants needed to match the grant with additional funding of at least 10 percent of the overall cost of the project. Incubation support was provided by an external consortium selected through a competitive tendering process. Further resources were consumed by administration of the competition and monitoring of projects (externalised to a contractor in Phase 7).
- **R&D activity and technical development:** The grants awarded are expected to lead to increased levels of R&D spending and acceleration of the project through the development pathway. This assumes public funds are not used to deliver activities the private sector would have taken forward anyway (deadweight) and did not divert attention from parallel R&D programmes (crowding out). Higher levels of R&D spending may induce some firms to increase their employment of R&D workers. This may not occur if the additional spending is placed with contractors or if it 'leaks' into higher salaries for employees.
- **Improvements in commercial readiness:** The incubation support provided by the programme is tailored to the needs of the business and could provide a wide array of benefits. Examples include validation of the business proposition, refinements to commercial strategy, improved readiness for investment, recruitment of talent, or development of supply chains. Incubation support may also encourage firms to pivot to alternative business models or routes to market.
- **Follow-on funding:** Accelerated technical development and improvements in commercial readiness will 'de-risk' the company and the technology being developed. As grants do not dilute shareholder equity, they may also de-risk the balance sheet of the firm. Reductions in risk will increase the attractiveness of the company to external investors, enabling it to attract follow-on funding to support further R&D or scale-up.
- **Economic benefits:** If firms can successfully navigate the challenges involved in commercialising their technologies, they will be able to generate revenues from sales (or licensing) of their technologies. This would result in economic benefits in terms of impacts on employment, turnover and Gross Value Added (GVA), assuming the technologies developed are eventually exploited in the UK.
- **Environmental benefits:** Over time the adoption of technologies developed by users will contribute towards energy savings and a reduction in carbon emissions. As the EEF is delivered in response mode, the drivers of these benefits will vary across projects including increasing energy system flexibility, reduced reliance on fossil-fuel energy supply, reductions in the cost of low carbon energy, or improved energy efficiency.
- **Spillovers:** The knowledge produced in the delivery of the project could have two types of spillover impact. The development of clean technologies may influence government regulation or other policies by demonstrating that they are technically and commercially feasible (or by revealing barriers to commercialisation). Classical knowledge spillovers arising from the accumulation of tacit or formal knowledge are also possible.

This hypothesised process is summarised in following figure.

Figure 2.1: Simplified logic model for EEF programme[9]



Source: Ipsos MORI analysis

[9] BEIS changed its name to the Department for Energy Security and Net Zero (DESNZ) in February 2023.

2.3 Projects supported

As illustrated in Table 2.1, most of projects receiving EEF support were in the buildings or the energy networks and storage technology areas (based on programme management data). This aligns with the profile of applications received for the EEF. On average, the largest grants were awarded to projects in the Carbon Capture area (£638,000). The average starting Technology Readiness Level (TRL)[10] for the projects awarded funding were broadly comparable across technology areas.

Table 2.1: EEF projects supported by technology area

Technology area	No. of funded projects	% of funded projects	% of applications	Average starting TRL
Buildings	48	31%	26%	4.9
Carbon Capture	8	5%	2%	4.2
Clean Industry	16	10%	7%	4.6
Clean Power	20	13%	22%	4.3
Energy Networks and Storage	38	24%	23%	4.3
Waste, Biomass and Water	18	12%	9%	5.4
Transportation	8	5%	8%	4.9
Other	0	0%	2%	-
Total	156			

Source: EEF programme Management Information; Figures may not sum to 100 percent due to rounding.

2.4 Hypotheses being tested

The key hypotheses being tested in the impact evaluation are presented in Table 2.2.

Table 2.2: Hypotheses being tested

Hypothesis	Main hypotheses
1: Impact of regulation on project pipeline and availability of follow-on funding.	Regulation provides signals of future demand for clean technologies (context), encouraging agents to adjust their research and investment priorities (mechanism), stimulating early stage of proof of concept work in clean technologies and applications for funding through EEF (outcome one) and increasing resources available for later stage R&D and scale-up (outcome two).
2: Impacts on R&D spending	Grants awarded to financially constrained firms (context), will increase the resources available to the firm (mechanism), leading to an increase in resources expended on research and development (outcome).

[10] Technology Readiness Levels (TRL) are a type of measurement system used to assess the maturity level of a particular technology. The measurement system runs from one to nine, with nine being the highest level of maturity. A description of the TRLs is provided in the Technical Annex.

3: Impacts on technological development	Where grants for R&D bring additional resources to deliver innovation projects (context), the results of tests and development work will validate the efficacy and efficiency of the technology (mechanism), leading to higher levels of technical development (outcome).
4: Impacts on commercial readiness	Provision of incubation support to firms with gaps or deficits in commercialisation skills (context), will build understanding of the market potential of the underlying technology and what is required to commercialise it (mechanism), leading to actions to improve the commercial readiness of the company (outcome).
5: Impacts on follow-on investment	De-risking of the technology, the business model and/or the management team achieved (context), will increase the expected returns on investment (mechanism), increasing appetite for investment by the private or public sector (outcome).
6: Impacts on commercialisation and adoption	Additional resources secured by the applicant are used to fund further technology and business development (context), demonstrating the commercial viability and efficacy of the technology (mechanism), enabling engagement of customers, adoption of the technology, and generating orders and revenues for firms (outcome).
7: Net economic benefits	Additional resources and/or revenues available to the firm (context), encourages additional investment in the production capacity and recruitment of workers (mechanism), increasing the output (GVA) of the firm in the UK (outcome).
8: Environmental impacts	Technologies commercialised by EEF beneficiaries are integrated into energy networks or other end-use applications (context), reducing energy consumption, the cost of energy production and/or increasing domestic energy production from low carbon sources (mechanism), resulting in reductions in emissions (outcome).
9: Spill-overs	Knowledge acquired from R&D has potential policy application (context), is disseminated to regulators and alters direction of regulation (mechanism), leading to more favourable conditions for commercialisation (outcome). Knowledge acquired from R&D has potential application in other research or industrial contexts (context), and is transmitted to other firms by circulation of workers in labour market or learning by imitation (mechanism), leading to the pursuit new avenues of inquiry with the potential further programme objectives (outcome).

3 Programme context

The Energy Entrepreneurs Fund (EEF) was established in 2012 to support the development of start-ups and SMEs in the clean technology sector and address shortages in private funding. This section provides a brief overview of how the sector has evolved since the programme was launched and explores its position in the wider funding landscape.

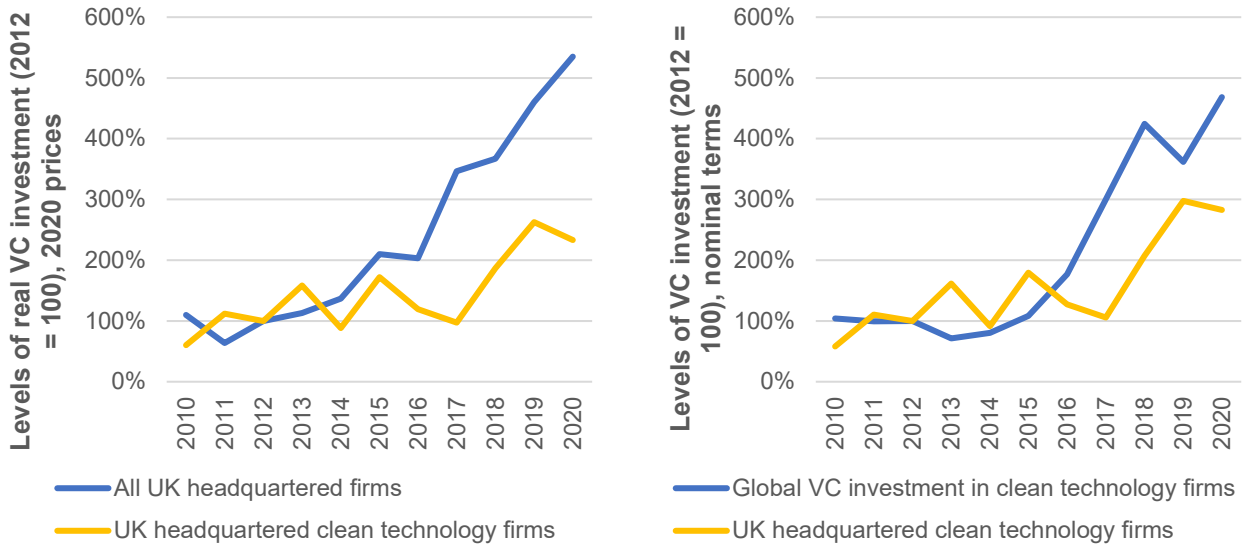
3.1 Private investment in clean technologies

The EEF was established in part to address shortages in equity funding for firms in the clean technology sector that were thought to be holding back development and commercialisation of low carbon technologies. Based on figures compiled by PitchBook:

- Levels of venture capital (VC) investment in UK headquartered firms in the clean technology 'industry vertical'[11] rose in real terms from around £200m in 2012 when the programme was launched, to £400-500m per annum between 2018 and 2020.
- While this represents more than a doubling of investment levels, overall levels of VC investment in UK headquartered firms expanded more rapidly over the same period (rising by over 400 percent from £2.8bn to £13.1bn in real terms).
- The UK has also not benefitted from a rapid expansion in global VC investment in the clean technology sector. While global VC investment in firms in the clean technology sector grew by 368 percent in nominal terms between 2012 and 2020 (from £3.9bn in £18.6bn), investment in UK headquartered firms grew by 182 percent.
- While UK companies accounted for 5.2 percent of global VC investment across all sectors, they only accounted for 2.5 percent of global VC investment in clean technology in 2020.

[11] An industry vertical describes a group of companies that focus on a shared niche or specialised market spanning multiple industries.

Figure 3.1: VC investment in UK headquartered clean technology firms, 2010 to 2020



Source: PitchBook

- These figures indicate that the UK clean technology sector has faced constraints in the supply of private funding and that it struggles to compete at the international level. Further analysis of the cohort of start-ups in the clean technology sector between 2010 and 2019 highlighted that the nature of the constraints faced are complex:
    - **First fundraisings**: 781 UK headquartered companies were founded in the clean technology sector between 2010 and 2019.[12] The companies were more successful in completing their first fundraisings than firms in other sectors of the economy. Almost 40 percent went on to raise equity funding from angel investors or VC funds, compared to 24 percent of all firms founded over the period. The average amounts raised (£1m) were comparable to firms in other sectors of the economy.
    - **Follow-on rounds:** Funding constraints faced by clean technology firms were more apparent in follow-on rounds. Around 43 percent of firms in the clean technology sector raising VC investment reached a third funding round in line with firms in other sectors. However, the average amounts raised by clean technology companies in later funding rounds (£2.4m) was substantially lower than those by firms in other sectors (£4.7m).
    - **Progression to an Initial Public Offering:** Firms in the clean technology sector were equally likely to successfully complete an Initial Public Offering as start-ups in other sectors (around one percent of companies founded between 2010 and 2020). Clean technology firms raised larger amounts of capital than other firms (£125m vs £106m on average) and attained higher valuations (£283m vs £95m on average).
    - **Demand side factors:** Based on PitchBook data, the annual number of new clean technology companies founded fell steadily from 2015 onwards (up to

[12] Based on figures compiled by PitchBook, which will be biased towards innovative firms seeking equity funding.

2020). As PitchBook tracks firms that have secured equity investment, recent figures will be biased downwards. However, the decline in UK headquartered clean technology start-ups was larger than seen globally. This could raise concerns regarding the strength of the pipeline of new companies seeking funding from the programme in any future interventions.

This picture does not fully align with the perspective offered by stakeholders consulted as part of the evaluation (applicants for funding as well as policy and industry stakeholders). Stakeholders were almost unanimous in suggesting that companies active in the sector faced a substantial shortage in the supply of funding.

The data is suggestive of a more nuanced picture. Firms in the sector appear to face constraints in raising private funding as they progress towards later stage R&D and scale-up but are not disadvantaged relative to other start-ups at the earliest stages. Demand side factors (i.e. the number and quality of firms seeking equity investment)[13] also appear to be a factor in the UK's competitive disadvantage with respect to other nations.

These findings do not point to flaws in the Business Case for EEF. However, it does suggest the grants awarded through the programme (at an average value of around £450,000) may be small relative to size of the apparent funding constraints faced by firms in the sector.

3.2 Public support landscape

Stakeholders consulted as part of the evaluation stressed the programme currently occupies a unique place in the public support landscape:

- **Response mode funding:** The EEF is delivered in response mode and is open to applications from across the clean technology sector. Stakeholders within DESNZ valued this aspect of the programme as it provided broad exposure to new ideas and technologies emerging from across the private sector. The programme was thought to offer useful insights for policy makers in revealing what novel technologies may prove technically and/or commercially viable and the barriers encountered by firms at commercialisation. In principle, this information could be used to inform the path of future regulatory development.
- **Commercialisation support:** The EEF also differs from most other innovation support programmes in that it pairs incubation support with grant funding for R&D.

The programme was launched during a period of substantial expansion in public support for industrial innovation which was accompanied by a proliferation of new programmes. In 2012, Innovate UK launched the Energy Catalyst which was also delivered in response mode and had analogous objectives to the EEF. The agency also increased its volume of thematic Collaborative Research and Development (CR&D) competitions, completing other long running schemes such as the Low Carbon Vehicles and Low Impact Building Innovation Platforms. The government has continued to introduce funding programmes that tackle similar issues. These

[13] Based on an analysis of Pitchbook data.

include DESNZ initiatives such as the Low Carbon Heating Technology Innovation Fund, the Thermal Efficiency Innovation Fund, and the Industrial Energy Efficiency Accelerator as well as numerous Industrial Strategy Challenge Fund providing funding for mission led research and innovation.

3.3 Broader policy context

Government policies and regulations influence the conditions for the commercialisation of clean technologies. The overall policy direction was set in 2008 when the UK passed the Climate Change Act into legislation in 2008 which set out a legally binding target to reduce greenhouse gas emissions by 80 percent by 2050 (compared to 1990 levels). The Climate Change Act also set out pre-determined carbon budgets to 'spend' over a five-year period to achieve the UK's overall targets.[14] In June 2019, parliament passed further legislation to reduce net emissions of greenhouse gases by 100 percent relative to 1990 levels by 2050. This will require all emissions produced by the economy to be offset by their removal from the atmosphere.

Successive governments have introduced a wide range of policies and regulatory initiatives to achieve these goals. It is beyond the scope of this report to provide a comprehensive summary of these initiatives. However, stakeholders within DESNZ and applicants highlighted that changes in the wider policy framework since the EEF was launched have created some uncertainties amongst investors, and in some cases disrupted commercialisation plans. Specific examples highlighted in the research included:

- **Feed in Tariffs:** The Feed in Tariff (FiT) subsidy scheme, which was available in Great Britain, was introduced in 2010 and ended in March 2019. The scheme secured payments (p/kWh) for renewable energy generation (solar, wind, micro combined heat and power boilers, and anaerobic digestation) on a 20-year contract with the goal of incentivising new renewable electricity generation and allowing small scale developers to recoup the cost of installation. DESNZ introduced the Smart Export Guarantee (SEG) in the wake of the FiT closure which required energy suppliers to provide payments for micro-generation of electricity, though there is no minimum price payment or minimum contract length to provide security to incentivise small scale installations.
- **Renewables Obligation:** In 2017, the Renewable Obligation (RO) programme, which acted as the UK's primary support mechanism for large-scale renewable electricity projects from 2002 onwards, closed operations. The mechanism required UK electricity suppliers to source a portion of their supply from renewable generation. UK suppliers issued a minimum number of Renewable Obligation Certificates (ROCs) which held a corresponding financial value to renewable electricity generators thereby increasing the proportion of renewably sourced electricity on the grid system and further enhancing the renewable energy market. In its absence, government policy moved towards the Contracts for Difference scheme (available in Great Britain only) to support new large-

[14] http://www.legislation.gov.uk/ukpga/2008/27/pdfs/ukpga_20080027_en.pdf

scale renewable electricity projects. The implications of closing the ROC regime signifies a shift away from renewable energy subsidies towards renewable energy price stabilisation.

- **Carbon price floor:** In 2013, the Carbon Price Floor (CPF) was introduced as a mechanism to bolster the effects of the EU Emissions Trading System (ETS). It ensured a minimum price for carbon and that if EU ETS credits were to fall below this price point, emitters must pay the difference to the Treasury. The policy intended to underpin the price of carbon at a level that drives low carbon investment.
- **Automotives:** Emission standards in the UK automotive sector have historically been led by European Commission directives. These directives have progressively introduced more stringent standards for the permitted level of emissions for new vehicles sold in the European Union. The latest directive (Euro 6) was introduced in 2014 and required automotive manufacturers to reduce average CO2 emissions across their range to 98g per km by 2020. More stringent standards have led to considerable investment in R&D focused on developing alternatives to thermal propulsion systems, which the industry coalescing around electric vehicles as the future technology standard in the mid-2010s.
- **Building technologies:** The buildings sector is a significant contributor to the UK's emissions. The government enacted a Zero Carbon Homes policy in 2011 that would have required all new homes built from 2016 to mitigate all carbon emissions produced on site from regulated energy use. Numerous applicants in earlier Phases of the scheme had developed innovations to support the delivery of this regulation. However, government took the decision not to proceed with the standard, which had a significant impact on demand for the products under development. Applicants also highlighted uncertainties around government's plans to implement the Future Homes Standards.

4 Process evaluation

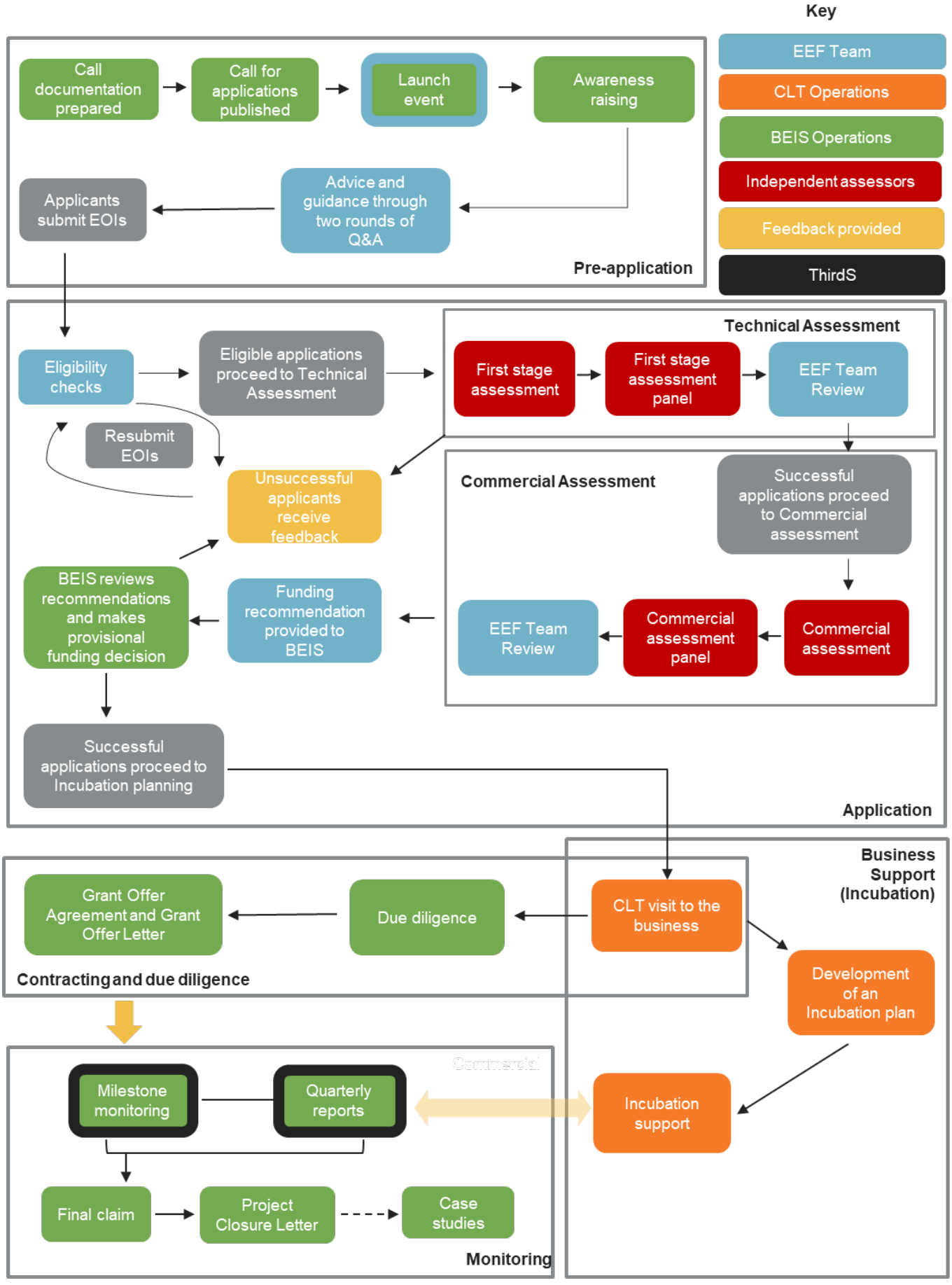
This section provides an assessment of the processes deployed to administer the Energy Entrepreneurs Fund. It is based on evidence collected from the applicant and stakeholder interviews and a review of Management Information.

4.1 Process overview

Figure 4.1 provides an overview of the processes used to deliver the EEF (a more detailed description is provided in the Technical Annex). Their effectiveness has been assessed in terms of how far they mitigated potential threats to the achievement of programme objectives:

- **Information asymmetry:** The government is faced with an information asymmetry problem in the delivery of the EEF programme. Applicants for funding have greater information than the government on the merits of their proposals and whether they would be taken forward without public support. The application process should 'reveal' these parameters to enable funding to be routed to proposals with greatest scope to deliver against programme aims.
- **Moral hazards:** Those awarded funding may face incentives to pursue less risky objectives after the grant has been secured, which deviate from the original objectives on which the application was assessed (for example acting on new information about their technology or route to market). This may alter the basis on which public funding was awarded or threaten the achievement of programme objectives. This risk can be managed with the specification of an appropriate contractual framework and monitoring of project delivery.
- **Incomplete contracts:** The outcomes of innovation projects are uncertain, and it is not feasible to develop a contract that accounts for all potential innovation outcomes. Facilitating the progression of projects that show promising results while avoiding the commitment of public funds to likely 'dead ends' requires flexibility both in the specification of the contract with the applicant and in its monitoring and enforcement.
- **Dissemination mechanisms:** The delivery of EEF projects may produce 'public goods' in the form of widely disseminated knowledge that could be used to inform or guide the development of policy, lower search costs for investors, or demonstrate the viability of investments in clean technology. The realisation of these benefits will be linked to the effectiveness of mechanisms used to disseminate this information to the relevant communities.
- **Efficiency and value for money:** Processes should also be judged against their efficiency and value for money. This will be partly linked to the resources consumed in the delivery of the process. However, value for money may also be threatened if resources are used to pursue technologies which are known to be 'dead-ends'.

Figure 4.1: Energy Entrepreneurs Fund – Process Map[15]



4.2 Complementarity with other public funding programmes

The evidence collected indicated there has been a level of duplication across parallel programmes. Many EEF applicants were applying to multiple programmes at the same time and some were offered support by multiple programmes and having to decide which funding stream to accept. This duplication in effort was not seen as a problem for DESNZ, with stakeholders and a small number of applicants reporting there was encouragement from Government to apply to multiple programmes to try to ensure that the maximum number of high quality applications received funding. Additionally, as the Department for International Development (DFID)[16] became a more prominent funder of the Energy Catalyst from the mid-2010s, it has been increasingly directed at addressing international development issues (leaving EEF as the main response mode programme targeting clean technologies).

4.3 Communications activity

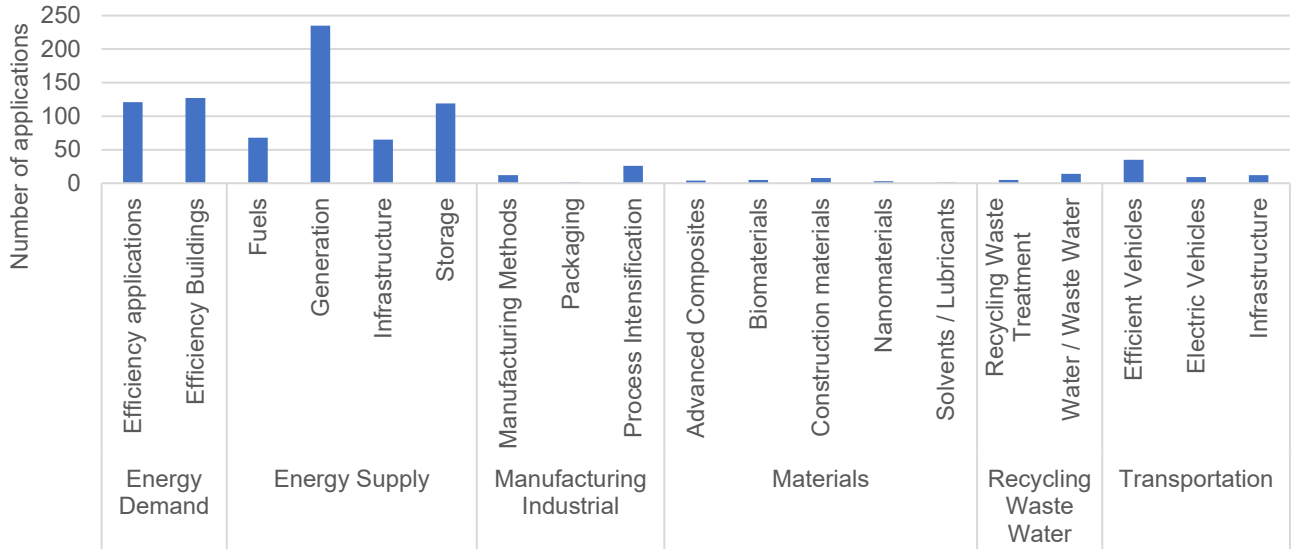
4.3.1 Penetration of the clean technology sector

The communications strategy to make potential applicants aware of the EEF programme has stimulated a high level of interest.[17] 692 organisations submitted a total of 894 full applications over the seven phases.

The applications covered a diverse range of technology areas in line with the technology agnostic nature of the programme as illustrated in Figure 4.2. Most applications related to energy demand and energy supply technologies. Stakeholders considered that the profile of applications reflected the areas where the private sector saw opportunities to generate profits. Areas where there is no commercial market and development is being directed by government, such as carbon capture, use, and storage (CCUS) and hydrogen, saw relatively low volumes of applications. Some stakeholders speculated that the branding of the programme may have encouraged the relatively low numbers of applications from organisations outside the energy sector that could have innovative ideas which contribute to the objectives of the EEF programme.

[15] BEIS changed its name to the Department for Energy Security and Net Zero (DESNZ) in February 2023.
[16] DFID merged with the Foreign & Commonwealth Office (FCO) in September 2020 to form the Foreign, Commonwealth & Development Office (FCDO).
[17] This is based on the views of applicants and stakeholders, and an analysis of programme Management Information. The research team did not collect the views of non-applicants.

Figure 4.2: Number of applications received by technology type (across all phases)



Source: EEF application forms

For Phases 1 to 6 of the programme, the EEF was promoted on the Government website, through the Knowledge Transfer Network (KTN), and clean technology networks. Most applicants stated that they found out about the programme from their professional networks or word of mouth (including being informed about the programme by the organisations delivering incubation support where they had existing relationships with them).

A small number of interviewees raised concerns that communications were not reaching potential applicants outside existing networks. Penetration is challenging to assess because the clean technology sector does not correspond to the Standard Industrial Classification groupings used to classify economic activities. A partial assessment has been completed by comparing the companies applying to EEF to the population of UK headquartered companies in the 'cleantech' industry vertical[18] [19]:

- PitchBook records indicate that 739 companies were founded in the 'cleantech' industry vertical between 2010 and 2019. Sixty-eight made an application to EEF. This suggests the programme attracted applications from nine percent of relevant start-ups and there may be an untapped pool of potential applicants (although not all would be suitable).
- The profile of applicants aligned with the profile of the wider sector in terms of the distribution across sectors and the age of companies. There was no evidence of structural bias in the profile of applications received.

[18] An industry vertical describes a group of companies that focus on a shared niche or specialised market spanning multiple industries.
[19] This was based on companies tracked by PitchBook and will not provide a complete record of all start-ups in the clean technology sector. The figures should be treated as indicative.

The communication strategy was altered for Phase 7 in response to concerns regarding its penetration of the sector. This involved more social media activity, a launch event, and involvement of other organisations (such as LEPs) to increase awareness. The altered strategy did not produce an increase in full applications submitted. 102 applications were received relative to an average of 127 in prior rounds. However, the number of applications needs to be set in the context of an apparent decline in the number of new start-ups in the sector observed since 2015.

4.3.2 Clarity of communications

The information provided by DESNZ explaining the application process was seen by applicants as providing a clear explanation of its requirements. Few ineligible full applications were received, indicating that the eligibility criteria were clearly explained. Applicants stated that they received adequate responses to any queries they had before and during the application process. Applicants also indicated that the assessment criteria were clearly explained. No suggestions were made to improve the communications developed.

4.4 Application process

The application process for the EEF involved two stages. Interested businesses first submitted an Expression of Interest. They were then invited to complete a full application providing details of the business proposition, the technology, the proposed R&D project, its potential environmental benefits, the project team, and why public funding was required.

4.4.1 Expressions of Interest

The Expression of Interest (EoI) process was designed to capture details of firms interested in submitting applications for funding and allow them to be invited to make an application through the on-line system. 1,419 EOIs were submitted between Phase 2 and Phase 7.[20]

Just under half of those submitting EoIs (48 percent) submitted a full application. No research was completed with those that did not apply (this was out of scope for the evaluation) and the reasons for non-submission are unknown. However, some stakeholders speculated that firms may have realised that their project was ineligible or unsuitable, or that they did not have the resources to complete the R&D project. The rate of non-submission is not considered problematic as the volumes of applications received have exceeded DESNZ's ability to fund them.

The process was not designed to filter out ineligible or unsuitable projects and the volumes of applications received created significant administrative costs. However, opportunities to realise efficiencies by adjusting the EoI process to collect information needed to determine eligibility or complete an initial quality assessment are limited.

[20] No information is available for the number of EOIs received for Phase 1 of the programme

An initial quality check of EOIs could eliminate the lowest quality applications and reduce the number of applications which require a technical assessment. However, this would most likely only lead to a small reduction in the number of applications requiring a technical assessment (for example a reduction of 20 percent if applications which scored lower than 40 out of 100 on the technical assessment were deemed to be unsuitable). It would also introduce a significant cost to the EOI process, so may not offer value for money.

4.4.2 Application form

A total of 894 applications for funding were received by DESNZ for the EEF programme across Phases 1 to 7. A total of £337 million of funding was applied for. These 894 applications related to 692 firms (6 firms bid multiple times and were successful with every bid, 62 firms bid both successfully and unsuccessfully, 63 firms bid multiple times and were only unsuccessful in their bid, and 563 only submitted a single bid).

Applicants and assessors indicated that they were broadly satisfied with the application form:

- **Application form:** Most applicants reported that the information they were asked to provide was relevant to their proposal. Applicants with experience of applying to other public schemes stated that the information being asked for was broadly comparable.
- **Proportionality:** Applicants generally reported incurring costs of around two to three weeks of labour time to complete the application form, although there was some variance. This was considered proportionate to the funds available and in line with similar schemes.
- **Timings:** Applicants considered that competition timelines gave them sufficient time to complete a high-quality response. While many described being ‘rushed’, this was driven by difficulties securing inputs from subcontractors or competing internal pressures.
- **Views of assessors:** Assessors stated that the information provided by applicants was appropriate and gave sufficient evidence to score applications against the criteria.

There were some areas where applicants and stakeholders considered greater levels of support could be offered:

- Applicants reported that the application form required them to quantify future sales volumes. Early stage companies that had not completed significant market validation found these questions difficult as they did not have the information needed to develop these projections.
- Applicants also reported that estimating the environmental impacts of adoption of the technology was also considered complex. This was more difficult for firms with projects at lower levels of technical maturity and little technical data. Applicants developing software rather than hardware were more likely to encounter difficulties estimating their emissions impacts. It may be beneficial to offer more guidance or an online “masterclass” or workshop to explain what type of information is required and how to estimate these impacts.

- Stakeholders and applicants suggested that providing some form of advice or review could be beneficial for businesses that are newer to applying for public sector support. This could include critical review of applicants' answers or a discussion to inform them of what is required. This advice would need to be provided by parties not involved in EEF (such as the KTN).

Some stakeholders involved in the assessment process reported that applicants provided a large amount of information. This increased the burden on the assessor and the applicant. It was suggested that content volumes could be reduced by making questions less open ended.

4.4.3 Quality of applications

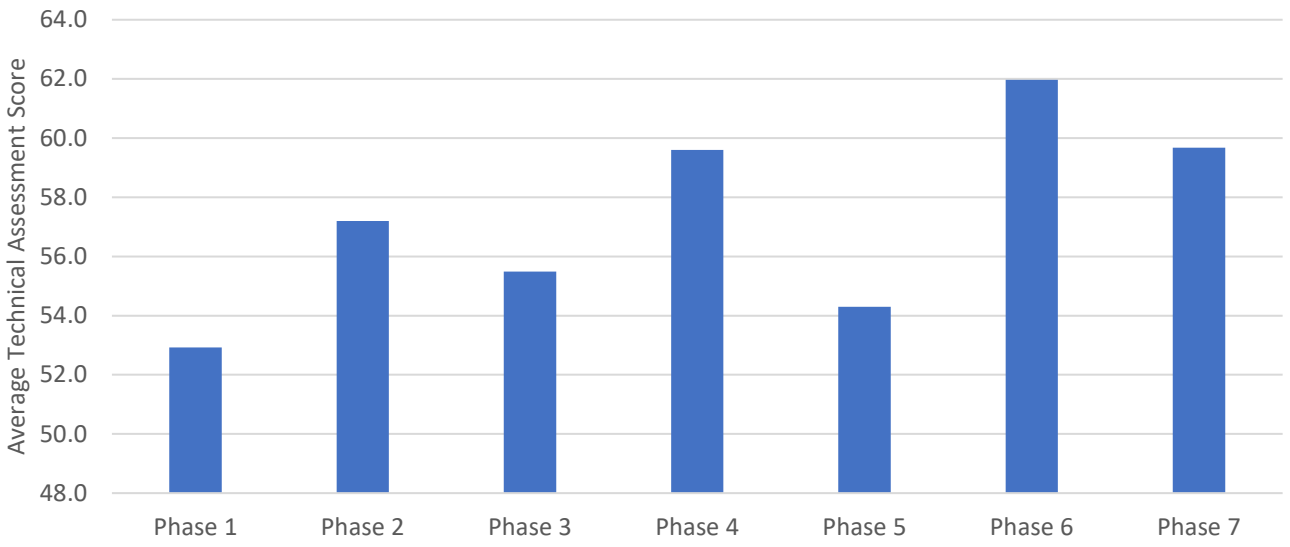
The application process led to the submission of a large pool of high scoring applications, giving DESNZ many options from which to select the portfolio of projects. Where technical assessment scores were available[21], 51 percent (363 of 718) received a technical assessment score of 60 or more out of 100. The grant request associated with these applications totalled £163m. This was more than double the funding awarded (£72m).

However, assessors noted that the quality of applications submitted varied. Around 17 percent (118 of 718) of applications attracted a score of 40 or less. Assessors considered that the key factor driving lower scores was an absence of evidence to substantiate the commercial or technical claims being made. Assessors were also clear that a fair assessment could only be made based on information provided in the application form and it would be inappropriate for them to seek further evidence through supplementary online searches.

The average assessor score for applications increased slightly as the programme progressed, with the highest average score being seen in Phase 6. Despite Phase 4 being targeted at a specific technology type, there was no decrease in the average score of applications submitted. Stakeholders and applicants were not able to provide any reasons as to why the average scores have varied across phases.

Figure 4.3: Average technical assessment score by phase

[21] Technical assessment scores were available for nearly all projects from Phase 2 to Phase 7, but the technical assessment scores for all Phase 1 projects was not available to the evaluation team



Source: EEF Applications, EEF technical assessment scores. Note that the average scores for Phase 1 are based on the subset of technical assessment scores which were available.

Reductions in the level of resources required for the assessment of low scoring bids could potentially be found by enriching the guidance provided to applicants. This guidance describes the questions that assessors will address in the assessment (for EEF Phases 1-7, with the guidance being updated during the delivery of the programme). However, it does not articulate the substantiating evidence that is sought, such as the importance of providing results of patent searches to demonstrate the level of novelty associated with the innovation.

4.4.4 Multiple applicants

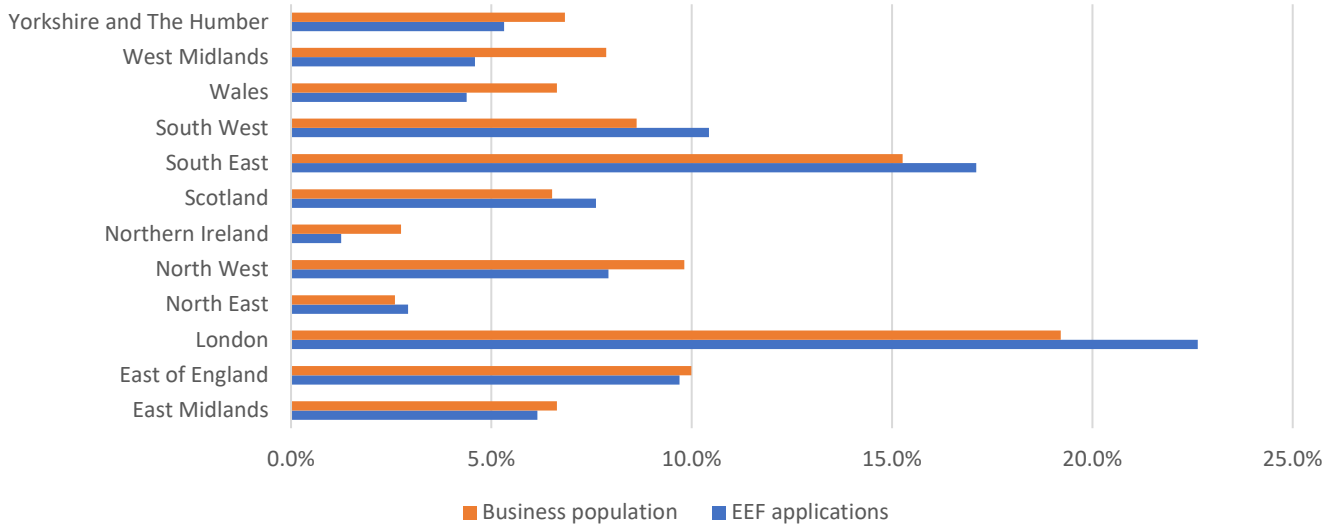
A total of 131 firms applied more than once for EEF grants and support, relating to 330 applications (just over one third of applications). Most of these (86 firms) applied twice, although some firms applied up to six times for funding. The reasons for multiple applications was explored in the depth interviews with applicants. Those that applied multiple times most commonly applied using the same technology. Despite applying using the same technology and having received feedback on their previous bid, the average scores awarded to applicants did not generally improve, and many applicants reported either not using the feedback received or not finding the feedback they received as being useful for their subsequent bids. However, there were a small number of examples of multiple applicants which did refine their bid based on the feedback they received (this was largely around feedback on the commercial aspects of their application, rather than the technology underpinning the application). This suggests that the feedback provided, if properly processed, could be useful in informing future applications to the EEF.

4.4.5 Geography of applicants

The London region attracted the most applicants across all phases (217), while the South East trailed close behind (164). Northern Ireland saw the fewest number of applicants across all phases (12) with no applicants in Phases 3 or 5. Of the English Regions, the North East saw

the fewest applicants (28), with no applicants during Phase 4. However, when examined across all phases, the number of applications to the EEF by region is broadly in line with the proportion of businesses operating in each region (see figure below).

Figure 4.4: Applications to EEF by UK Nation and English Region



Source: EEF Applicant Database; Companies House data

4.5 Assessment and award process

4.5.1 Assessment criteria

Stakeholders involved in the assessment process and management of the programme agreed that the criteria for assessing applications in the technical assessment and by the commercial panel aligned with the aims of the programme. The domains against which applications were assessed were considered appropriate and useful in selecting which projects to support. No stakeholders highlighted any significant omissions.

The technical assessment criteria are accompanied by scoring criteria giving details on the evidence applicants need to provide to attain different scores. These include some thresholds for quantitative aspects, such as the size of the potential market, to support consistency across assessments. Assessors and other stakeholders commented that:

- **Assessment of the carbon case:** Guidance on assessing the 'carbon case' for funding the project does not provide thresholds against which the significance of the environmental benefits should be assessed.
- **Evidence:** The scoring criteria award higher scores to proposals that are accompanied by greater evidence of market potential or validation. Some assessors reported this favours technology at higher maturity levels. Analysis of award decisions supports this. Sixteen percent of firms putting forward technologies at TRL3 were awarded funding, compared to around 25 percent of firms that put forward technologies at TRL4 to TRL8.

The added value of public sector funding is included as a component of the technical assessment and carried a five percent weight in the overall score (in Phase 7). This raises a possibility that high quality, but low additionality, proposals can still obtain high technical scores. There could be a case for additionality as a 'pass or fail' criterion. However, as shown in Section 5, levels of deadweight were low and only a small share of declined applicants obtained alternative funding to take their projects forward.

4.5.2 Selection of technical assessors

The technical assessment involved the assessment of the submitted application form by three technical assessors. These assessors were selected from technical experts from within DESNZ Science and Innovation team and external contractors with relevant skills and experience. The technical assessment scrutinises technical aspects and the strength of the underlying business model and proposed route to market. Each application was assessed and scored out of one hundred.

Stakeholders considered that an effective assessor pool requires both knowledge of engineering and the clean technology industry. It was acknowledged that not all internal assessors had a detailed knowledge of every technology area. However, stakeholders involved in the technical assessment process and programme management suggested that while external assessors were used by DESNZ and could offer complementary technical understanding, the stakeholders considered them less able to place the project in its market context and judge the strength of its commercial rationale.

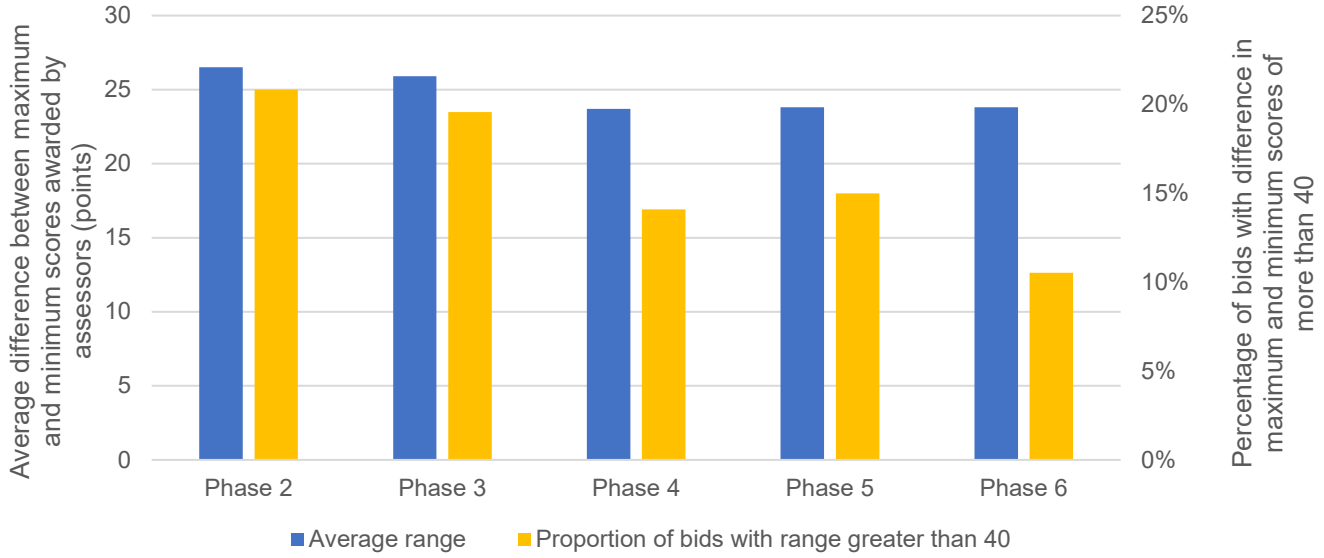
Some stakeholders also raised concerns about the amount of time that internal assessors could commit to completing assessments. While the assessment process was not considered disproportionate (at around 2 to 3 hours per assessment), the workload needed to be completed alongside normal responsibilities. This limited the level of time some assessors could make available and the depth they could provide in the comments.

4.5.3 Effectiveness of the technical assessment

Evidence gathered from applicants indicated that few EEF-funded projects did not reach commercialisation because the R&D project failed to deliver against its intended aims and objectives. This indicates that the technical assessment has been broadly effective in ensuring resources are allocated to projects that are technically feasible.

Stakeholders involved in the management of the programme and applicants raised concerns about the level of variation in scores awarded by the three assessors assigned to evaluate each application (for Phases 1 to 6 of the EEF programme). Figure 4.3 below shows that the range between the minimum and maximum scores awarded varied between 23 and 27 points between Phase 2 and 6. Between 10 and 20 percent of applications had a gap of more than 40 points. As the average technical assessment score was 56 points, this underlying variance could potentially have a significant impact on the likelihood of success.

Figure 4.5 Range in technical assessment scores and proportion of bids with range higher than 40 points by Phase



Source: Management Information, technical assessment scores

Stakeholders accepted that some variance across individual assessment scores was inevitable. However, their analysis of the comments made by assessors suggested that they had taken different approaches to evaluating the merits of bids, and in some cases, had not followed the guidance. Analysis of the assessments completed for Phase 6 highlighted:

- **Variation across assessors:** There were examples of large variances. The most extreme involved one application that received scores of 1, 41, and 84. When examining the scores for this application in detail, one assessor concluded the proposed team had none of the skills needed in the technology area while another concluded the team had all of the skills needed to deliver the project, based on the same written response. This highlights challenges in using average scores to determine which applications progress.
- **Internal and external assessors:** Thirty one percent of the assessments were completed by assessors internal to DESNZ. Assessments completed by internal assessors were associated with greater variability.
- **Variability across domains:** The largest contributors to overall variation in scores were the assessments of the commercial case for the innovation (questions 1 and 2). In principle, this area would be the priority for improving the consistency of scores.

In Phase 7 a new approach to moderation was introduced to reduce variability in scores. This involved two stages of moderation during the technical assessment. The first involved team leaders moderating the scores awarded by their team members, and the second involved team leaders moderating scores across teams. It was reported that this increased the transparency of the technical assessment process, as more individuals were involved in the moderation of scores and increased information about the moderation process was documented.

4.5.4 Commercial panel

The second stage of assessment involved a review of the highest scoring applications from the first stage by a commercial panel led by the EEF delivery partner. The commercial panel was made up of unpaid experts from the investment community and other organisations considered able to assess the commercial merits of the applications (e.g. Carbon Trust, Nesta). Each proposal was assessed by two members of the panel against six criteria. The commercial panel then met to form consensus recommendations on which projects should receive funding based on their ability to attract follow on venture capital investment.

Members of the commercial panel considered they were provided with sufficient material to form an understanding of the business and project. Stakeholders with knowledge of the process also considered the panellists had the required knowledge and skills to robustly assess the projects and businesses. The commercial panel was thought to add value to the assessment process and there was only a weak correlation between the scores awarded in the technical assessment and by commercial panellists, indicating the panels were not assessing applications with the same perspective, and therefore adding input from a different viewpoint to the technical assessment.

However, some concerns about the commercial assessment were raised by stakeholders:

- **Technical viability:** Some technical assessors raised concerns that the rank order of proposals could change substantially following the panel. Examples were given of proposals that were considered to have issues with their technical viability that rose closer to the top of the list following the commercial panel (which considered the value of the potential commercial outputs). This was not a widespread concern and only four proposals with a technical score of less than 60 were funded. There are also safeguards as the recommendations of the commercial panel are advisory rather than binding.
    - It may be beneficial to consider a higher quality threshold for proposals to be considered by the commercial panel to reduce the risk that technical infeasible projects receive support. Stakeholders involved in the assessment process also suggested that the panel could include representation from technical assessors to communicate any concerns.
- **Preparation:** There was no guarantee that the unpaid panel members would prepare sufficiently for the commercial panel meeting. Stakeholders highlighted a risk that projects assigned to panel members that had prepared less diligently would have less information presented at the panel.
- **Criteria:** A final concern related to how the commercial panel formed assessments. The panel were given criteria to assess against but could discuss topics that were not within these criteria. This could lead to a lack of clarity on how decisions were formed.

As highlighted in Section 6, many firms benefitting from the EEF have not been able to secure follow-on funding or commercialise their products. There are questions as to whether adjustments to the commercial panel process could focus more on the constraints faced:

- **Level of maturity:** A common constraint reported by applicants was that the EEF scheme did not advance their project sufficiently to attract investment or support commercialisation. The way in which the panel consider whether the programme of R&D would advance the project sufficiently to attract private investment could be reviewed. A focus on production costs alongside sales projections may help identify projects whose development may be constrained by issues with profitability.
- **External factors:** In many cases, commercial viability was affected by external factors that influenced demand for the technologies. Examples included changes to policies creating the end market for the innovation (e.g. cancellation of the Zero Carbon Homes policy or reductions in Feed-In-Tariffs for renewables) and falling oil prices. These external factors cannot necessarily be predicted by panellists – it may be beneficial to include DESNZ policy colleagues in the assessment process, who may have more insight into potential future policy changes that would affect end markets.

4.5.5 Feedback to declined applicants

Declined applicants were provided with feedback on their applications. Many declined applicants reported that they considered that the technical assessors did not fully understand the technology, which influenced the score they received (an endemic feature of innovation competitions). Most of the declined applicants that complained about the feedback were also unsuccessful in applying for other funding, suggesting that the technology (or their ability to communicate the benefits of their application) was the reason for being unsuccessful.

4.5.6 Multiple awards

Sixteen firms successfully applied for EEF support on more than one occasion – most of these received two awards, but four firms received three or more awards (17 projects). Of these firms that were interviewed, all stated that they had received multiple awards for the same (or very similar) technology. The firms that received multiple awards did feel that there were additional benefits to receiving more than one round of support from the EEF. The most common reason for this was that at the end of the first EEF project, the technology was not sufficiently developed to generate commercial outcomes, and the further support was necessary to move the technology further towards a commercial outcome in order to secure private follow-on funding. These firms did explore other public funding opportunities, but felt that the timing and focus of the EEF application phases suited their needs. The firms had also had a positive experience of the EEF programme, and were happy to receive support from the programme again.

4.6 Due diligence and Grant Offer Letter

Successful applicants were required to complete a due diligence process and agree a Grant Offer Letter that set out the terms and conditions of the grant award and defined their obligations. The following points of feedback were made on this process:

- **Due diligence:** The due diligence process involved an undertaking in difficulty test (this was undertaken in all phases, although the format of the undertaking in difficulty test was altered to be a more stringent assessment in later phases) to check the financial health of the applicant as a requirement of the State aid rules. Applicants and stakeholders reported that this test required a significant amount of time. Another factor reportedly creating delays was applicants not having their match-funding or consortium agreements in place (though in later rounds DESNZ would allow the applicant to raise the match funding as an obligation in the Grant Offer Letter). However, no projects failed the due diligence process.

  Due diligence also involved an initial meeting between DESNZ, the incubation support team and the applicant which included a further discussion of the technical merits of the applicants' technology. As few projects were abandoned due to technology failures, formal checks on technical claims made by applicants are unlikely to reduce risk.
- **Milestones:** The Grant Offer Letter defined technical milestones that each applicant needed to meet to unlock the next tranche of funding. This was seen as a strength of the Grant Offer Letter, offering DESNZ significant protection from the risk of continuing to fund R&D projects that are failing to deliver against their objectives.
- **Timescales:** Stakeholders involved in the management of the EEF programme reported that the agreement of milestones was thought to contribute to long timescales for the signature of the Grant Offer Letter. On average, around four months (120 days) elapsed between the intended timing of the Conditional Offer Letter and the start date of the project recorded. This did not vary substantially across Phases and is longer than observed in other DESNZ programmes funding industrial R&D. For example, a process evaluation of the Aerospace Technology Institute[22], which involved substantially larger grants, estimated that the time elapsed between the Conditional Offer Letter and the signature of the Grant Offer Letter was 57 days. The time taken to sign the Grant Offer Letter was not a material concern for applicants, who did not highlight any examples where this has had an adverse effect on project delivery.
- **Withdrawal of funding:** Some comments were made by stakeholders that in some instances, the Grant Offer Letter could be tightened to allow DESNZ to withdraw funding more rapidly. Applicants were given six months to resolve issues arising in the delivery of the project. However, the stakeholders reported that some milestones have clear success or failure implications and value for money could in some cases be improved if funding was withdrawn more rapidly. An example was given of one project that did not pass safety tests (which would clearly be required if the technology were to be successfully commercialised).
- **External risk:** The Grant Offer Letter did not allow DESNZ to withdraw funding if there were changes in the external context that meant that the project was unlikely to prove commercially viable. This could include changes in the policy environment or the arrival of a superior competitor. One relevant case involved a project where the commercial case for investment was based on revenues from Feed-In-Tariffs. Changes were made

[22] BEIS (2017) ATI Process Evaluation

to policy between the application and the Grant Offer Letter that meant that the technology could no longer be exploited profitably. The applicant was permitted to complete the R&D project but did not seek to pursue it further and did not disseminate the knowledge outcomes from the project.

4.7 Incubation support

Incubation support was a central element of the programme. Firms awarded EEF support had an initial meeting with an incubation planner to decide which support activities the business would benefit from, which was formalised in an Incubation Support Plan. The plan could be changed as a business' needs altered throughout the project.

Feedback provided by the stakeholders (those involved in the management of the programme and the delivery of incubation support activities) and applicants indicated that the quality and relevance of the incubation support activities was generally high:

- **Scoping meeting:** Successful applicants generally considered that the incubation support activities they agreed were suitable for their business. Any issues were usually resolved through further meetings between the incubation manager and the participant.
- **Range of support available:** The support activities were delivered by a consortium of providers. Where the providers in the consortium did not have the skills or experience to deliver a specific incubation support task then specialist sub-contractors were drafted in. Few participants highlighted gaps in the incubation support offer.
- **Quality and usefulness of support provided:** Successful applicants reported a high level of satisfaction with the quality and usefulness of the support they received in the CPR (3.2 and 3.1 out of 4 respectively). The following points were raised in interviews:
    - **Depth of expertise:** The advantages of providing the support in collaboration with large engineering suppliers were stressed. As EEF is technologically agnostic, incubation support providers require knowledge of many markets and technology areas. Successful applicants valued outputs that provided specific details enabling them to develop their commercialisation strategy, such as details of regulatory requirements in overseas markets. It was suggested that large engineering firms best placed to provide this support and expertise as they had knowledge across different sectors and multiple markets, although this required personnel to be well networked across their business. Outputs produced by well-known companies were also thought to give additional credibility with external investors.
    - **Non-tailored outputs:** Successful applicants found non-tailored outputs less useful – although these were reported to be provided infrequently (compared to tailored outputs) by both stakeholders involved in the provision of incubation support and successful applicants. Stakeholders involved in the delivery of incubation support noted that where this occurred, it could reflect the engagement of the company with the incubation support package. For example,

if the successful applicant stated that they wanted support to produce market demand projections to 2050, it was thought to signal that the successful applicant did not intend to make short-term use of the findings. However, stakeholders involved in the management of the programme and the delivery of incubation support activities also considered that non-tailored outputs often arose where the management teams at the successful applicant had weaker commercial skills or experience and were therefore less able to judge what types of output would be most useful to them.

- **Seniority:** Some successful applicants reported that the budgetary constraints of the support package meant that one to one interaction with applicants was led by junior members of the team that could struggle to gain traction with a CEO of a start-up.
- **Understanding of SMEs:** A small number of successful applicants (nine businesses) considered that the incubation support was tailored to larger businesses that lacked understanding of how small businesses operate. As an example, one applicant perceived that an individual providing fundraising knowledge primarily had knowledge of fundraising in a corporate rather than a VC backed enterprise context.
- **Timing:** A small number of participants stated that while the incubation support was helpful, they would have been better delivered in different orders or at different times within the project to maximise their impact.

4.8 Monitoring

Findings from the interviews with stakeholders suggests that the project monitoring procedures put in place did provide an adequate framework for understanding the progress of projects. The information collected, and the knowledge and experience of monitoring officers was seen to be sufficient, and appropriate to the size of projects, to understand the progress of projects.

Applicants reported that the monitoring of their projects was generally proportionate and helpful in ensuring that they achieved their objectives. Most reported meeting with their monitoring officer regularly and reported that they had sufficient knowledge to challenge them and offer advice about the project. Specific themes arising in the interviews included:

- **Change requests:** Many applicants reported that the process involved in making requests for minor and more significant changes to their project was broadly proportionate. DESNZ were also commended for their flexibility during the COVID-19 pandemic in supporting extensions to Grant Offer Letters.
- **Suitability of monitoring framework:** Monitoring officers described challenges in assessing whether applicants had met technical milestones when difficulties were encountered. This raises questions as to how far success/fail criteria and associated evidence requirements were sufficiently unambiguous, although no specific examples of this issue were provided by stakeholders consulted.

- **Termination:** Only a small number of projects were closed prematurely, and a concern was raised by some stakeholders involved in the management of the programme that the monitoring approach taken may have been too supportive. This would imply technically, or commercially, unviable projects were able to continue when they should have been closed. The reasons for the terminations were not foreseen at the technical assessment process.
- **Flexibility:** At the same time, some stakeholders also considered that the approach taken to fundamental changes in scope was inflexible. An example was highlighted of a project that sought to 'pivot' in response to the incubation support findings that its original approach would not be commercially viable. While the alternative approach was viewed as an improvement, an argument was made that the integrity of the competition would be diminished if such changes were approved (and funding was withdrawn).

For Phase 7 of the EEF programme, monitoring arrangements were externalised to contractors. This has been positively received by DESNZ as it has reduced pressures on internal staff that previously accommodated the role within their normal duties. There has been no impact on satisfaction amongst applicants. However, there were concerns raised by stakeholders involved in the delivery of incubation support that the absence of DESNZ from key discussions with applicants has led to some inertia where significant change requests were involved.

4.9 Reporting and knowledge management

The monitoring process also produced knowledge-based outputs with potential use beyond keeping track of the progress made by individual projects.

- **Reporting burdens:** Most applicants were satisfied with the amount of reporting they were being asked to complete. They considered the information they were asked to provide necessary but time consuming to complete (though no more than other public programmes). Duplication was reported in a minority of cases where monitoring officers and incubation support managers were asking for similar information to be reported. Effective sharing of reports could help prevent such issues arising in the future.
- **Policy development:** The information most valued by DESNZ for the purposes of policy development was evidence on the barriers to commercialisation faced by applicants. This was largely compiled on an ad-hoc basis and the externalisation of the monitoring function was thought to have distanced DESNZ from project results and the issues firms were encountering. There may be benefits in developing a knowledge management function to support dissemination of lessons learned from the delivery of projects (e.g. a synthesis of the challenges encountered by projects and what impact this had on their ability to raise further funding or commercialise their technology).
- **Feedback into selection process:** There was no evidence of a significant feedback loop in which the lessons from historic projects informed the selection process. The outputs of any synthesis of project lessons could also inform the technical assessment (e.g. by highlighting examples where similar projects have encountered issues).

- **Commercial Progress Report:** Most stakeholders involved in the management of the EEF programme, the delivery of incubation support activities and monitoring felt that when completed, the Commercial Progress Report collected all relevant metrics for EEF participant businesses. This included commercial and technical metrics, albeit the outcomes were self-reported by the applicant. For Phases 1-4, the Commercial Progress Record was voluntary, meaning that not all EEF participants completed the form, but this has been rectified in subsequent phases.

4.10 Conclusions

Phases 1 to 7 of the EEF have been largely administered effectively and efficiently:

- Promotion of the scheme has generated high levels of interest and given DESNZ many options to allocate funding to projects meeting its quality thresholds. The assessment process appears broadly fit for purpose and was considered proportionate. Few projects failed to progress because the technology did not meet expectations, and few would have moved forward in the absence of public funding (demonstrated by the high levels of additionality achieved – see Sections 5, 6 and 7). The contractual framework used to award funding to applicants was considered robust and gives DESNZ flexibility to discontinue projects if they fail on technical grounds.
- Incubation support was positively received by applicants and considered useful when it provided specific details supporting the development of their commercialisation strategy. Providers of incubation support were considered to offer the breadth of expertise to deliver outputs of the level of specificity needed and no gaps in the package were highlighted. However, questions were raised as to how far the smallest or least mature businesses benefitted from incubation support.
- Some stakeholders raised concerns that projects encountering difficulties were given too much support by DESNZ. There may have been opportunities to increase value for money by withdrawing funding from projects that proved not to be technically or commercially viable. However, there was also a view that arrangements were too inflexible in cases where projects needed to ‘pivot’ to alternative objectives.

The main factors inhibiting the progress of applicants beyond the tenure of the grant stemmed from failures to advance the R&D project sufficiently to attract investment or issues with commercial viability. DESNZ could consider the following steps to improve value for money (although these may reduce the number of applications for the programme):

- Strengthening scrutiny of how far the proposed R&D project would need to advance in order to be likely to attract follow-on funding during the assessment stage under the policy implemented by the Government at the time of the appraisal.
- Adjusting the design of programme to require applicants to complete market validation to confirm commercial viability before it is permitted to progress the R&D project. This could give an opportunity to applicants to pivot to new objectives as well as identify cases where public investment in the R&D project may not lead to the desired results.

- Creating more flexibility to discontinue projects where changes in external commercial factors limit the likely future exploitation of the technology. This could involve adopting a ‘stage-gate’ review process that allows for go/no-go decisions based on external parameters as well as the achievement of technical milestones. This could also facilitate adaptation and re-prioritisation to changing external circumstances where appropriate.
- Developing a knowledge management function within the programme to codify the learning from projects. This could provide a resource that could be communicated to policy teams as well as assessors when appraising future applications for funding through the EEF (or other relevant programmes).
- Potential areas where the application process could be strengthened would be through the provision of additional information and guidance on specific areas of the application (such as modelling the environmental impacts), potentially through an online “masterclass” or workshop. Additional advice or a review function could be offered by organisations not directly involved in the EEF (for example KTNs) if DESNZ provide information and guidance to these organisations.
- The commercial panel assessment could be more efficient if a higher quality threshold for proposals to be considered by the commercial panel was introduced to reduce the risk that technically infeasible projects receive support. Additionally, broadening the participation in the commercial assessment panel (to include technical and policy experts) could help to increase the likelihood that projects achieve longer-term outcomes.

5 Short term outcomes

This section presents an assessment of the short-term outcomes of the Energy Entrepreneurs Fund Phases 1-7. It explores the effect of the programme in leveraging additional R&D investment into clean technologies, associated progression of projects through the development pathway, and development of the underlying business model. The findings are based on the programme of depth interviews with EEF applicants, programme Management Information, primary research with programme stakeholders and data collected from secondary data sources.

The primary research included depth interviews with 169 applicants (101 successful and 68 firms whose applications were not successful). These depth interviews were conducted via MS Teams or Webex. Further depth interviews (as part of case studies) were conducted with seven firms and their customer / partner organisations.

The secondary data sources analysed included:

- Data collected as part of the delivery of the programme (Management Information), such as completed CPRs, application forms and programme monitoring.
- Data from the Office for National Statistics (ONS) Secure Research Service (SRS) Business Enterprise Research and Development (BERD) dataset.

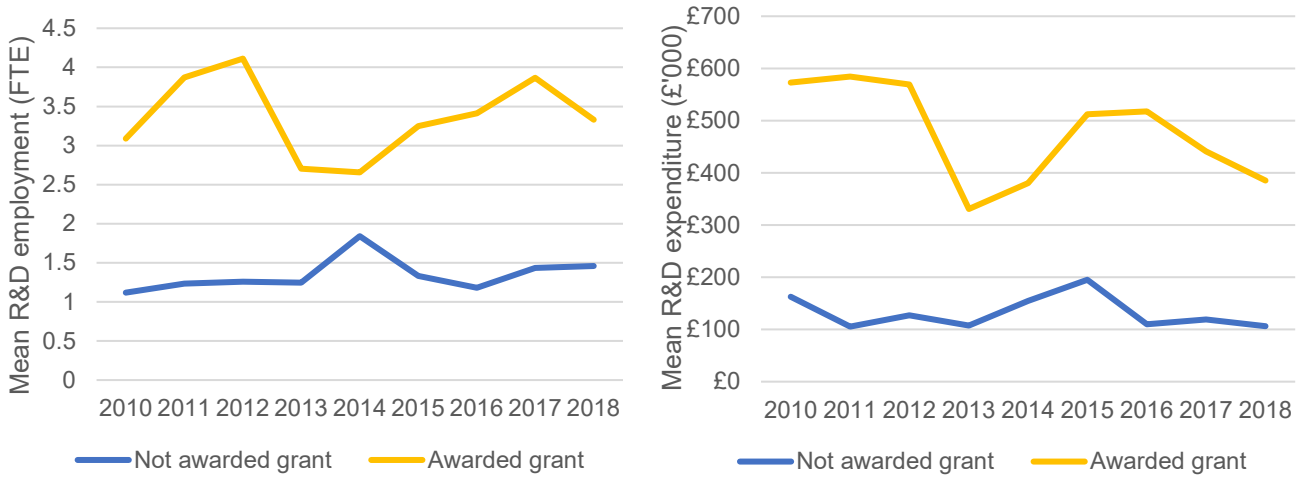
5.1 Effects on Research and Development (R&D) activity

5.1.2 Overall impacts on R&D spending and employment

Participation in the EEF increased levels of R&D activity amongst firms supported by the programme. The most robust evidence in support of this conclusion was derived from a series of econometric analyses that compared the R&D spending and employment of those awarded grants to a comparison group of firms whose applications were declined.[23] As illustrated in Figure 5.1 below, the average R&D spending of firms increased relative to the comparison group between 2013 and 2018.

[23] Using secondary data derived from the Office for National Statistics' Business Expenditure on R&D survey. The approaches used in this analysis compared the outcomes achieved by high scoring declined applicants and successful applicants. It should be noted that the EEF assessment process aimed to ensure that the programme was selecting participants most likely to achieve positive outcomes. The econometric approaches used aimed to minimise this potential bias. For more details please see the Technical Annex.

Figure 5.1: Average R&D employment and expenditure (2019 prices), 2010 to 2018



Source: Business Enterprise R&D Survey (2021). Ipsos MORI analysis.

The findings of the econometric analysis provided strong evidence that participation in the EEF programme led to an expansion of R&D activity. The estimated effects of the programme on measures of R&D activity are summarised in Table 5.1. The key findings included:

- The overall impact of the programme on R&D spending was estimated at between £328m to £580m by 2020, compared to grant spending of £67m. This indicates the EEF was successful in leveraging additional R&D spending and that additionality was high.
- It was also estimated that the EEF led to the creation of between 140 and 320 R&D jobs in the companies benefitting from the grant.
- The estimated effects of the programme on R&D spending were larger than those observed on R&D employment. The findings suggest that at least some of the increased R&D spending has been absorbed by higher wages.

Table 5.1: Estimated impact of EEF on R&D expenditure and employment

Measure	Estimated average increase (%, high-low range)[24]
R&D expenditure	38 – 68
R&D employment	13 – 30
Wages of R&D workers	39 - 73
Publicly funded R&D	7 – 58

[24] The figures represent the estimated percentage change on each indicator as a result of participation in the EEF programme. For example, as a result of taking part in the EEF programme a firm will (on average) increase the number of people employed in R&D by between 13% and 30%.

Privately funded R&D	41 – 69

Source: ONS Business Enterprise R&D Survey, Ipsos MORI analysis

5.1.2 Factors contributing to expansions in R&D activity

The data gathered from the depth interview programme was used to explore the conditions under which the EEF produced increases in R&D activity using Qualitative Comparative Analysis[25]. These findings indicated that applicants increased their R&D activity under the following five sets of conditions or 'causal pathways':

- They were successful in their EEF application; or
- They were an early stage business[26] with existing Intellectual Property (IP)[27]; or
- They had existing IP but did not have significant finance prior to EEF[28]; or
- They were an early stage business but did not have significant finance prior to EEF; or
- They were a mature firm with significant finance but no existing IP.

The first pathway suggests that receiving EEF support was a factor in businesses increasing their R&D spending and employment, regardless of the characteristics of the project or the business. However, the findings also suggest that a wide variety of different groups of declined applicants also expanded their R&D activity following their application to the programme. Given the findings of the econometric analysis, the results indicate the programme has increased the overall level of R&D investment but not the likelihood that firms expanded their R&D activities.

5.1.3 Experiences of declined applicants

Almost 4 in 10 declined applicants interviewed reported that they continued with the project in some form. However, they were rarely able to proceed with the project as envisaged in their application and faced substantial difficulties in securing funding:

- **Actions taken to obtain follow-on funding:** Nearly two thirds of declined applicants interviewed sought funding from other sources after their EEF application was declined. Nearly all of those that pursued alternative finance sought alternative public funding while a smaller share sought private funding. Alternative public funding was sought when the project was considered at too early a stage to interest investors or where there were problems establishing a route to market.
- **Success in obtaining further funding:** Declined applicants were rarely successful in obtaining funding from other sources. Some of the declined applicants interviewed that sought funding reported they secured alternative public grants, private equity markets, and infrequently both. Some declined applicants continued to develop their innovative project with investment from its directors, sales that the company made in other areas,

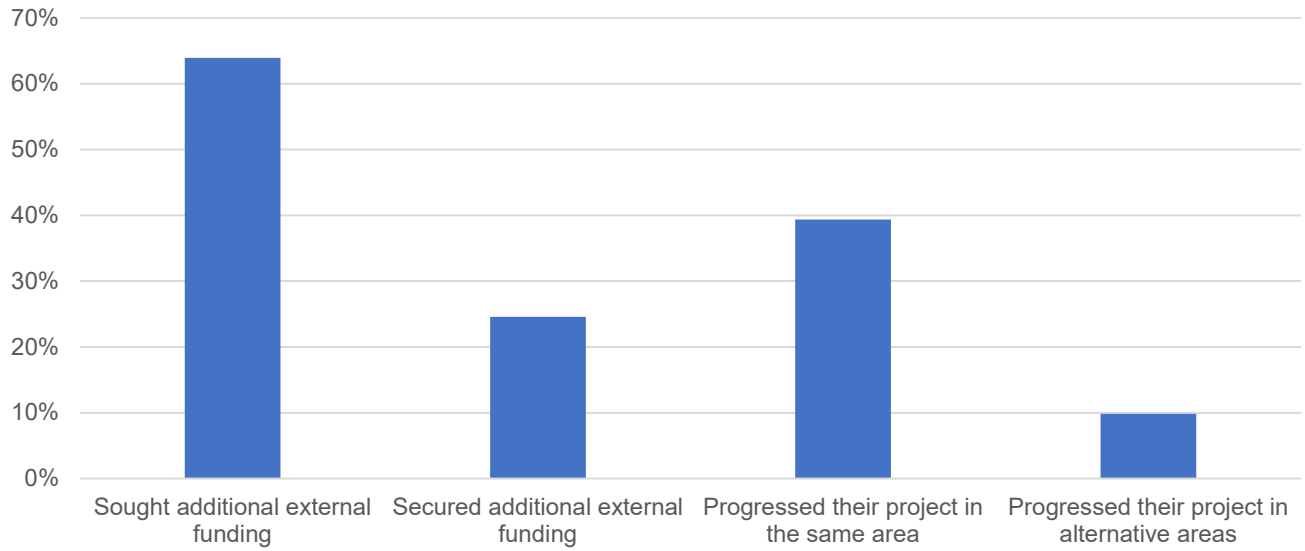
[25] This was measured using a binary variable that equalled 1 in cases where applicants had experienced an increased in R&D employment and/or spend, and equalled 0 where no change or a negative change was observed. The conditions selected were based on the combination that minimised contradiction within the cases.
[26] An early stage business was defined as business operating for less than five years.
[27] Existing IP is measured as whether a business had secured IP for the innovation prior to its EEF application.
[28] Significant finance is defined as having secured £250k or more private investment prior to the EEF application.

small investments from friends and family, or in-kind contributions from existing networks. These contributions tended to be small and only enabled piecemeal progression of the project.

- **Barriers encountered:** The main barriers in obtaining further funding reported by declined applicants included:
    - The technology was at too early a stage of development. This would not necessarily be an issue for those seeking public funding but issues arose in relation to the eligibility criteria for alternative funding sources (with applicants applying for Horizon2020 funding) and the level of funding being sought (above £1 million for some of the applicants highlighting this barrier).
    - The commercial market for technologies was tied to government policies which also had upstream impacts on the ability of firms to obtain funding. For example, one declined applicant described how policy moves away from promoting biomass reduced the funding available for their technology. Interventions in adjacent markets could also have an impact. One firm developing a solar product to compete with ground source heat pumps found themselves facing subsidised competition when grants for adopting the latter were introduced. This meant that both public and private funding sources saw their product as unviable.
    - A small number of applicants were unsure why their applications for funding (for sources of public funding other than the EEF) had been unsuccessful. For example, one felt that they had a strong business case for grant funding, but were rejected, and stated that they thought that the assessors did not understand their technology – but when probed could not provide another reason for why the application had failed. This could suggest that there is an internal barrier within the business, in that they do not have the skills to explain their technology and the benefits it will generate.
- **Self-funding:** Most firms that continued with the project did not obtain additional funding from elsewhere. This had a substantial effect on the overall resources available to continue the project. As an example, one company described bringing forward part of their technology with internal funding of under £10,000 but applied for over £800,000 of EEF grant funding. This meant that they had made a small amount of technical progress (on a single component of a wider technological plan), but not as much or as wide ranging progress as they would have with EEF support.
- **Effects on project delivery:** The reduced funding available to the declined applicants had a significant impact on delivery of the projects. The most common effect was that the project was delivered on a reduced scale, making less technical progress than they could have with the EEF funding. For example, one company aiming to develop a commercially ready prototype of a solar product ended up developing a small batch of the product in a laboratory setting at a lower specification to provide proof of concept.
- **Sector:** Declined applicants in the clean power technology were most likely to continue with their project, although there were limited commonalities across cases that provide a clear explanation for this pattern.

- **Alternative actions taken:** A small number of declined applicants interviewed reported they progressed R&D activities in related fields, but not the technology proposed for EEF funding. For example, one declined applicant repurposed software to be used to support household energy usage in houses into a forecasting application.

Figure 5.2: Progression of project proposals, declined applicants



Source: Depth interviews, applicants declined EEF funding; Base: 66 applicants whose application was not successful

5.2 Impact on technological progress

5.2.1 Project results

Programme Management Information suggests that few projects encountered significant technological issues. Of the 156 projects, CPR information was available for 92.[29] Most self-reported they had achieved the technological targets (such as successfully developing a prototype or validating findings) they described in their application and a small proportion only partly met their objectives. Partially meeting objectives means that the project did achieve technical progress, but did not progress as far as they had planned for in their application. A handful of participants reported that the R&D project demonstrated that the technology was not feasible. These patterns were confirmed by the depth interview programme, which highlighted:

- **Challenges encountered in delivery:** EEF participants reported multiple challenges in the delivery of their EEF projects. The most common issues related to logistical and management challenges such as being unable to access equipment and infrastructure, not having the right staff available to deliver the project, or limited cashflow. Some external challenges were also reported. These were less common but predominantly arose from issues with government policy and regulation. These included challenges in

[29] This is because not all projects have been completed, and those that have not been completed did not submit a CPR. Additionally, in Phases 1-4, it was not compulsory for participants to complete a CPR, therefore not all firms completed one.

developing a commercial product that is in line with regulatory requirements, regulatory bodies not understanding the innovation being developed, not being able to achieve market / regulated emissions targets, or requirements for licences. Few respondents (six out of 92) reported issues with the underlying science behind their innovation (and were generally able to progress with other work packages).

- **Technical performance vs expectations**: It should be noted that claims that projects met their objectives did not always imply that the project was a technical success (for example successfully building a prototype, but the prototype not performing at a required level). There were examples of projects that experienced (or were experiencing) unanticipated technical issues with the performance of their innovation. In some cases, these projects were not feasible for the technology as described in the application to achieve the outcomes they had set out in their workplan.
- **Technical success vs commercial success:** A small number of firms found that the technology they were developing would not be useful for the market. While the R&D project was successfully completed, they pivoted their technological development to another area. For example, one participant that was aiming to move their technology into roofing and building panels saw that regulation may make this a challenging market and pivoted towards refrigeration and electric vehicle battery cooling. This highlights the potential value of completing a commercial viability test before embarking on the R&D project, as recommended in Section 4.
- **Projects partially meeting objectives:** While a small share of projects only partly met their objectives, these could have potentially significant implications for the commercialisation of the technology. For example, one project aimed to develop a form of solar panel that could be used on roofs and walls – but they found the wall panel did not yield the required amount of power, so development of this stalled. However, the solar panel being used on roofs could still be a significant commercial success.

The Management Information also suggested that CCUS projects were less likely to achieve all their goals in comparison to projects in other technology areas. Interviews with CCUS projects suggested that these projects had encountered technical problems, which prevented them from making as much progress as expected. For example, one project identified that its results using one material were not satisfactory and they were forced to switch to another material. There was no observable pattern in the starting TRL of the projects which did not fully achieve their goals.

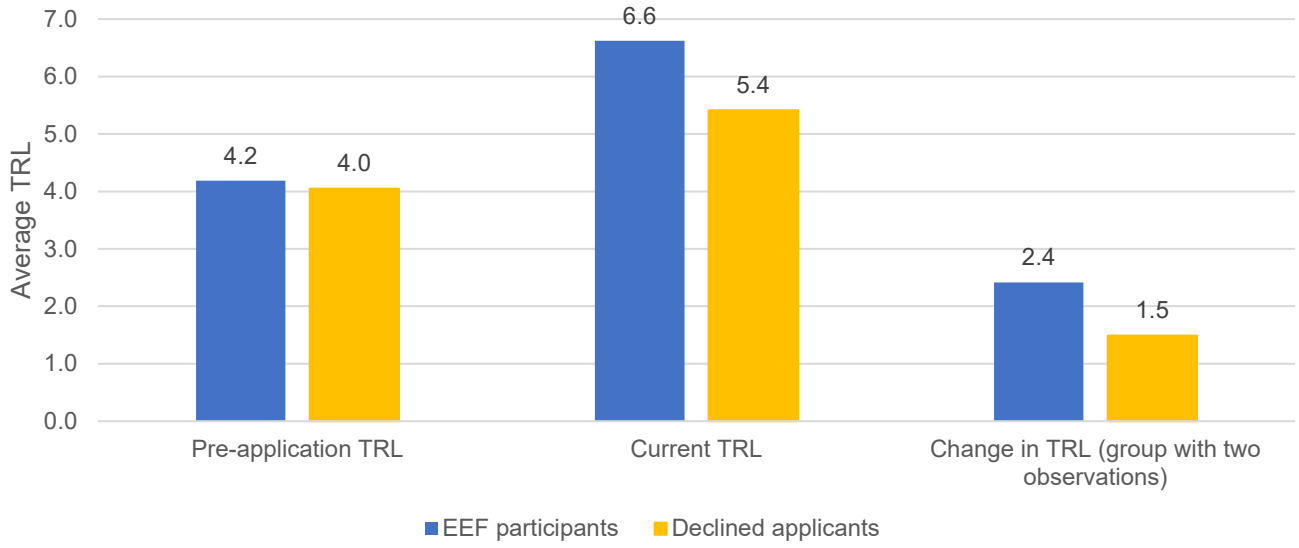
Some of the firms interviewed were delivering their projects during the COVID-19 pandemic. The impact of COVID-19 on the delivery of projects rested on whether a physical presence was required in laboratories and other facilities. Project delivery was also delayed when building owners, such as a Local Authority, decided to close a facility even though tenants were willing and able to use it. A similar issue of exposure to ‘tangible factors’ arose when the work was dependent on supply chains disrupted by the pandemic. In these situations, delays of around six months were not uncommon. In contrast, software development projects with less disruption due to homeworking fared better. Overall, there was no evidence of unexpected effects of COVID-19 on the ability to deliver.

5.2.2 Impact on technical progression

The interview data gathered suggested that EEF participant projects made faster technical progress than the projects of declined participants:[30]

- Of 79 EEF participants and 51 declined applicants where baseline and current TRL data was provided, EEF participants advanced by an average of 2.4 TRLs since the application[31], in contrast to 1.5 for declined applicants (see figure below). As noted, the primary reason why declined applicants were not able to progress their technology in the absence of EEF support was an inability to secure finance to deliver the project.
- The level of progress made during the grant was more significant than progress achieved afterwards. Funded projects moved from an average TRL of 4.2 at the application stage to 6.1 at the end of the grant, and advanced to an average TRL of 6.6 after the project was completed (with the time elapsed after project completion varying by project). These patterns will partly reflect the increasing cost and time of completing R&D at higher TRL levels.
- Fifteen of 79 firms awarded EEF grants (which provided TRL information) progressed to TRL9 in comparison to 7 of 51 declined applicants.

Figure 5.3: Average changes in Technology Readiness Levels between application and late 2020, firms awarded EEF grants and declined applicants



Source: Depth interviews with applicants, Base = 130 (79 successful applicants and 51 applicants whose application was not successful).

5.2.3 Factors contributing to applicants increasing technical readiness

The data gathered from the programme of depth interviews was also used to explore the conditions under which the EEF programme supported increases in technical readiness using

[30] It is not possible to compare the level of progression to expectations at the point of application, because up until Phase 5 of the programme the application form did not include an estimate of anticipated technical progress.
[31] Term now in subsequent paragraphs refers to the time of research taking place in September – November 2020.

Qualitative Comparative Analysis (QCA). These results suggested that applicants moved along the TRL scale (by at least one level) under the following four causal pathways:

- They were successful in their application; or
- They were a firm with more than 10 employees; or
- They had existing IP and significant finance prior to EEF; or
- They were a mature firm and significant finance prior to EEF.

As with the QCA results for R&D activity, receiving EEF support was a factor in accelerating technical progression regardless of the characteristics of the project or the business. This finding was confirmed by the logistic regressions. In addition, having more than ten employees and significant finance prior to EEF were important conditions for technological progress. This may be the case as larger or more mature firms would be better resourced with the skills, expertise and capacity to conduct R&D and less likely to be constrained by capital markets, enabling them to move an innovation closer to market.

The complementary regression analyses also highlighted that projects in the waste, biomass and water group were less likely to advance than other technology areas. Thematic analysis of relevant depth interviews highlighted that projects in this group reported needing large amounts of funding (for example to build plants) to advance the technology further, and found it difficult to secure this funding from public grants or the equity market.

5.2.2 Other project benefits

Alongside technical progress (described above), EEF participants described other benefits that were generated from the delivery of the EEF project. These included:

- **Technological skills and knowledge:** Some participants reported that individuals within their own organisation had acquired further skills and knowledge in the technological area in which the project was being delivered. EEF participants said that the most important mechanism for acquiring skills was the delivery of the technical project and learning about the technology, although a small number of EEF participants reported providing more formal training (such as design software training) as a result of the technological advancements they had made through the EEF project.
- **Other project delivery skills:** A smaller number of EEF participants reported that staff at their organisation had acquired project management skills and the skills and experience to deliver R&D projects (such as understanding what is needed to deliver R&D projects and ensure progress is made, and how to deliver projects to tight timescales).
- **De-risking and collaboration:** The successful delivery of the project has supported some participants in de-risking their technology, for example through generating new IP (either through patents or through knowledge generation), having papers published, and building new relationships with academics and potential customers. Demonstrating (to other funders) that the technology actually worked in practice was the main driver in de-risking the technology, which enabled firms to secure finance to further develop their

technology. The ability to demonstrate the technology worked to potential customers was also highlighted by a small number of interviewees.

5.3 Impact on commercial readiness

5.3.1 Benefits of incubation support

A variety of incubation support activities were provided to EEF participants. On average, EEF participants had received more than five incubation support activities during the course of their EEF project. The incubation support activities provided to a participant were tailored to their business needs at the beginning of their involvement with the programme, and could be altered throughout their project delivery as their needs changed. The table below shows the types of support delivered to projects in different technology areas. The types of incubation support provided included:

- **Market analysis:** support for firms to assess markets and identify routes to market, including help for firms to develop their market proposition.
- **Business development and sales:** support to develop greater understanding of how a customer will benefit from innovation, identify trial sites and support with sales.
- **Strategy:** support to develop business models and business plans.
- **Technology / Technical support:** various technical support activities such as independent validation of testing, expert input into technology development and support around Intellectual Property.
- **Product development:** support to develop prototypes, trials, and competitive analysis.
- **Supply chain:** support to clarify supply chain needs, and establish supply chain plans and strategies, including manufacturing strategies.
- **Team:** support to identify and fill skills gaps and support upskilling and recruitment.
- **Fund raising:** support to enhance financial readiness and secure external finance.

Table 5.2: Proportion of projects in each technology area having received the different types of support

Technology area	Base	Market analysis	Technology	Business development and Sales	Fund raising	Strategy	Product Development	Supply Chain	Team
Buildings	48	81%	55%	34%	35%	17%	34%	28%	17%
Carbon Capture	8	100%	50%	38%	13%	25%	75%	13%	38%
Clean Industry	16	44%	33%	13%	19%	13%	13%	7%	20%
Clean Power	20	85%	35%	10%	45%	40%	30%	10%	20%
Energy Networks and Storage	38	76%	32%	42%	34%	26%	3%	16%	18%
Transport	8	88%	25%	13%	25%	25%	13%	38%	13%
Waste, Biomass and Water	18	78%	39%	56%	44%	44%	33%	17%	11%
Total	156	78%	41%	**34%**	34%	33%	25%	19%	18%

Source: Programme Management Information – Management Information provided details of incubation support activities delivered to 155 projects – assumed project with missing data received zero incubation support activities

Most EEF participants stated that they felt that the incubation support that they had received through the programme had helped their business. Around two thirds of EEF participants interviewed stated that the incubation support met or exceeded their expectations and a similar share stated that the support received was well matched to the needs of their company. Examples of how the incubation support enhanced the commercial readiness of EEF participants included:

- **Upskilling the EEF participants with commercial skills.** A variety of commercial skills that have been acquired were described by some participants, ranging from operational skills (invoicing and milestones for payments), knowledge of manufacturing processes, and how to interact with potential customers.
- **Providing market research reports or commercial support**, including developing business plans and developing market segmentation reports, which the participants have subsequently been able to utilise. This included examples where the incubation support identified potential customers that the EEF participant did not know about. For example, one applicant highlighted the incubation support helped them to develop a business plan, which was then used to underpin a successful application for angel investment. A small number of participants highlighted that the incubation support forced the management team to think about their technology in commercial terms, leading the company to change the market they were targeting.
- **Making introductions between participants and useful networks or contacts**. Some participants highlighted this as an example of how the incubation support helped their firm. This included direct introductions to potential customers or investors, which supported the participants on their route to gaining further finance. An example of this was where the incubation delivery staff helped make introductions to a wide range of potential partners including Research and Technology Organisations (RTOs) and large end customers to allow the firm to grow their reputation and validate their technology by large players.
- **Investment advice and introductions**, including providing information and guidance for companies to use in pitches for finance, (which had been utilised with positive outcomes), and making introductions to potential funders was highlighted by a small number of participants.
- **Other benefits** reported included the incubation activities supporting the development of a more professional website, where potential investors or customers could find out more information about the company or technology, support with branding and naming of companies or products and using incubation funding to temporarily provide staff to fill vacant roles at the participant company (for example a financial officer).

The value of incubation support was highlighted by the fact that multiple EEF participants reported that they remained in touch with the incubation support staff after the project has completed.

Nearly all participants stated that in the absence of the EEF programme, they would not have sourced any incubation support. The primary reasons for this were:

- **Resource:** The incubation support offered to participants was costly, and in the absence of the programme most participants would not have had the resources to spend on incubation support activities, especially as many were dependent on the grant funding awarded by the programme as well.
- **Provision of challenge:** A second reason highlighted by participants was that without the critical review at the incubation planning meeting, they would not have known what type of incubation support they needed.
- **Knowledge:** Some businesses, particularly smaller and newer businesses, stated that without the programme they would not have known where to source incubation support.

Larger EEF participants (i.e. those with 10 or more employees) were more likely to report that they felt that the incubation support had helped their business. This pattern was mirrored in the satisfaction with incubation support and for how well the participants felt the support was matched to the needs of their business. This aligns with findings highlighted in Section 4 that stakeholders in the programme considered that (possibly contrary to expectations) those companies with less well-developed commercialisation skills and/or business models were less able to define an incubation support package that would support their on-going development.

5.3.2 Impacts on commercial readiness levels (CRLs)

EEF participants also made faster progress in developing the business models underpinning their technologies than declined applicants. Based on coding of interview data (from 91 interviews) against the commercial readiness levels (CRL) scale - a nine-point scale describing the evolution of business models to widespread adoption, the findings indicated that:

- Ninety percent of EEF participants advanced their CRLs compared to 63 percent for declined applicants.
- On average, firms awarded EEF grants advanced 2.8 CRLs in comparison to 1.9 for the declined applicants (with the time elapsed after project completion varying by project, which will impact upon commercial readiness).[32]
- However, a roughly similar small proportion of EEF participants and declined applicants advanced to CRL8 (initial products are sold, business ready to support larger scale production and sales) and CRL9 (widespread adoption). This suggests that there were a small number of outlying successes in terms of commercial progress in both the participants and the declined applicants.

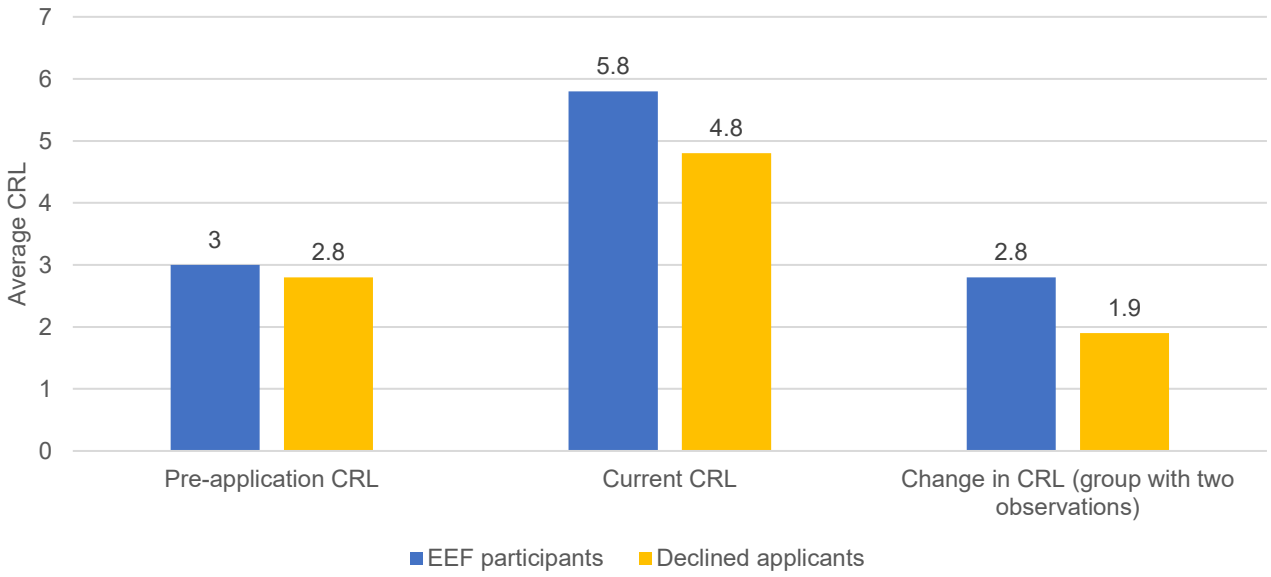
Most EEF participants who progressed to higher CRLs advanced from CRL3 or 4 to CRL6 to 8. This represents a level of advancement from little customer engagement prior to their participation in the programme to product design optimisation. Those making the most progress tended to be micro-businesses, were less than five years old, and rarely had completed any meaningful market research activity prior to applying to EEF. Only a small number of EEF applicants reported making no progress against the CRLs. These projects were at the lowest CRLs (2 or 3) prior to application and the firms did not use incubation

[32] This is an average across all interviewees which provided a baseline and current Commercial Readiness Level during the interview – and includes interviewees who reported having made no commercial progress.

support for ‘business development and sales’, ‘strategy and business planning activities’, or ‘product activities.’

Declined applicants tended to report smaller changes in their CRLs (most commonly moving from CRL3 to CRL4).

Figure 5.3: Average changes in Commercial Readiness Levels between application and late 2020, firms awarded EEF grants and declined applicants



Source: Depth interviews with applicants, Base: 91 applicants

5.3.3 Factors contributing to increase in Commercial Readiness

Different analytical approaches provided conflicting findings for the impact of the EEF on commercial readiness. The QCA analysis of in-depth applicant interviews identified three causal pathways for increasing commercial readiness. Applicants progressed along the CRL scale if:

- They had existing IP; or
- They were an early stage, micro business; or
- They were a microbusiness or a larger firm that was unsuccessful in its EEF application

The findings from the QCA analysis did not suggest that participation in the EEF was a factor in enabling progression against the CRL scale. This would be consistent with the results above that most participants and declined applicants reported making some commercial progress. However, the chart above also suggests that participation in the EEF programme influenced the amount of progress made overall. Additionally, complementary logistic regression analysis found that:

- Being an EEF participant (including receiving incubation support and being awarded grant funding) had a positive impact on the probability that the company would make commercial progress. This finding was significant at the 95 percent level.
- The analysis also suggested that larger businesses (those with more than 10 employees) were more likely to make commercial progress than micro-businesses. This would fit with the finding that more mature businesses have more capacity to take on board the recommendations from the incubation support and act on them.

- The Clean Industry technology area was significantly less likely to report commercial progress than other areas, although no evidence from the qualitative interviews provided a reason as to why this would be the case.

5.4.4 Contextual factors

Analysis of the interview data suggests that there appear to be some linkages between the type of incubation support received, and the ability of projects to see large increases in CRLs. Compared to all EEF participants, those displaying the greatest changes in commercial readiness were much more likely to have used their incubation support for 'business development and sales activities' and somewhat more likely to have drawn on incubation for 'market support activities.'

There also appeared to be a relationship between the views of the quality of the incubation support and the commercial progress made. Just over half of EEF participants which had made less commercial progress (an advancement of two CRLs or fewer) said that the incubation support had helped their business. This rose to nearly three quarters among participants that had made more commercial progress (advanced three or more CRLs).

5.4 Other commercial outcomes

The Management Information for the EEF programme collected data on other shorter term commercial outcomes. The most relevant of these were indicators around the protection of IP, the formation of industrial partnerships and having customer trials or pilots in place.

A significant number of EEF participants that had completed their project (around one third of participants that had completed the CPR or completed the Commercial Impact Survey) reported having filed for more patents at the end of the project than they had at the start. The majority of projects filed for one or two patents during the EEF project, although some projects reported having filed for over ten patents each.[33]

The information collected in the CPRs, completed at the end of an EEF project, indicates that more than half of EEF participants reported that they had developed industrial partnerships by the time they completed the EEF projects. These firms reported either the value of the partnerships or the number of partnerships formed. Where the number was reported, firms reported having developed between one and ten new industrial partners, with at least 83 new partnerships in total. Other firms reported that the project had strengthened their existing industrial partnerships. Projects starting at the lowest TRL reported having the largest number of new industrial partnerships per project.

The majority of projects which had completed a CPR stated that they had customer trials and/ or pilots in place. These projects had at least 317 pilots and/or customer trials ongoing or in the

[33] This data includes some double counting – as in Phases 1 to 4 of the EEF programme the same patent filed in the UK and internationally could be included in the CPR as 2 filings.

pipeline (some projects provided the value of their trials, rather than the number of trials). The number of trials per project ranged from one to 108.

5.5 Conclusions

The EEF has been largely successful in achieving its intended shorter-term outcomes:

- EEF enabled participants to increase their R&D activity. The overall impact of the programme on R&D spending was estimated at between £329m to £580m by 2020, compared to grant spending of £67m. It was estimated that the EEF led to the creation of between 140 and 320 R&D jobs in the companies benefitting from the grant.
- The additionality of the R&D activity supported by the programme was high. Most declined applicants struggled to raise significant alternative funding for their projects and have only progressed them in a relatively piecemeal way.
- The R&D activity supported by the grants enabled firms to accelerate the development of their technologies. Firms awarded grants achieved more rapid development of their technology than declined applicants. Delivering the project also had additional benefits, such as acquiring technological and project management skills.
- Most projects were viewed as technical successes by applicants and there were few examples of technologies that did not perform in line with expectations. However, technical success is not synonymous with commercial success in the expected area, and there were a variety of examples of projects where the applicant pursued alternative directions at the end of the project because there was no market for the technology. This reinforces the recommendation made in Section 4 that some projects may benefit from more thorough market validation and business model development before progressing with R&D.
- EEF participants also advanced more rapidly in developing their business models and making commercial progress. The incubation support was generally considered by applicants an important factor in enabling this progression, who highlighted numerous benefits arising from the support. Those making the most significant progress tended to receive ‘business development and sales support’ activities.
- There were a variety of signals that less mature firms were less able to benefit from the programme and engage effectively with the incubation support.

6 Post completion outcomes

This section presents the key findings of the impact evaluation in relation to the medium-term outcomes and impacts expected from the EEF.[34] It identifies the outcomes that have been achieved by businesses after the EEF support had finished, and an assessment of the extent to which different elements of the EEF programme have contributed to the achievement of these outcomes. The findings are based on the programme of depth interviews with EEF applicants, programme Management Information, primary research with programme stakeholders and data collected from secondary data sources.

The primary research included in-depth interviews with 169 applicants (101 successful and 68 firms whose applications were not successful). These depth interviews were conducted via MS Teams or Webex. Further depth interviews (as part of case studies) were conducted with seven firms and their customer / partner organisations.

The secondary data sources analysed included:

- Data collected as part of the delivery of the programme (Management Information), such as completed CPRs, application forms and programme monitoring.
- Data from the Office for National Statistics (ONS) Secure Research Service (SRS), including the Business Structure Database (BSD) dataset.
- Financial data from Beauhurst and Pitchbook (financial information databases) and information about the number and value of awards made by Innovate UK.

6.1 Post completion outcomes

A summary of outcomes achieved by EEF 1-7 participants after they completed the project highlights that most interviewed firms decided to continue with the development of their technology (or moving towards a commercial product) after completing the EEF supported project. Information collected from the depth interviews with applicants suggested that some had decided to pivot to a new technology.[35] This occurred when the firm realised that the intellectual property they had developed could be more profitable in alternative commercial applications or where new collaborations formed following completion of the project enabled an alteration of their direction.

Only a small number of firms reported abandoning the project. Reasons given included a lack of resources, the company ceasing to trade, technological issues that could not be overcome,

[34] The outcomes categorised as “post completion” could also be achieved during the project for participants that made a large amount of commercial progress.
[35] 50 participants provided an answer to this question – the question was not posed to EEF participants that were yet to complete their EEF supported project.

and a strategic decision by the company and investors to move away from the technology area.

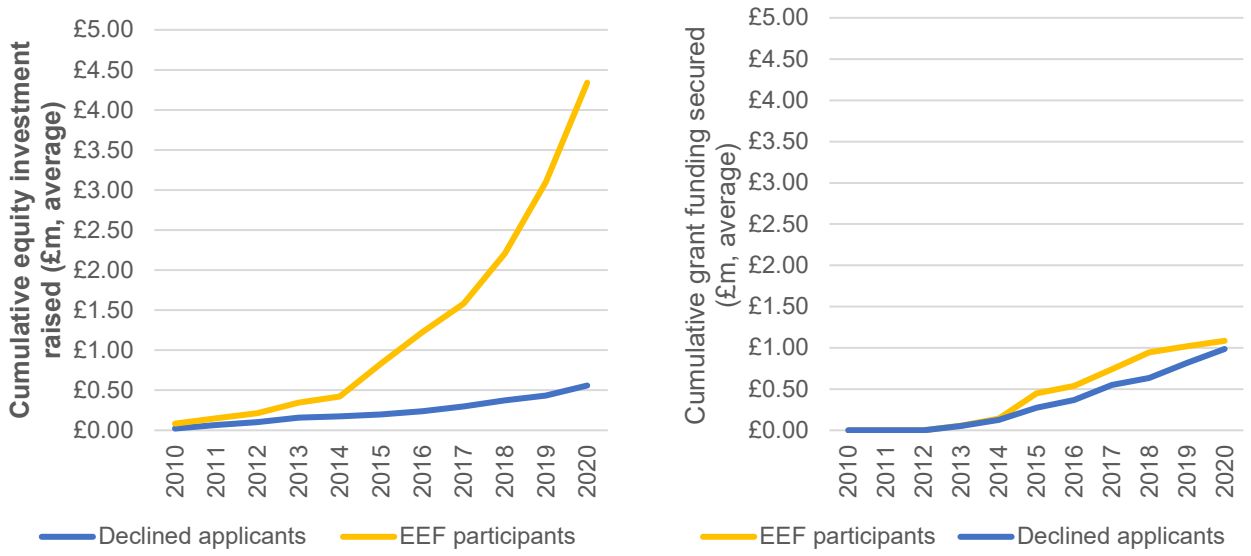
6.2 Impact on follow-on funding

6.2.1 Overall impact on follow-on funding

The statistical analysis of financial datasets provided strong evidence that the EEF enabled firms to secure follow-on funding for onward development of their technologies and scale-up. While firms benefiting from the programme were not substantially more likely to obtain follow-on funding than declined applicants, they were able to raise funds in significantly larger amounts:

- **Success in attracting follow-on funding:** The interview data suggested that a slightly higher share of successful EEF applicants than declined applicants had secured additional funding.
- **Equity funding raised by EEF participants:** Analysis of Beauhurst records indicated that firms awarded EEF grants raised a total of £485m in equity funding in the years following their application to the programme. Beauhurst records do not capture public fundraisings, and a small number of EEF participants also progressed to an Initial Public Offering. Separate analysis of PitchBook records (which captures investment raised on public capital markets) indicated that EEF participants raised £821m in the years following their application to the programme.
    - The interviews suggested that higher shares of EEF participants than declined applicants raised private capital following their participation in the programme. As illustrated in Figure 6.1, this was reinforced by an analysis of Beauhurst data, which showed that firms benefitting from the programme raised an average of £4.3m in equity funding by 2020, whereas declined applicants raised an average of £0.6m over the same period.
- **Public funding:** Findings from the interviews suggested that firms benefitting from the EEF were also more likely than declined applicants to secure follow-on funding from the public sector. Analysis of Beauhurst records indicated that firms benefitting from the programme raised a total of £61.1m in subsequent grants from the public sector, largely Innovate UK grants. Firms benefitting from the programme also obtained an average of £1.1m in subsequent grants, compared to £0.9m for declined applicants.

Figure 6.1: Cumulative equity investment raised and public sector funding secured by EEF applicants between 2010 and 2020 (Beauhurst data)



Source: Beauhurst (2020), Ipsos MORI analysis.

6.2.2 Econometric analysis

Econometric analysis of the financial data extracted from Beauhurst suggested there is a high level of confidence that the EEF programme had a positive impact on the level of equity funding raised by firms (i.e. that differences in the levels of funding raised can be attributed to the programme).[36] Each grant awarded through the programme was estimated to increase the equity investment raised by firms by £0.7m to £2.1m on average by 2020 (from an average grant value of £462,000). These findings were visible in almost all models and largely consistent across the analysis.

The programme was also estimated to have had an impact on the ability of participating companies to attract further public funding (with the estimated effect ranging from £0.2m to £0.6m) compared to equity investment. Analysis of how these effects varied across types of project is provided in the Technical Annex.

6.2.3 Factors contributing to ability to obtain follow-on funding

QCA analysis identified three sets of conditions that contributed to applicants securing follow-on funding. An analysis of all applicants suggested they secured follow-on funding if:

- They were a larger firm and had significant (private or grant) finance prior to EEF; or
- They were an early stage business and were unsuccessful in their EEF application; or

[36] The approaches used in this analysis compared the outcomes achieved by high scoring declined applicants and successful applicants. It should be noted that there was a large degree of analytical work undertaken during the assessment process to ensure that the programme was selecting participants most likely to achieve positive outcomes. The econometric approaches used aimed to minimise this potential bias. For more details please see the Technical Annex.

- They were a larger firm and had significant (private or grant) finance prior to EEF; or
- They were an early stage firm and had significant finance prior to EEF.

These models did not indicate that participation in the EEF programme increased likelihood that firms attracted follow-on funding (a finding also confirmed by logistic regression analysis). This is consistent with the findings set out above as the principal effect of the EEF was to increase the overall amount of funding secured by the firm. However, the findings highlight that obtaining private backing before the application for EEF was an important predictor of whether they would attract follow-on funding.

It follows that firms that had raised significant finance prior to their application to the EEF programme would be well-positioned to leverage in additional follow-on finance for their R&D projects. The fact that they had received existing investment indicates that a degree of de-risking has taken place, that their business has a commercially viable product or service. In these circumstances, larger firms may have more capacity, resource, and experience to seek and pitch for additional funding.

This also aligns with findings set out in Section 5 that suggested that start-ups at very early stages of development were less able make best use of the incubation support. These findings together suggest that firms need to reach a minimum level of commercial development (in terms of skills and experience) for EEF to have a positive effect in leveraging follow-on funding. This is not connected to the level of maturity of technology and the econometric analysis indicated that grants awarded to develop projects at TRL3 and TRL4 tended to have the largest effects. However, existing financial backing appears to be an indicator of whether a firm is ‘ready’ to participate in the programme and could potentially be used in the selection process to maximise value for money for the programme. It also suggests that newly established start-ups may require an alternative form of support to help the reach the level of ‘readiness’ required.

6.2.4 Barriers encountered

Findings from the interviews suggested that both successful and declined applicants tended to explore further public funding options rather than obtain funding finance from the private sector. Around 10 percent of participants reported they explored public grants rather than private funding because they had not made sufficient progress with commercialisation to secure private funding. For example, one EEF participant stated the number of potential buyers was limited and customers would only make technology purchases every few years. Another stated that they needed an agreement in principle with a customer to secure funding from the private market, so they were looking for grant funding to get them further to a stage where they could secure it.

Although most EEF participants that had secured private funding had not encountered significant barriers, some EEF participants said that they had sought private funding following the completion of their projects and encountered significant barriers in doing so:

- **Sector:** Of these, most were in the Waste, Biomass and Water technology area (which is linked to the maturity of the technology in this sector, as discussed below) and most were micro-businesses.
- **Maturity:** The most reported challenge was that the technology was not advanced enough to secure external finance:
    - Where this was the case, companies were looking for multi-million pound investments. Two of these projects were still at low TRLs while two had made progress to later stage development activities. An example of why this was a barrier for those at a higher technological readiness level is that the level of investment required would have meant that the owners would have lost control of the business with private investment at that stage, so preferred to advance their technological development further to enable them to maintain control of the business when private investment was secured.
    - Two of these EEF participants also reported that the structure of the market they were aiming to sell into was challenging (power and fuel sectors), which they felt meant the technologies needed to be more advanced to secure funding, as commercial viability was more difficult to prove. For example, the end goal for one company was to sell cleaner jet fuel, but to get to that stage they first need to prove their technology could generate the required materials for jet fuel, and they needed funding for this stage of development.

6.3 Commercialisation and adoption of technologies

6.3.1 Commercialisation outcomes

The interviews with applicants and the review of EEF programme Management Information indicated that some of the projects have progressed to commercial outcomes via sales or licensing agreements by 2020:

- **Products launched:** From Phase 5 onwards, the CPR (a report completed by participating firms at the end of their project) included a question about whether projects had launched their products. Combining this data with responses to the Commercial Impact Survey undertaken by the incubation support provider (covering projects from Phases 1 to 5 of the programme) shows a total of 30 EEF participants reported launching 66 products to market, although a large proportion of these products (15 percent) are from the same business which launched multiple products.[37] Most of these products launched were in the buildings sector, followed by energy networks and storage and waste, biomass and water.[38] This is self-reported information.

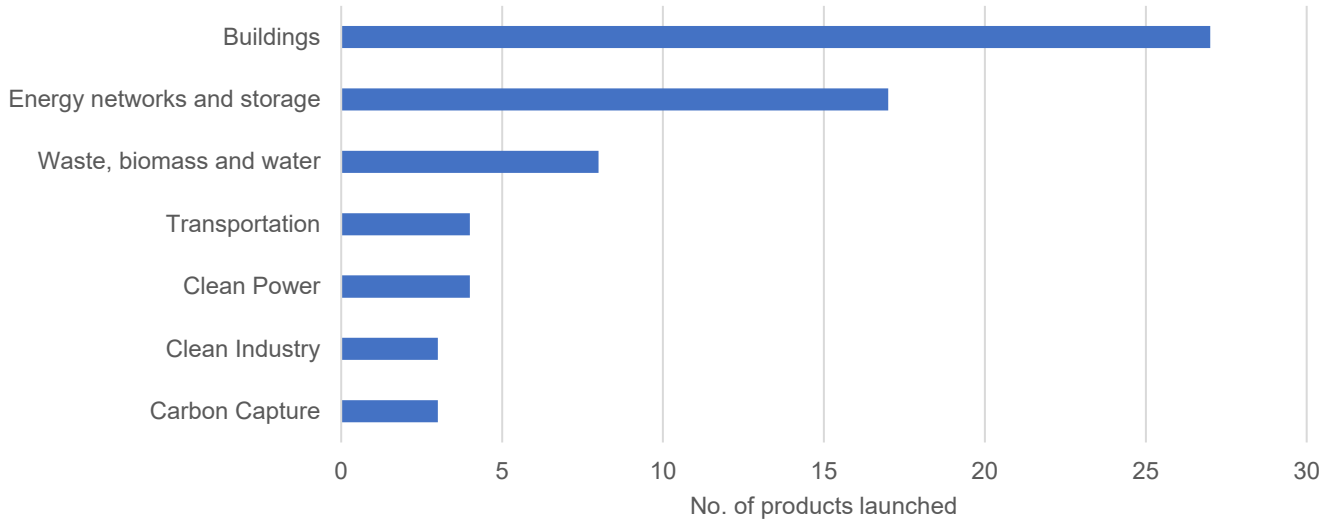
[37] Entailing 61 products among survey respondents, and five products among those that completed the CPR but not the survey.
[38] This is self-reported information, which when compared to the findings from the qualitative interviews appears to be a high estimate

- **Sales agreements:** The interview data indicated that a quarter of firms benefitting from the EEF had reached sales agreements with customers. Where sales were achieved, a combination of interview data and MI indicated that the values of sales achieved varied widely, from less than £10k to approximately £5m. Successful EEF applicants were also more likely to generate sales than declined applicants.
- **Licensing agreements:** Drawing on evidence in the CPR, the applicant interviews, and Commercial Impact Survey, some successful applicants managed to secure licensing agreements for the technologies they had developed. These covered a variety of technology areas such as building efficiency, fuels, and manufacturing process intensification but most frequently involved energy or power generation and energy networks. There is limited information about the headline value of licencing agreements, but where this is available, the value ranges from £50,000 to £3 million.
- **Adoption:** Licencing and sales of technologies do not always entail the widespread adoption of technologies. Nevertheless, a small number of EEF participants had progressed to CRL9 (widespread deployment of technology achieved).

EEF participants that generated sales also generally attached strong importance to incubation support. Many of the sales generating projects were motivated to apply to EEF because of a combination of grant and incubation support. There was particular interest amongst them in profiting from the market support activities provided as part of the latter. Most of the participants that were motivated to apply for the EEF by the combination of support and provision of finance. Of these firms, most indicated that the incubation support had helped support commercialisation and move the firm towards making sales.

EEF participants (four participants) that had reached CRL9 (i.e. widespread adoption) also tended to say that the incubation support had worked well for them, indicating they were well matched with their support provider, and that the incubation support had helped the business. One of these four EEF participants in particular spoke in detail about how incubation support had helped deepen their understanding of commercialisation, namely by making them more aware of certification and IP issues, as well as helping validate their technology.

Figure 6.3: Number of products launched by technology area by EEF participants by 2021



Source: EEF CPR and Commercial Impact Survey

6.3.2 Factors contributing to commercialisation outcomes

QCA analysis of EEF applicants' commercialisation outcomes (e.g. secured IP, licensed technology, secured a sales agreement) identified three causal pathways for a positive outcome. The analysis suggests that applicants achieved at least one commercialisation outcome if:

- Their application to EEF had been successful and the business had reached maturity (i.e. had been operating for five years or more). This indicates that EEF has had a positive effect on the ability of more mature firms to commercialise; or
- They had existing IP; or
- They had significant finance prior to EEF.

The presence of existing IP and significant finance prior to EEF were also standalone conditions for commercial outcomes. In the first instance, firms with existing IP would be able to licence their technologies and make sales agreements more quickly than those who had not yet undergone the process of securing IP. In the second instance, significant existing finance prior to their application to EEF would suggest that these firms were developing technologies with commercial viability and could de-risk the technologies to potential customers.

While the QCA points to a number of factors involved in achieving successful commercialisation, the logistic regression did not identify any statistically significant factors which contributed to a business achieving commercial outcomes.

6.3.2 Barriers to commercialisation

In terms of participants who reported that they had not yet secured sales agreements, the most commonly given reasons were:

- **Stage of development:** The technology was not advanced enough to make sales viable. Where applicants highlighted this as a reason, most technologies were still at TRL4 or TRL5, despite commonly having potential customers interested in the technology.
- **Policy factors:** Some businesses highlighted government policy and regulatory issues as a barrier to commercialisation. Two EEF participants and two declined applicants suggested that government policy meant that there was no substantial market for the technology they proposed. One EEF participant reported that policy had focussed on electricity consumption rather than heating, which meant that investors did not see a market for their technology. Some applicants also highlighted that the structure of the market that they were aiming to sell into was linked to policy and the regulation of the market. For example, one company which had developed a technology to reduce energy consumption was having to partner with energy supply companies, who they felt had limited motivation to promote a reduction in energy demand due to the way in which the market is regulated. In the buildings sector, regulatory issues were raised by applicants. One applicant stated that they needed additional regulatory approval to operate in the social housing sector.
- **Commercial viability:** A small number of participants reported that while there was interest in their technology and the product was sufficiently advanced to begin production, they could not manufacture the product (as yet) at a price which would be appealing to the market and had not secured sufficient sales agreements.

The COVID-19 pandemic has also acted as a brake to commercialisation. For instance, in many industries international trade fairs are a major source of orders. Hence, cancellation of these events significantly reduced or eliminated commercial outcomes over the pandemic period. Not surprisingly, several firms have had to endure several months of zero or greatly reduced cashflow and in several cases where systems could not be installed in closed buildings, business is generally ‘on pause’.

Some firms at a less advanced stage were less damaged by the pandemic than those seeking to deliver on sales commitments. For some firms there are also assumed to be unexpected commercial opportunities associated with government’s ‘build back better’ policy agenda, especially regarding a green recovery. This has increased future commercial opportunities above original assumptions. There are also cases in which firms were able to successfully switch from domestic to overseas markets when the former dried up unexpectedly – so this switch to exporting may have been a positive consequence of COVID-19 for some firms.

6.4 Economic impacts

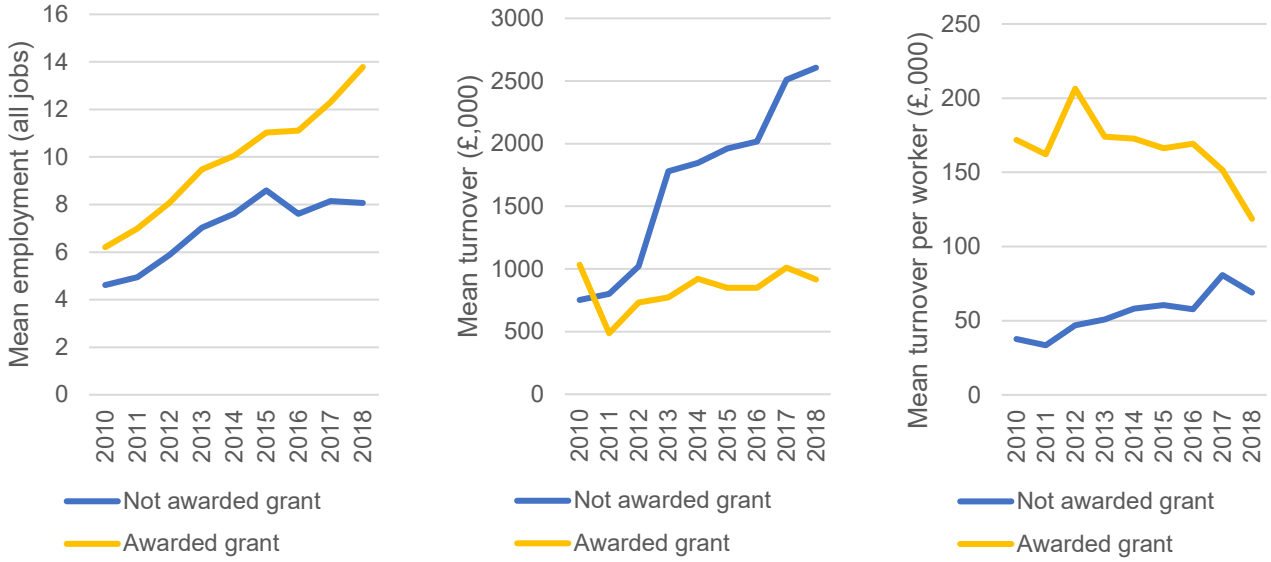
6.4.1 Overall impact on economic indicators

The following figure illustrates the key trends in terms of employment, turnover, and turnover per worker (taken as a proxy for productivity/GVA) for both applicant firms that were successful in their application and those which were not. The data is taken from the BSD. The data in the

BSD only ran until 2018 at the point of analysis, so will not identify any more recent changes in these metrics. The analysis showed that:

- Average employment for firms receiving EEF support rose consistently between 2010 and 2018. Declined applicants saw little growth in employment levels beyond 2016.
- The turnover of firms participating in EEF rose since 2011, but not as rapidly as those that were declined support.
- Turnover per worker was lower on average for firms not awarded grants between 2010 and 2018 compared to the successful applicants.

Figure 6.4: Mean employment, turnover and turnover per worker (2019 prices) between 2010 and 2018



Source: Business Structure Database (2021). Ipsos MORI analysis

The trends presented above provide context for the analysis but in themselves do not describe causal impacts of the programme. The econometric analysis of the BSD sought to identify the causal relationships (until 2018) and indicated that:

- **Impacts on employment:** There is a high level of confidence that the programme has increased the number of workers employed by firms receiving funding through the EEF programme. The findings imply that firms employed between 16 and 21 percent more workers if they received support. Aggregating these results over the average number of employees in the baseline year (13), and the number of grants awarded (133), this equates to between 275 and 365 jobs created in total by 2018. These results are broadly in line with those obtained for R&D employment – indicating that firms have largely recruited R&D (rather than production) workers.
- **Impacts on turnover:** There was no robust evidence that the programme had a net impact on turnover up to 2018. These results indicate that the effect of the programme on commercialisation outcomes were limited by 2018. The findings are consistent with the hypothesis (demonstrated in Section 5.1) in which the programme has enabled

participating firms to increase their investment in intangible capital (via R&D spending) – but exploitation of those investments was limited so far.

- **Impacts on productivity (turnover per worker):** The findings showed a negative effect on turnover per worker. Again, this is consistent with firms increasing their investment in intangible capital and implies that the programme had not produced many economic benefits (in the form of increased productive capacity) by the end of 2018 (which is the latest available data; programmes may improve productivity further in the future).

An analysis of the information collected in the qualitative interviews also did not show differences between EEF participants and declined applicants in turnover or employment.

6.5 Environmental impacts

The DESNZ EIP KPI data, the applicant interviews and CPR information covered the potential scale and scope of environmental impacts as well as how far these have been achieved. The interview transcripts were coded to align with relevant DESNZ Energy Innovation Portfolio KPIs: reduction in CO2 emissions (KPI9), increased energy efficiency / reduced energy demand (KPI7ii), and increasing energy system flexibility (KPI7iii).

6.5.1 Environmental indicators: overall impact

Potential reduction in CO2 emissions

The analysis showed that:

- Reductions in CO2 emissions were not the primary outcome for many applicants – this was seen as a result of the primary technological and commercial outcomes. Just over half of EEF participants and declined applicants (where relevant information was provided) were developing technologies with the potential for considerable effects,[39] and around one quarter had the potential for some effects[40] in reducing CO2 emissions.
- A slightly higher proportion of technologies being developed by EEF participants than declined applicants were classified as a paradigm shift or 'gamechanger' scale (technologies that will generate radical changes in energy consumption / CO2 reduction potential).[41]

[39] The definitions for the scale of environmental impacts follow those used for the DESNZ Energy Innovation Programme (EIP) KPIs. The research team coded information collected in the interviews against these scales. "Considerable effect" is defined as a project which will result in changes to the way in which energy is generally produced, or consumed (most stakeholders will notice a change, resulting in adapted behaviours by some).
[40] As above, "Some effect" is defined as a project which may have an effect on the energy system (some stakeholders will notice a change, resulting in adapted behaviours by a few).
[41] As above, "paradigm shift /'gamechanger'" is defined as a project which will produce radical changes to the way in which energy is considered within the designated scope (changes noticed by all stakeholders, resulting in adapted behaviours by all).

- A small number of declined applicants were developing technologies where the CO2 reduction potential was considered 'negligible'[42].

As the data on CO2 reduction potential is based on applicants' self-report, it should be treated with some caution. However, this data showed that the potential scope of CO2 emission reduction effects varied between EEF participants and declined applicants. EEF participants were much more geared towards whole energy system level reductions[43] than those not receiving EEF support.

However, considering the small numbers of projects reaching CRL9 and low commercialisation or adoption rates (see section on commercialisation and adoption above), the data suggests that few projects have (to date) delivered on their full CO2 reduction potential. All declined applicants which provided relevant data in the depth interviews[44] suggested they had achieved 0 to 25 percent of their emissions reduction potential. Nearly all EEF participants also reported achieving 0 to 25 percent of their emissions reduction potential; a small number reported achieving 25 to 50 percent or full achievement of their potential CO2 emissions reduction scale of effect.

EEF participants tended to provide more detail about the tests and studies into real CO2 reductions (in relevant environment) and therefore the level and quality of information provided gave more confidence in the assessment of their CO2 reduction potential.

Increased Energy Efficiency / Reduced Energy Demand

KPI data and interview transcripts reveal that reduced energy demand as an environmental outcome was not a stated target for many projects supported through the EEF. The potential scale of effect appeared to be higher in case of EEF participants, with two indicating potential for a paradigm shift/gamechanger[45] impacts due to their technology while none of declined applicants pointed towards this scale of expected effect. Similarly, no EEF participants that were interviewed or that had submitted a KPI response (or completed a CPR) anticipated their solution would have only a negligible effect[46] on reduced energy demand, while one of the three declined applicants said so. The numbers of observations are too low to draw any definitive conclusions.

[42] As above, "negligible effect" is defined as a project which will have a negligible impact on the scope area – unlikely that any stakeholders will notice the project beyond the project team and those close to the project.
[43] The definitions of the scope of environmental impacts follow those used for the DESNZ Clean Energy Innovation Portfolio KPIs. The research team coded information collected in the interviews against these categories. "Whole energy system" is defined as a project that will affect an aspect of the entire energy system (e.g. implement smart meters across all households in the UK).
[44] Responses in the qualitative interviews were coded to the KPI classifications based on the description of the impact the technology.
[45] "Paradigm shift /'gamechanger'" is defined as a project which will produce radical changes to the way in which energy is considered within the designated scope (changes notice by all stakeholders, resulting in adapted behaviours by all).
[46] "Negligible effect" is defined as a project which will have a negligible impact on the scope area – unlikely that any stakeholders will notice the project beyond the project team and those close to the project.

The declined applicants with energy demand reduction potential tended to have a sector/subsector scope[47], with around half of EEF participants with increased energy efficiency as a stated target had the potential to influence the whole energy system. All of the declined applicants which provided information had achieved less than 25 percent of the project's potential while in case of EEF participants there were two projects who said they had achieved all of their reduced energy demand scale of potential.

Increased energy system flexibility

A small number of EEF participants aimed to increase energy systems flexibility. In terms of their ability to increase energy system flexibility, similar numbers of EEF participants offered a paradigm shift, considerable effect, or some effect in this area. Examples of potentially significant impacts were in the field of nanomaterials. Most projects expected to deliver impacts at the sectoral/regional level[48], while a small number of projects had a potential to influence the whole energy system or had sub-sector/regional scope. These projects had so far reportedly delivered 0 to 25 percent of their potential energy system flexibility effect.

6.6 Spill-over impacts

6.6.1 Knowledge spill-over impacts

One of the potential impacts of the EEF programme was that knowledge and expertise would be shared more widely throughout the clean technology sector as a result of the technological progress made by EEF participants. This could be expected to come about through the sharing of ideas between organisations, individuals moving between organisations and bringing new learning to new organisations, and organisations learning to reverse engineer technologies developed through the EEF as a result of the participants filing for patents.

The evaluation found limited evidence of knowledge spill-overs. Where applicants reported sharing knowledge and information about their technology, this was only with sub-contractors or other members of the consortium delivering the project. There was also no evidence collected that suggested any patents filed by EEF participants were being reverse engineered or used by competitors.

One participant stated that there was an attempt to create a community of clean technology companies that had been supported by the EEF, with events held where companies could meet and discuss commonalities and provide support. However, according to the interviewee, there was little sharing of technological learning at these events. Another participant described attending the Rushlight Show to exhibit their technology. Overall, these cited examples were from a minority of respondents, indicating that technological spill-over knowledge impacts have been limited.

[47] "Sector/subsector scope" is defined as a project which will affect energy within a specific sub-sector (e.g. manufacturing of sports cars, personal banking) of the economy or a sub-regional area (e.g. London, port towns)
[48] "sectoral/regional level" is defined as a project which will the project will affect energy within a specific sector of the economy (e.g. domestic dwellings, the glass industry) or a regional area (e.g. South West England).

Stakeholders also provided views on the EEF events. The stakeholders that were involved in the management of the programme felt that there were opportunities for knowledge spill-overs within these events - for example, at the “Towards Successful Commercialisation”, where EEF participants were invited to attend a conference event, where they could present and discuss their technology with other EEF participants, investors and trade bodies. This gave EEF participants the opportunity to learn from each other, and stakeholders reported that EEF participants found these events useful. The stakeholders reported that EEF participants had provided feedback to the programme managers that they wanted to speak to other participating firms at these events to try to find solutions to the common problems they were facing (trying to get products commercialised).

6.6.2 Policy spill-overs

Nearly all interviewed participants reported that their EEF project had no impact on Government policy or regulations. However, a small number of interviewed EEF participants have described feeding into Government policy and regulations. The ways in which they described feeding into policy were:

- Holding discussions or being invited to discuss their technology with policy makers within Government or with regulators (four participants). The policy makers described by participants included DESNZ (then BEIS), the Ministry for Housing, Communities and Local Government (MHCLG) and Ofgem. One company stated that when their project finished, they presented the findings to MHCLG and their technology was allowed in the building regulations published in 2019. These companies did not feel that these policy impacts would have taken place in the absence of the EEF programme, either due to the technological progress they were able to make or the incubation/monitoring support they received from the programme.
- Demonstrating that a technology was commercially viable. Two interviewees stated that they felt that their projects had demonstrated that offshore wind was more commercially viable than previously thought, leading to a shift in government policy.

This aligns with the information provided in the stakeholder consultations that there has been some impact on policy making from the EEF programme, but that this is limited. It was reported that meetings between EEF participants and policy makers were rare, and set up on a case-by-case basis, depending on whether the incubation support managers felt the technology could contribute to policy. The incubation support managers would then work with the programme management at DESNZ to facilitate a meeting between policy makers and the project. The primary route to policy teams was via the Science and Innovation team running the EEF programme who provided information to each policy team within DESNZ about the technology area covered. However, the stakeholders involved in the management of the programme felt that the information generated by innovation projects was very different to the type of information required by policy teams. In general, the information collected and used by policy teams was described by multiple stakeholders as coming through specific routes that are well established. Innovators can join these open consultations, but the information they provide would not be given any more weight than the evidence provided by anyone else in the consultation.

The EEF programme also attempts to inform policy makers through the “Towards Successful Commercialisation” days discussed above, so that they can see and learn about the technologies being developed in the EEF programme.

6.7 Conclusions

The key findings from the analysis of the longer-term outcomes of the EEF indicate that:

- The EEF programme had a substantial positive impact on the ability of participants to raise follow-on funding both from private markets and publicly funded grants. Each grant awarded through the programme was estimated to increase the equity investment raised by firms by £0.7m to £2.1m on average by 2020 (from an average grant value of £462,000).
- However, a large proportion of EEF participants have not yet secured follow-on funding to support follow-on R&D and scale-up (around 70 percent of participants). This is partly due to timing and some projects were still on-going at the time of the research. These firms tended to explore public funding options as they had not progressed to the point at which they could attract private investors. Firms often reported they needed to complete a commercial demonstration trial to attract follow-on investors. This can require substantial funding and given the evidence set out in Section 3 that clean technology firms face funding constraints at later stages, there may be value in considering the possible benefits of additional public sector support for follow-on R&D for the most promising projects.
- There was also evidence that start-ups at very early stages of development were less able to benefit from the programme. The EEF did not appear to have a causal effect on fundraising amongst those that had not already attracted financial backing from the private sector. This could imply firms need to reach a minimum level of development for EEF to have a positive effect in leveraging follow-on funding.
- As highlighted in Section 4, it is recommended that DESNZ consider the value of funding firms with less evolved business models to validate the proposed route to market and explore issues of commercial viability. This could take the form of a precursor programme to the EEF to help build readiness for the programme. Existing financial backing could be used as an indicator of whether a firm is ‘ready’ to participate in the programme.
- The programme had achieved relatively modest impacts on commercialisation at the time of the research, and the scale of the impact on commercialisation was much lower than the impact on fund raising. This is also a function of the time elapsing since grants were awarded (insufficient time had elapsed for many participants to commercialise their technology), and most participants had not abandoned their commercialisation of their technology. However, commercial viability (partly arising from the direction of government policy) was often reported as a barrier to commercialisation. This highlights the importance of establishing the commercial viability of the proposed technology before committing funding to more costly R&D projects.

- As few projects have resulted in widespread adoption to date (due to insufficient time elapsing to commercialise technologies), there was limited evidence that EEF participation has led to significant economic (in terms of productivity effects) or environmental benefits (although many technologies have the potential to do so).
- There was also limited evidence that the EEF programme has had any significant spill-over impacts outside of some isolated examples of policy influence. As highlighted in Section 4, it is recommended that DESNZ develop a knowledge management function to reveal barriers to commercialisation originating in policy.

7 Economic evaluation

This section presents the key findings of the economic evaluation of the Energy Entrepreneurs Fund. It identifies the key costs of the programme, and the economic value of the impacts that the programme has achieved.

7.1 Costs of the programme

The total cost of the EEF programme to the public sector can be split into three categories:

- The value of R&D grants spent by businesses supported by the programme (representing the most significant component of costs);
- The cost of providing the incubation support to participants; and
- The administrative cost of running the EEF programme (e.g. costs of the assessment process and monitoring).

Systematic records of annual public expenditures could not be provided for the purposes of the evaluation, but estimates are provided in Table 7.1 below. It is assumed that completed projects claimed the full grant awarded by DESNZ. The costs of projects that were incomplete in March 2020 were estimated by assuming a linear spending profile over the duration of the grant. Estimates of the costs of incubation support and administration were provided by DESNZ.

The total cost of the EEF was estimated at £78.3m. As an annual expenditure profile could not be provided, these costs are presented in nominal terms and have not been discounted.

Table 7.1: Estimated public sector cost of the EEF programme, 2012/13 to 2019/20 (undiscounted, nominal terms)

Type of cost	Estimated spending (£m)	Source
Grant expenditure	£67.1	Management Information
Incubation support expenditure	£10.1	DESNZ reported expenditure
External expenditure on assessment and monitoring	£0.6	DESNZ records and estimated assessment costs
Internal DESNZ management and monitoring costs	£0.5	DESNZ estimated values
Total	**£78.3**	

Source: As described in the table. Grant expenditure for projects that were incomplete in March 2020 have been estimated by assuming a linear spending profile.

7.2 Cost effectiveness

7.2.1 R&D spending

The EEF will be more cost-effective if grants for R&D stimulate additional private R&D investment. If the net effect of the programme on R&D spending is smaller than overall public spending, this implies that public funding has been used as a substitute for private investments that would have been made anyway (i.e. deadweight).

The results of the evaluation indicated that the EEF programme increased total R&D spending (both private and publicly funded) of successful applicants by £328m to £580m (in 2020 prices) by the end of 2020 (see Technical Annex for details of these calculations). Allowing for the value of the EEF support on the R&D projects (£67m), this implies that the programme leveraged additional R&D spending of £261m to £513m. As highlighted in Section 5, there was some evidence that a share of this increase in spending was absorbed by the salaries of R&D workers.

Nevertheless, these findings suggest that the programme had a significant effect in leveraging private investment in clean technologies and are indicative of high leverage ratios (£3.90 to £7.64 per £1 of public spending). This is consistent with high rates of additionality and suggests that the programme has addressed shortages in the supply of funding for private R&D in clean technologies. This also aligns with the evidence presented in the previous sections that highlight the significant challenges that firms that were not awarded places on the programme have encountered in securing funding to pursue their R&D projects.

The findings are consistent with the broader literature on the impact of direct public support for R&D. These studies tend to show that R&D grants 'crowd-in' rather than 'crowd-out' industrial R&D. For example, research undertaken by The Department for Business, Innovation & Skills (BIS; a predecessor to DESNZ) in 2014[49] showed that public grants for R&D increase businesses' own spending on R&D by 30 percent. Finding comparators for EEF is challenging as published evaluation studies consider impacts over different time horizons and no robust assessment of the impacts of schemes promoting innovation in the UK clean technology sector could be found. Table 7.2 below provides some comparisons to some recent schemes that indicate the EEF is an efficient means of stimulating R&D spending:

- DESNZ research completed in 2020[50] suggested that £1 of public spending on R&D leveraged between £1.96 and £2.34 of private R&D spending over a twenty-year time horizon. This encompasses the effects of direct funding for industrial R&D as well as R&D spending in the academic and public sectors.
- The Biomedical Catalyst programme was launched in the same year as EEF and provided grants for R&D in the biotechnology and medical technology sectors (without incubation support). An evaluation examining its effects over the 2012 to 2018 period

[49] BIS (2014) Estimated the Effect of UK Direct Support for Innovation
[50] BEIS (2020) The relationship between public and private R&D funding

suggested it leveraged between £0.76 and £1.48 in private R&D spending per £1 of public sector spend[51].

- HMRC research into R&D tax relief for SMEs published in 2020 suggests that the EEF has proven more efficient than general indirect support for R&D. This study suggested each £1 of tax foregone increased R&D spending by £0.75 to £1.28 (although the study only considered 'in-year' effects).

Table 7.2: Estimated impact of EEF support on R&D spending and leverage ratios - £s of additional R&D spending per £1 of public spending

Scheme (timescale for evaluation)	Estimated impact on R&D spending (£m, high – low)	Public sector expenditure on the scheme (£m)	Estimated leverage of R&D spending (£m, high low)	Estimated leverage ratio (£s of R&D spend per £1 of public sector cost)
EEF (2012 – 2020)	328 – 580	67	261 – 513	£3.90 - £7.64
Selected comparators				
Public support for R&D (effect over 20 years)[52]	N/A	N/A	N/A	£1.96 - £2.34
Biomedical Catalyst (grant funding, 2012 – 2018)[53]	248 – 350	141	107 – 209	£0.76 - £1.48
R&D tax relief for SMEs (effect over one year)[54]	N/A	N/A	N/A	£0.75 - £1.28

7.2.2 Leverage of equity investment

The cost-effectiveness of the programme can also be understood in terms of how efficiently it has stimulated additional equity investment to fund follow-on R&D activities and scale-up. The results of the evaluation indicated that the EEF increased the amount of private funding raised by participating firms by £109m to £326m by the end of 2020. This gives a leverage ratio of £1.63 and £4.67. Again, the Technical Annex provides details of these calculations.

There are few directly relevant comparators as the broader literature tends to focus on R&D expenditure rather than equity investment. The few comparators available indicate that the EEF has been moderately cost-effective in leveraging equity investment into clean technology start-ups:

[51] The Biomedical Catalyst focussed on a different sector to the EEF, which may explain some of the differences between the programmes. As outlined in Section 3, the UK clean tech sector has struggled in recent years to attract VC investment at the same rate as other sectors.
[52] BEIS (2020) The Relationship Between Public and Private R&D funding
[53] Innovate UK and MRC (2019) Biomedical Catalyst Impact Evaluation
[54] HMRC (2020) R&D Tax Relief for SMEs Evaluation

- The impact evaluation of the Biomedical Catalyst (using similar methods and data) suggested that grants for R&D in the biotechnology and medical technology sectors produced large effects on follow-on equity investment and a leverage ratio of between £4.99 and £6.36 per £1 of public sector spending.[55] These findings may reflect differences in strength of investors' appetite to invest. Several companies supported by the Biomedical Catalyst went on to attract significant sums of capital by floating on public capital markets, while relatively few EEF beneficiaries progressed as far as an Initial Public Offering.
- The DESNZ funded ICURe programme provides commercialisation support to teams of university researchers, and seed capital of up to £500,000 for those teams with the greatest potential to exploit their intellectual property through a spin-out. Evidence from the impact evaluation of the scheme suggested it leveraged between £1.04 and £1.16 in additional equity investment per £1 of public spending.

Table 7.3: Leverage ratios - £s of additional equity investment per £1 of public spending

Scheme (timescale for evaluation)	Estimated impact on follow-on equity investment (£m, high – low)	Public sector expenditure on the scheme (£m)	Estimated leverage ratio (£s of R&D spend per £1 of public sector cost)
EEF (2012 – 2020)	109 – 326	67	£1.63 - £4.67
Biomedical Catalyst (2012 to 2018)	703	111 – 141	£4.99 - £6.36
ICURe (2013 to 2018)[56]	19 – 21	18	£1.04 - £1.16

7.2.3 Value for money associated with incubation support

The value for money associated with the incubation support provided by the programme cannot be established directly because no participating firms received the R&D grant or the incubation support in isolation. Inferences have instead been made from comparisons to the effects of Innovate UK grant awards received by the same group of firms.

The EEF differs from Innovate UK grant awards in two important respects. Innovate UK has historically provided funding for R&D projects (both in response mode and through thematic competitions) but this has not been paired with incubation support. Monitoring of Innovate UK is undertaken by external monitoring officers. Prior to Phase 7, EEF projects were monitored by officers internal to DESNZ who may have been closer to policy and better equipped to advise applicants on the direction of their technology. The following comparisons will conflate these two effects, although it should be noted that EEF grant beneficiaries did not highlight that monitoring officers had a significant effect on the development of their commercial strategy.

[55] The Biomedical Catalyst focussed on a different sector to the EEF, which may explain some of the differences between the programmes. As outlined in Section 3, the UK clean tech sector has struggled in recent years to attract VC investment at the same rate as other sectors.
[56] Innovate UK (2020) ICURe Evaluation Report 2020

Table 7.4 compares the estimated effects of participation in the EEF programme and Innovate UK awards[57] awarded to the same group of companies (both before and after the application was made to the EEF):

- The impacts of the EEF were substantially larger than Innovate UK grant awards on all measures of business performance aside from turnover, where no statistically significant effects were observed.
- Innovate UK grant awards received by this group of firms were 40 percent smaller on average than the funding awarded through the EEF. This is not sufficient to explain the differences in the relative impacts of the two types of award, presuming that the impact of grant funding is proportional to the size of the grant.
- One interpretation is that the incubation support has substantially amplified the impact of the R&D grants awarded through EEF. Given the share of overall costs accounted for by the incubation support package, this would suggest that it offers high value for money (though the results do not permit quantification of this).

These results should not be considered definitive. The impact of grant funding may not be proportional to the size of funding awarded. It is possible that only larger grants allow applicants to de-risk their technologies sufficiently to enable them to attract private investment. Applicants often attributed their difficulties in raising follow-on funding to insufficient technical maturity. It is also important to note that the findings only provide an estimate of the impacts of Innovate UK grants awarded to the specific firms that have applied for EEF funding and should not be taken as an assessment of their effectiveness in general terms.

Table 7.4: Relative impacts of the EEF and Innovate UK grant awards on R&D spending and employment, equity investment, employment and turnover (effects per grant award)

Metric	EEF	Innovate UK grant awards
Average grant award (£)	£462,000	£274,000
R&D expenditure (% effect)	38 to 68	-7 to 0
R&D employment (% effect)	13 to 30	No effect
Equity investment raised (£m effect)	0.72 to 1.31	0 to 0.11
Employment (% effect)	16 to 21	3 to 4
Turnover (% effect)	No effect	No effect

Source: BERD, BSD, Beauhurst and PitchBook, Ipsos MORI analysis.

There is no strong evidence to inform an assessment of the relative cost-effectiveness of different types of incubation support activities. The research did not provide any evidence that specific types of activity were more or less effective across the portfolio of companies. The usefulness and impact of the incubation support was typically linked to the specificity of the

[57] The impacts of Innovate UK grant awards were estimated by including the cumulative number of Innovate UK grants received by firms as a control variable in the regression analyses set out in the Technical Annex.

outputs produced and the ability of the applicant to identify what types of outputs would support the development of their commercialisation strategy.

7.2.4 Cost effectiveness by type of project

The number of grants awarded through the EEF was relatively small which has limited scope for exploring differential effects across types of project. However, some comparative work was completed that suggested:

- **Technical maturity:** There were signals that projects that started at lower TRL levels produced larger impacts on R&D activity and equity investment.
- **Sector:** It was only possible to make comparisons between awards made to projects in the 'energy demand' and 'energy supply' sector groupings. These indicated that the programme had large effects on R&D activity regardless of the sector. However, the effects of the programme on downstream outcomes (such as equity investment) were exclusively driven by the energy supply sector.
- Evidence from the applicant interviews indicated that changes in policy have been a contributory factor to these patterns. Many projects in the 'energy demand' sector involved the development of technologies to decarbonise or improve the energy efficiency of the built environment and were initiated in anticipation of the Zero Carbon Homes regulation. Numerous applicants stressed that the reversal of the plans to enact these regulations meant that their products ended up having no market when this had previously been assumed to have been a commercial opportunity.

7.3 Cost benefit analysis

7.3.1 Economic benefits

In line with the guidance set out in the HM Treasury Green Book, the economic benefits of this type of programme would normally be understood in terms of the productivity gains realised by firms benefitting from the programme. The EEF has increased investment in R&D and leveraged private funding into clean technology companies. However, it did not increase the turnover of participating firms and there was no extensive evidence of commercialisation at the time of the analysis. This implies that the programme had not produced increases in economic output or productivity at the time of writing.

A forward-looking approach is needed to understand the economic benefits of the programme (i.e. how far can the EEF be expected to produce significant commercialisation of clean technologies in the future?). This has been addressed by examining the effect of the programme on the underlying value of participating firms. Assuming a well-functioning financial market, the value of the firm will represent the present value of expected future profits over and above the risk-free rate of return. If R&D investments are expected to increase the future profitability of the business, the present value of future profits will be capitalised into the value of the firm.

These effects can also be understood as a partial measure of the net benefits of the programme. While the future expansion of the firm may displace competitors, the economic activities displaced can be assumed to be earning a 'normal' rate of return. The value of clean technologies will be linked to how far they help consumers reduce their emissions (subject to external policy choices, e.g. carbon pricing). Therefore changes in valuations will also capture the value of the future environmental benefits of the EEF to the degree that investors expect future Government policy to be effective in ensuring consumers pay for the environmental costs of their behaviour.

Indicative estimates of the impact of the programme on the underlying valuations of firms are set out in the Technical Annex and show:

- There was a high level of confidence that the EEF had a positive effect on the valuations of firms by the end of 2020. The preferred results indicated that the programme increased the underlying value of firms by £4.3m to £5.3m per grant awarded.
- This implies that the investments in intangible capital stimulated by the programme are expected by investors to produce economic (and by implication, environmental) benefits in the future. However, these expected benefits are not yet visible in tangible growth in turnover or realised profits and are subject to a degree of uncertainty.
- Applying this result to the 156 grants awarded gives a total increase in the value of firms of £671m to £826m. This is taken as a measure of the present value of the net economic (and by implication, the environmental) benefit of the programme.

7.3.2 Environmental benefits

The environmental benefits of the programme have been estimated based on evidence provided by applicants (in the completed CPRs and qualitative interviews, including case study interviews) on the achieved CO2 reductions provided and the expected level of adoption.

In the qualitative interviews, successful applicants tended to provide more detail about their project outputs and/or third-party studies of achieved CO2 reductions (in relevant environments) than unsuccessful applicants. There were 11 successful projects that provided sufficient evidence to draw reasonably robust conclusions related to the level of CO2 reductions/savings that they will achieve. The technologies involved a variety of routes to CO2 reduction. This is a small subset of the total number of project participants (133 companies) and the analysis has been conducted on a case-by-case basis to provide a snapshot of the impact that the portfolio as a whole may provide. However, the following caveats should be borne in mind:

- The analysis cannot be understood to constitute a programme level analysis with respect to monetising environmental benefits.
- No independent evidence gathering has been conducted as part of the analysis and all evidence is self-reported.

- Environmental benefits that would have been achieved in the absence of the EEF programme (the counterfactual) have not been estimated due to insufficient evidence, and figures should not be viewed as the additional environmental benefit of the EEF programme. While the broader findings suggest that deadweight was relatively low, systematic evidence on how far similar reductions could be achieved with competing technologies was not available.

Approach

The following approach has been used to monetise the potential environmental benefits of a selection of EEF projects:

- **Likely emissions reductions (low estimate):** The estimation of the CO2 emissions is associated with the project activities delivered to date, or sales that have been achieved following the conclusion of the project. Where projects have trialled equipment, a ten year asset life has been assumed, and any ex-ante calculations assume that this equipment realises CO2 emissions/ reductions over a ten year life.
- **Projected emissions reduction (high estimate):** The high range uses company sales projections provided in completed CPRs and interviews (including case study interviews) and estimates CO2 emissions associated with the realisation of these sales projections. Sales projections provide an estimate of an anticipated wide-scale adoption of the technology, but the effects of project optimism bias will affect these results.
- The reality is that the actual impact of the EEF projects is somewhere between the two, and likely, in the short term, to be closer to the lower end of the range.
- The monetary value associated with the CO2 reductions uses the DESNZ traded value[58] of carbon[59], and is provided in 2018£, using the DESNZ GDP deflator.

Results

A summary of the results of the likely emissions reductions associated with the 11 projects are shown in the table below[60]:

[58] The 2009 guidance on the Carbon valuation in policy appraisal (applicable when the analysis conducted) states (page 26): "In relation to EU targets, there is a fundamental distinction between the traded sector of the economy, and the non-traded sector. The traded sector of the economy relates to all emissions which are covered directly, or indirectly (i.e. electricity use), by the EU Emissions Trading System".
The majority (8 of 11) of projects used to form the analysis of emissions reductions are from the power sector (e.g. wind turbines, CCUS, electricity use), and therefore traded emissions were considered the most appropriate for the analysis. If values for non-traded emissions are used across the analysis, the environmental return on investment (ROI) for the environmental analysis is of approximately 2.3. Use of EU ETS traded values for the projects assessed represents a cautious calculation of environmental benefits in order to reduce the risk of overstating the scale of benefits across the portfolio of EEF projects.
The UK government published an updated policy paper in September 2021 setting out a revised guidance on the valuation of greenhouse gas emissions in policy appraisal and evaluation. Carbon values (Central Series) are higher in this revised guidance than both the traded and untraded values set out in the 2009 guidance. This revised guidance was released after the analysis had been undertaken and therefore was not used in the analysis. Use of the 2021 carbon values is expected to result in a much higher ROI (c.6).
[59] https://www.gov.uk/government/publications/updated-short-term-traded-carbon-values-used-for-modelling-purposes-2018
[60] For more information about the methodology, please see the Technical Annex

- The anticipated CO2 savings for the 11 projects is approximately 170,000 tCO2, which equates to an average of just over 15,500 tCO2 per project. In monetised terms, this is valued at approximately £5m (in 2018 terms) over a 10-year time horizon.
- The value of the grant provided to the 11 projects amount to £4.8m. The subset of 11 projects produce a likely return on investment of £1.03 per £1 of public spending in terms of environmental benefits only.
- There are some significant variations in the scale of CO2 savings across the projects. Project G, an operational plastic recycling project, is anticipated to provide 120,000 tCO2 of this total alone (74 percent of all anticipated CO2 emissions from this subset of 11 projects), with an environmental return on investment of 5.25. Project I, a vehicle emission retrofit, is anticipated to provide 24,000 tCO2 reductions, assuming the company meets 2 percent of its short-term sales objectives.
- Eight of the 11 projects had negative environmental returns on investment based on current progress. Only evidence that provides a clear demonstration of committed sales, market commercialisation and associated wide scale adoption of the technologies are used as assumptions in this estimate.

Table 7.5: Indicative evidence of the reduction in emissions of technologies developed through the EEF

Project No.	**Total Grant Received Cost**	**CO2 emissions reductions**	**CO2 monetary impact**	**Cost of project CO2 reduction**	**Environmental benefit Return On Investment**
Units	**£**	**(tCO2)**	**(£2018)**	**£ per reduction tCO2**	
A	202,400	13,617	226,867	15	1.12
B	788,996	730	17,833	1,081	0.02
C	150,000	3,259	21,706	46	0.14
D	558,080	1,980	48,370	282	0.09
E	387,594	323	9,897	1,200	0.03
F	191,163	76	982	2,515	0.01
G	695,004	126,000	3,650,605	6	5.25
H	800,000	300	8,692	2,667	0.01
I	348,433	24,000	907,653	15	2.60
J	160,794	96	63,130	1,675	0.39
K	530,462	905	24,896	586	0.05
Total	**4,812,925**	**171,286**	**4,980,631**	**28**	**1.03**

Potential future CO2 emissions reductions

The 11 cases selected for this analysis have all produced ex-ante modelling of the effect their technology will have on environmental emissions. The upper bounds of these ranges provide an optimistic view of the environmental benefits that could be realised and attributed to the EEF programme. The ex-ante modelling shows that there are four categories of projects funded by the EEF:[61]

- **High Impact** – Project B, an Industrial scale carbon capture technology, which if successfully applied at its project partner's site, will conservatively save approximately 36.5m tCO2 over a ten year period. This equates to monetised benefits of approx. £2.5bn over ten years.
- **Medium Impact** – Three of the 11 projects offer medium scale impacts, with ex-ante projections that estimate savings between 750,000 – 2 million tCO2 over a 10-year period per project. The projected monetised savings from these projects together equates to approximately £161m over ten years.
- **Small Impact** – Four of the 11 projects offer small impact, with ex-ante projections that estimate savings between 68,000 – 250,000 tCO2 over a 10-year period. The projected monetised savings from these projects together equates to approx. £23m over ten years.
- **Very small or niche impact** – Four of the 11 projects offer very small or niche impacts, with ex-ante projections that estimate savings between 900–11,700 tCO2 over a ten year period. The projected monetised savings from these projects together equates to approx. £730k over ten years.

This largely reflects the findings from the environmental benefits described in Section 6.5 in terms of how projects perceive their own contribution to CO2 reduction. However, most of the environmental benefits in the programme are likely to arise from a small number of successful projects that are focused on industrial/energy generation carbon reduction as their focus.

7.3.3 Indicative Cost Benefit Analysis

An indicative social welfare analysis has been completed by comparing the effects of the programme on R&D investment to its economic benefits capitalised into the valuations of firms (see above):

- The present value of additional R&D spending stimulated by the programme was estimated at £253m to £446m.[62] This is taken as a measure of the net social cost of the programme.
- The increase in the total value of firms of £671m to £827m is attributable to the programme.

[61] It is important to note that these are potential savings dependent on wider scale adoption of the technologies
[62] Calculated from the annual increase in R&D expenditure presented in Section 7.2.1 and applying a discount rate of 3.5 percent per annum in line with the HM Treasury Green Book with a baseline of 2012

- These give an indicative Benefit to Cost Ratio (BCR) of £1.50 to £3.26.[63] The midpoint of these results (£2.39) aligns with the hurdle rate of return normally applied in the economic appraisal of these types of programme.

The findings are subject to the following limitations:

- Using firm valuations as a measure of economic benefit (as presented above) assumed that financial markets are well-functioning. However, the programme itself is predicated on an assumption that markets do not price investments in clean technologies effectively. If so, then firm valuations may not provide a reliable guide to the economic benefits of the programme.
- Estimates of the impact of the programme on firm valuations are likely understated because the value of firms that do not attract follow-on investment is unobserved.
- Firm valuations only capture private benefits to the investor. These measures will only capture environmental externalities to the degree that future government policy encourages consumers to fully internalise the environmental costs of their resource consumption. Additionally, this measure of benefit will not capture other economic benefits that may arise from future exploitation of the technologies (e.g. wage benefits for workers or knowledge spill-overs).
- Estimates of the costs of the programme only capture the additional R&D spending of participating firms and do not include administrative costs involved in the delivery of the programme.

7.4 Conclusions

- The EEF has proven cost-effective as an instrument for leveraging private R&D investment into novel clean technologies. The level of additionality associated with the R&D grants is high and indicates that the programme has addressed shortages in the availability of funding for R&D.
- The EEF has been moderately cost-effective in delivering downstream outcomes such as leverage of follow-on investment and increasing the underlying value of the firms benefitting from the programme. This reflects the challenges encountered by firms in developing commercially viable technologies and in some cases the failure of expected markets to emerge.
- The impacts of the EEF are substantially larger than those observed from the grants awarded by Innovate UK to the same group of firms which are not paired with incubation support. This could suggest that the incubation support provided through the programme has had a significant amplificatory effect and increased the value for money associated with the programme. While there are competing explanations for this finding,

[63] This has been calculated by dividing the increase in the firm valuation by the increase in R&D expenditure. The range has been calculated by dividing the low value for the increase in value of firms by the high value of the additional R&D expenditure (£671m / £446m), and the high estimate has been calculated by dividing the high value of the increase in firm value by the low estimate of the increase in R&D expenditure (£827m / £253m)

there is no evidence to suggest that major changes should be made to the fundamental design of the programme.

- An indicative cost-benefit analysis indicates that the programme is likely to deliver net benefits that exceed its net costs. However, the central benefit-cost ratio only just exceeds the hurdle rate of return applied in the economic appraisal of these types of programme.
- The preceding section highlighted that firms have faced a variety of constraints in commercialising their technologies. Some of these constraints have originated in the failure of government policy to create appropriate incentives for the market to adopt the technologies emerging from the programme. This is reflected in some of the patterns observed, including the relatively low returns generated by projects in the 'energy demand' sector grouping.

However, an analysis of ex-ante modelling of the environmental benefits undertaken by applicants suggests that around one third would not be expected to deliver emissions reductions that exceed the value of grants awarded over a ten-year time horizon (even under the most optimistic assumptions). However, this is based on a small sample of projects which provided sufficient evidence to undertake an analysis of the environmental effects. Assuming projects will primarily generate future profits from their emissions reduction potential, these projects were never likely to be commercially viable. This raises a question as to whether there may be value in integrating a formal appraisal of the potential environmental benefits of the programme as part of the project selection process.

8 Conclusions

This section presents the key findings from the research, bringing together the findings from the process, impact and economic evaluation work. It also presents the recommendations from the research, which can be used to inform any future phases of the EEF programme or other Government funded innovation schemes.

8.1 Key findings

The key process evaluation finding was that Phases 1 to 7 of the EEF have been largely administered effectively and efficiently:

- Promotion of the scheme has generated high levels of interest and given DESNZ many options to allocate funding to projects meeting its quality thresholds. The assessment process appears broadly fit for purpose and was considered proportionate. Few projects failed to progress because the technology did not meet expectations, and few would have moved forward in the absence of public funding (demonstrated by the high levels of additionality achieved). The contractual framework used to award funding to applicants was considered robust.
- Incubation support was positively received by participants and considered useful when it provided specific details supporting the development of their commercialisation strategy. Providers of incubation support were considered to offer the breadth of expertise to deliver outputs of the level of specificity needed and no gaps in the package were highlighted. However, questions were raised as to how far the smallest or least developed businesses benefitted from incubation support.

The EEF programme has been largely successful in achieving the shorter-term outcomes, but only a small proportion of EEF participants have achieved longer-term outcomes in terms of significantly commercialising their technology as yet:

- EEF support (through grant funding) has supported participants to increase their R&D activity, both in terms of expenditure and employment. The overall impact of the programme on R&D spending was estimated at between £328m to £580m by 2020, compared to £67m of grant funding committed. This indicates the EEF was successful in leveraging additional R&D spending. It was also estimated that the EEF led to the creation of between 140 and 320 R&D jobs in the companies benefitting from the grant. This shows that the additionality of the programme was high.
- EEF participants achieved higher levels of technological progress than declined applicants (2.4 TRL level increase compared to 1.5 for declined applicants). Support from the programme was seen as a key driver for technological progress in both the QCA and logistic regression analysis. Participating in the EEF programme also had additional benefits, such as acquiring technological and project management skills.

- EEF participants achieved higher levels of commercial progress than declined applicants. Participants that reported commercial progress were more likely to report that they were satisfied with the quality of the incubation support. Support from the EEF programme was identified as a key driver of commercial progress in the larger EEF participants (with more than 10 employees) who were more likely to report that they felt that the incubation support had helped their business. This suggests larger businesses may be more receptive or more able to implement the incubation support they receive.
- The EEF programme had a significant positive impact on the ability of participants to raise follow-on finance – both from private financial markets and publicly funded grants. Each grant awarded through the programme was estimated to increase the equity investment raised by firms by £0.7m to £2.1m on average by 2020 (from an average grant value of £462,000). The programme is also estimated to have had a smaller effect on the ability of participating companies to attract further public funding (with the estimated effect ranging from £0.2m to £0.6m). Applicants stated a need to complete demonstrator trials to support securing follow-on funding, and the EEF programme helps them to complete these trials.
- The evidence suggests that most EEF participants are yet to achieve a commercial outcome for their technology. Most EEF participants have not abandoned their technology and still believe there is a commercial opportunity associated with the technology. This suggests that there is a gap between participants completing the technical aspects of their EEF project and having a commercially viable project.
- There is limited evidence that EEF participation has led to significant gross economic (in terms of productivity) or environmental impacts yet. This is explained by the limited number of projects that have achieved commercial outcomes to date. These economic and environmental impacts may need more time to occur.

The economic evaluation provides evidence that the EEF programme has offered value for money in terms of the outcomes achieved so far – and the value for money is expected to increase in the future as more EEF participants move towards commercial and environmental outcomes.

- The EEF has been moderately cost-effective in delivering downstream outcomes such as leverage of follow-on investment and increasing the underlying value of the firms benefitting from the programme. This reflects the challenges encountered by firms in developing commercially viable technologies and in some cases the failure of expected markets to emerge.
- The impacts of the EEF are substantially larger than those observed from grants awarded by Innovate UK to the same group of firms which are not paired with incubation support. This could suggest that the incubation support provided through the programme has had a significant amplificatory effect and increased the value for money associated with the programme.
- An indicative cost-benefit analysis indicates that the programme is likely to deliver net benefits that exceed its net costs. However, the central benefit-cost ratio only just

exceeds the hurdle rate of return applied in the economic appraisal of these types of programme.

8.2 Areas to consider for future policy design

Some changes to future policy design that DESNZ could consider to improve value for money are:

- Strengthen scrutiny of how far the proposed R&D project, if completed, would be likely to attract follow-on funding during the assessment stage under the policy implemented by the Government at the time of the appraisal.
- Adjust the design of the programme to require applicants to complete market validation to confirm commercial viability before it is permitted to progress the R&D project. This would be a higher priority for firms that have not already secured private backing and could provide an opportunity for applicants to pivot to new objectives as well as identify cases where public investment in the R&D project may not lead to the desired results. It may be possible to deliver this as a precursor programme to the EEF to help build readiness for the programme.
- The assessment process should be more closely aligned with policy decisions being made by the Government at the time of the application. This could involve consulting with relevant policy teams prior to the assessment process beginning.
- Create more flexibility to discontinue projects where changes in external commercial factors limit the likely future exploitation of the technology. This could involve adopting a ‘stage-gate’ review process that allows for go/no-go decisions based on external parameters as well as the achievement of technical milestones. This can also facilitate adaptation and re-prioritisation to changing external circumstances where appropriate.
- There could also be a case for considering the possible benefits of additional public sector support for follow-on R&D for the most promising projects. This could be targeted at those technologies that have evolved their business model and achieved technical targets, but have not yet reached the point of commercial demonstration trials.
- Monitoring can continue to be delivered by third parties rather than DESNZ staff as there has not been any reported drop in the quality of monitoring, however efforts should be made to ensure EEF participants still have access to DESNZ staff to prevent increases in the time taken to make decisions and to allow participants to feed information directly into DESNZ.
- Develop a knowledge management function within the programme to codify the learning from projects. This could provide a resource that could be communicated to policy teams as well as assessors when appraising future applications for funding through the EEF (or other relevant programmes).
- As many of the outcomes and impacts could be generated many years after the completion of the EEF project, an additional monitoring requirement could be introduced to collect outcome information from EEF participants five or ten years post project

completion – in the form of a short survey. This would provide a cost-effective mechanism to collect robust information about the longer-term outcomes achieved.

Appendix – Suggestions for EEF8

The research team were made aware during the final stages of the evaluation that DESNZ intended to deliver an eighth phase of the EEF programme. DESNZ asked the research team to provide some insights into the delivery of the programme to ensure that the eighth phase was delivered in the most efficient and effective manner possible, and to suggest an approach to evaluating EEF8. These recommendations are summarised below.

Awareness raising

The analysis of the applications received for EEF phases 1-7 suggests that the current approach to raising awareness about the programme (advertising through KTNs, LEPs and holding a launch event) has been successful in securing a sufficient number of high quality bids to award support to. However, there were some concerns that not all relevant firms were being made aware of the potential support available through the EEF, particularly those that were not already engaged with clean technology or KTN networks.

For Phase 8, DESNZ could consider two options for the awareness raising of the EEF programme:

- Continue to use the existing processes, which will likely lead to the submission of up to 200 applications (maybe higher given the time elapsed since the EEF7 application process was open) for support from firms that are engaged in innovation and clean technology networks. This will most likely deliver a sufficient number of high quality bids to award support to, which will lead to projects making significant technological and commercial progress that they would not have achieved in the absence of the EEF.
- Invest more resources into awareness raising activities. This would be undertaken to ensure more firms are aware of the support on offer. This increased activity could include more engagement with local organisations (LEPs, local councils) or more generalist business networks, so that businesses that are not experienced in engaging with central government (do not currently engage with DESNZ or look at .gov websites) and do not engage with KTNs or clean technology networks are aware of the programme and can potentially submit an application.

The second option would most likely increase the number of applications received, and increase the resources required to assess the applications, and may not lead to an increase the quality of bids. However, it would provide more equal opportunities to secure support for all firms with a relevant idea.

Application process

The current application process was viewed to be effective in collecting the correct information to inform a technical and commercial assessment of the applicant project and firm. No additional information would need to be collected in any application form for proposed EEF8.

However, there are potential mechanisms which could improve the ability of some firms to submit a high quality application – potentially increasing the number of applications submitted as fewer firms are discouraged by the application form. These would be:

- Offer more guidance or an online “masterclass” or workshop to explain what type of information is required to complete the environmental impacts section of the application form and how to estimate these impacts. A cost-effective way to offer this guidance would be to make the guidance available online and provides links to it in the application form – meaning all applicants have equal access to the guidance.
- Provide information about the programme and application process to third parties, such as KTNs, LEPs or business support organisations. Information on the EEF application website / form can state that businesses can ask for advice/support from these organisations when applying. This would potentially be beneficial for smaller firms and those that have limited experience in applying for public support.

These two mechanisms would most likely increase the number of full applications received, and increase the resources required to administer the application and assessment process.

Assessment process

The current assessment process appears to be fit for purpose and proportionate. It is recommended that a form of the two-stage assessment process (technical and commercial assessments) is retained, as both stages appear to add value to the assessment process. However, there are ways in which the assessment process could be improved in the future. These would be:

- Strengthening scrutiny of how far the proposed R&D project would need to progress to be likely to attract follow-on funding during the assessment stage. This would need to be done on an application by application basis, and identify the level of technological (and commercial) progress that would be required by the project and firm in order for it to secure private sector funding. A focus on production costs alongside sales projections may help identify projects whose development may be constrained by issues with profitability.

  This input could be provided by the green finance stakeholders involved in the commercial panel assessment. The stated level of technological progress in the application can be compared to this assessment, and support only awarded to those applications which can realistically make the level of progress to secure private funding.

- Strengthening knowledge of external factors during assessment process. In many cases, commercial viability was affected by external factors that influenced demand for the technologies, such as policy changes. These external factors could not always be predicted by panellists – therefore it may be beneficial to include DESNZ policy colleagues in the assessment process, who may have more insight into potential future policy changes that would affect end markets.

A more administrative point about the assessment process is that it should be ensured that all assessors have sufficient resources to complete a detailed assessment of each application, rather than having to fit this in around other work commitments. This would mean ensuring the current pool of assessors have sufficient time to commit to the assessment process, or widening the pool to spread the assessment process across more assessors. This would incur an additional cost as new assessors will need to receive training and guidance documents and be supported when making their assessments.

Additionally, it is recommended that the two-stage moderation of technical scores is retained.

Awarding support and due diligence

The awarding support and due diligence process was seen to be effective, although the process took longer than the processes associated with other programmes. One of the reasons for the duration of the process was the difficulty in undertaking test. The programme will have to follow government guidelines for this, but the test may be altered as the previous test was based on European Union guidance.

An additional driver for the long timescales was the agreement of milestones for the projects. The milestone approach was seen as a strength of the Grant Offer Letter, and should be retained. However, potentially having less negotiation around milestones with applicants could reduce the timescale between the awarding of funding and the projects starting.

One potential area for improvement would be a potential tightening of the Grant Offer Letter. Applicants were previously given six months to resolve issues arising in the delivery of the project, but it could be clear that a project is not going to successfully deliver before the six months are completed – and the Grant Offer Letter could be revised to allow the project to be stopped earlier.

It should be noted that the timescales to agree the Grant Offer Letters was not seen as problematic for the delivery of projects, so no major changes to the processes to agree the Grant Offer Letter are recommended.

Incubation support

Incubation support was a central element of the programme, and was generally considered to be a helpful component of the support provided. The structure of the incubation support (initial meeting to set out an incubation plan followed by delivering incubation support activities

throughout the project) was seen to be appropriate, and the breadth of incubation support activities was seen as a strength, with the catalogue covering almost everything a supported firm could require. It is recommended that the structure and catalogue of activities are retained for EEF8.

Another strength of the incubation support offered was that it could be tailored to the needs of the firm, and it could be provided by a large, multi-national engineering firm or a support company which had a greater understanding of the needs of a micro-business. It is recommended that a wide range of suppliers is retained for the provision of incubation support activities for the following reasons:

- Some firms will require very specialist support, which can only be provided by a firm with a niche area of expertise (rather than a large engineering firm) – for example around specific IP issues.
- Some small and micro firms feel they benefit more from receiving support from businesses which understand how micro-enterprises work in practice, and feel the advice from larger firms is unhelpful to their circumstances.
- However, the incubation support offered by the large engineering firms is seen as valuable (and of a high quality) due to the depth of expertise and knowledge of global markets, as well as the gravitas their involvement brings to participants in meetings with potential partners and customers. Therefore, support from these companies should be retained.

Some more administrative recommendations about the provision of incubation support are around maintaining the flexibility of the offer (the incubation plan being revised as the project is ongoing) and the management of the incubation support activities. The management of the incubation support activities should ensure that appropriate staff members are utilised to deliver the incubation support activities (for example senior staff meeting company CEOs), even if this means fewer incubation support activities are delivered, and ensuring that all incubation support outputs are tailored to the specific firm, rather than being generic.

Monitoring and data collection

Findings from the interviews with stakeholders suggests that the project monitoring procedures put in place did provide an adequate framework for understanding the progress of projects. Monitoring for Phase 7 of the EEF programme was externalised to contractors to reduce pressure on internal DESNZ staff. As there has been no observed impact on satisfaction among EEF participants, it is recommended that this arrangement could be continued for EEF Phase 8. However, it is recommended that some arrangements are made to ensure that participants still have a direct line of communication to a DESNZ staff member.

The current Management Information being collected from participants covers all the required indicators for the EEF programme and does not need to be altered. However, it is important that the completion of these forms is compulsory.

A recommendation for Phase 8 of the EEF would be to improve the knowledge transfer from the Management Information collected from participants at the end of their project and the assessment process. Lessons from historic projects can provide useful information for the assessment process around routes to commercialisation and challenges associated with particular technologies, and could provide useful input into the technical and commercial assessment process.

Alternative mechanisms to potentially increase successful outcomes

The above has highlighted changes that can be made to the existing processes to improve the performance of the EEF programme in Phase 8. However, one larger potential change to the processes employed by the programme could lead to an increase in positive outcomes. This change would be to adjust the design of programme to require applicants to complete market validation to confirm commercial viability before it is permitted to progress the R&D project. This could give an opportunity to applicants to pivot to new objectives as well as identify cases where public investment in the R&D project may not lead to the desired results.

This larger change should be considered by DESNZ, as they may alter the performance against some key KPIs (for example the number of businesses supported and the number of businesses making technological progress) as well as improving positive outcomes achieved.

Evaluation plan

The research team have also reflected on the processes used in this evaluation and would make the following suggestions for evaluating EEF Phase 8.

Evaluation objectives

The key evaluation objectives would be similar to those which were included for the evaluation of EEF Phases 1-7. However, it is recommended that there are fewer, more focussed questions. These would be:

- How effective have the processes used in the delivery of EEF8 been in driving successful outcomes (with a particular focus on the processes which have been altered between EEF Phase 7 and Phase 8)?
- How has EEF Phase 8 contributed to the achievement of technical and commercial outcomes for participating businesses?
- What are the expected longer-term economic and environmental benefits from EEF Phase 8?
- How do the achievements of EEF Phase 8 compare to those achieved in previous phases of the programme?

- Does EEF Phase 8 offer Value for Money?

Timing and methodological approach

Baseline assessment and measurement of participant progress during delivery

There were some issues around the recollection of applicants about their technologies and applications during the depth interviews conducted for the evaluation of EEF Phases 1-7 – particularly for those applications from earlier phases of the EEF. For an assessment of the baseline position of applicants of EEF8, it is recommended that the programme MI is utilised rather than collection through subsequent primary research.

As described above, the research team concluded that the MI currently being collected (through application, project closure and CPR documentation) for the EEF programme covers the required fields. However, as stated above, it will be important to make the completion of these documents compulsory of EEF Phase 8 participants to ensure participant progress over the lifespan of the contract can be monitored.

One potential additional data field for EEF Phase 8 would be to ensure that a Monitoring Officer or Incubation Support lead provides evidence for the CRL that the firm has achieved at various points throughout the delivery of the project. This could be fed back into the MI data (which would have data for all other technological and commercial outcomes) for participants. However, the current application form does not collect information about the CRL of a business at the point of application. This could be added to the application form as a simple tick box question to avoid discouraging businesses that are unfamiliar with CRLs from applying (providing the scale with descriptors and a tick box next to each description). This would provide a baseline measure of CRL for both participants and declined applicants at the point of application.

It is not recommended that any primary research is undertaken to assess the progress of applicants towards technical or commercial outcomes during the lifespan of EEF Phase 8 contracts, as the information is being collected by the existing programme MI and the primary research would provide little added value. The MI should be used to evaluate the progress of participants towards their stated outcomes.

Process evaluation

To collect evidence to support the first evaluation objective highlighted above (the process evaluation objective) primary research will be required. It is recommended that this primary research takes place towards the end of the EEF Phase 8 project delivery (two to three years post contract award). The timing of this research would be to balance the need for recall about all aspects of the application and delivery processes, but to allow sufficient time to pass to allow participants to experience the processes involved in delivery.

This would be a programme of depth interviews, with successful and declined applicants and programme stakeholders, to collect information to inform a process evaluation. The applicant

interviews would not need to be undertaken with all participants. Assuming a similar number of successful applicants as in previous phases, it is recommended around half of the participants are interviewed during this process evaluation stage, with a similar number of declined applicants interviewed at this stage.

Impact evaluation

Due to the time period required for commercial outcomes to be achieved, it will not be appropriate to evaluate the performance of EEF Phase 8 against commercial objectives at the completion of project contracts. It is recommended that the collection of data to inform an impact evaluation takes place post-completion, and is split into two phases:

- An early impact evaluation to take place five years after the award of the contracts. This would allow at least one-year post completion of the project for participants, and allow a sufficient period of time for declined applicants to attempt to progress their project by other means (if this is feasible).[64] The approach to data collection should involve a series of depth interviews with successful and declined applicants to collect information about the key outcomes from their project and their business (those that were collected for this evaluation). The early impact evaluation should also collect data about participants and declined applicants from secondary data sources (from the ONS and financial databases) to support an econometric analysis (if feasible from the sample size of successful businesses).
- A longer-term impact evaluation to take place eight years after the award of the contracts. This would involve the same approach of depth interviews with participants and declined applicants, asking for outcome data points. Again, the longer-term impact evaluation should collect data about participants and declined applicants from secondary data sources to support an econometric analysis of the impacts (if feasible). The purpose of this final evaluation would be that it has allowed a sufficient period of time post project completion for commercial outcomes to realistically be achieved. If they have not been achieved at this point, it will be possible to conclude that they are unlikely to be commercially viable.

The surveys of participants and declined applicants for the impact evaluation should include all EEF Phase 8 participants, and all high scoring declined applicants.

Economic evaluation

It is recommended that an economic evaluation of EEF Phase 8 is not undertaken until the post completion impact evaluations are undertaken. However, it is recommended that different forms of economic evaluation are undertaken during each stage of the impact evaluation:

- Cost Effectiveness Analysis: This can take place in the early impact evaluation. This would assess the costs required to achieve some of the shorter-term objectives – such

[64] The feasibility of the econometric analysis of secondary data sources is dependent on having sufficiently large sample sizes. Presently it is not known how many businesses would be awarded support through EEF Phase 8 or how many high scoring declined applicants there will be. The feasibility of econometric approaches would need to be explored at the outset of any evaluation of EEF Phase 8.

as technological progress or new relationships formed as a result of participation in the programme, and compare these to benchmarks from other evaluations undertaken. This should be possible as the costs associated with EEF participation (grant funding and the cost of incubation support) can be split between technological and commercial outcomes (e.g. grant funding targeting technological progress).

- Cost Benefit Analysis: A more complete assessment of the value for money of EEF Phase 8 should be completed during the long-term impact evaluation. This would utilise information about the impact of participation in EEF on productivity and R&D expenditure (and environmental impacts if these have been achieved) and compare these to the cost of delivering the programme.

Summary of approach

The table below summarises the approach to data collection and analysis for the evaluation of EEF Phase 8.

Table A1.1: Recommended approach to evaluate EEF8

Data collection / analysis approach	Timing		
	Baseline and over the course of project delivery	Post completion (early impact)	Long-term post completion
Analysis of management information	✓		
Depth interviews with participants and declined applicants (process evaluation)	✓		
Depth interviews with stakeholders (impact and process evaluation)	✓		
Depth interviews with participants and declined applicants (impact evaluation)		✓	✓
Analysis of secondary data sources (impact evaluation)		✓	✓
Cost Effectiveness Analysis (Value for Money)		✓	
Cost Benefit Analysis (Value for Money)			✓

The approach outlined above will allow the DESNZ delivery team to draw lessons from the delivery of the programme during and towards the end of the delivery of the EEF Phase 8 programme. However, it will not lead to drawing inaccurate conclusions about the impact of the programme by assessing the commercial impacts before they have had time to be achieved. This can be collected from the later impact evaluations.

Ensuring participation in the evaluation

There were some challenges in ensuring businesses that had engaged with the EEF programme would participate in the evaluation activity. This was both for successful applicants and applicants that had their application declined, although this was experienced more acutely in declined applicants. One of the factors for this was the time between the point of application and the depth interviews taking place. This has been addressed in the recommended design by splitting the data collection exercise into three separate time periods.

Another factor which reduced participation in the evaluation was that businesses were not required to take part in the evaluation. As the businesses were not under an obligation to participate, they could decline. To reduce this risk factor for an evaluation of EEF Phase 8, all successful applicants should be contractually obliged to participate in evaluation activities. For businesses that had their application declined, this is more complicated as they cannot be contractually obliged to take part. However, providing details that the programme will be evaluated at the point of application – that the programme will be evaluated and applicants could be asked to participate in evaluation activity and asking them to consent to be being contacted as part of an evaluation – may help with participation.

Additional information from non-participants

One group of businesses which were not covered in the evaluation of EEF Phases 1-7 was businesses which expressed an interest in taking part in the EEF programme, but did not submit an application. Information from this group should be collected as part of the evaluation of EEF Phase 8, and can feed into the process evaluation (and potentially through matching in secondary data sources, the impact evaluation). The potential information which could be collected from non-applicants would be:

- Feedback from non-applicants about their decision not to apply, which could feed into the process evaluation. This information would need to be collected just after their decision not to apply. Non-applicants will be unlikely to recollect submitting an EOI for EEF Phase 8 or the reasons for not submitting an application at the point when the process evaluation would take place. Therefore, in order to collect information about the reasons for non-application, feedback could be requested (in the form of a short online survey, potentially only a couple of questions) asking for the reasons for non-application. This could be sent out in the month after the EEF8 application window closes.
- The details of EEF Phase 8 EOI submissions (stored within programme MI). This could then be used to monitor any outcome indicators among non-applicants in secondary data sets (to note if they perform differently to declined applicants and EEF

participants). Additionally, details from the EOI (and potentially these being matched to ONS databases) could be used to identify if there are any systematic differences between non-applicants and applicants as part of the process evaluation.

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