productivity insights network

PIN - Productivity Projects Fund

Small Project Report

Assessing the productivity and environmental effects of low carbon innovation programmes

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UKRI Economic and Social Research Council

About PIN

The Productivity Insights Network was established in January 2018 and is funded by the Economic and Social Research Council. As a multi-disciplinary network of social science researchers engaged with public, private, and third sector partners, our aim is to change the tone of the productivity debate in theory and practice. It is led by the University of Sheffield, with co-investigators at Cambridge Econometrics, Cardiff University, Durham University, University of Sunderland, SQW, University of Cambridge, University of Essex, University of Glasgow, University of Leeds and University of Stirling. The support of the funder is acknowledged. The views expressed in this report are those of the authors and do not necessarily represent those of the funders.

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Introduction

The UK faces the twin challenges of low productivity growth and the threat of climate change. However, productivity and low carbon goals are often viewed separately in policy development and evaluation. Productivity is often defined narrowly as labour productivity, focusing on the relationship between outputs and inputs (e.g. revenues per worker) without taking account of non-market values associated with the use, preservation or generation of environmental assets. At the same time, there are a plethora of definitions, indicators, metrics to assess low carbon outcomes, but very little consistency in application. Innovation policies face particular challenges in this context, where demonstrating and the linking *future potential* growth/ productivity and low carbon outcomes is even more difficult.

In parallel to productivity and low carbon policy imperatives, COVID-19 represents a juncture at which to review the objectives of different policy areas, including innovation policy, and to reflect as to whether the focus and balance needs to change (Cook and Vorley, 2021). Whilst economic growth through commercial enterprise is often seen as the core focus for innovation policy, for instance with three of Innovate UK's five objectives focused on business, industry growth and commercial impacts (Innovate UK, 2019), there has been an increasing focus on wider societal objectives, including clean growth and the net zero transition. In order for innovation policy to be effective in contributing to economic and social welfare in a broad sense, it is increasingly important to consider the inter-relationships between different drivers and outcomes, and effectively assess (and where appropriate measure) progress towards intended effects. An approach that embeds the environmental effects associated with low carbon innovation and cleantech within economic and productivity measures could provide a more holistic view (Owen et al., 2020).

This project has sought to examine the following three research questions:

- How is the effectiveness of innovation programmes measured in relation to low carbon and productivity outcomes?
- How could low carbon outcomes be considered in terms of their contribution to productivity, e.g. through composite measures or mixed approaches?
- What are the implications for ex ante appraisal of programmes, and monitoring and evaluating success?

The work is intended to inform the design and assessment of innovation programmes, particularly those with the potential to address productivity *and* low carbon challenges.

The research has involved a review of low carbon innovation programme literature (including business cases, logic models and evaluation evidence), and consideration of guidance for measuring, accounting for and monetising environmental costs and benefits. In developing the findings, the study has enhanced and refined existing programme logic models in an illustrative way: these are the authors' own developments and have not involved consultation with any programme leads.

Key findings

How is the effectiveness of innovation programmes measured in relation to low carbon and productivity outcomes?

Thirteen programmes were incorporated in the review of how low carbon and productivity outcomes were (or are expected to be) assessed, drawing on desk research of readily available documents. The intention was to examine a range of programme types, rather than being exhaustive, and the mix of programme types included support for low carbon technologies at

different levels of technology and market readiness, e.g.: R&D and innovation support schemes designed to develop new low carbon technologies (i.e. earlier stage); finance and fund support schemes offering investment to innovative companies developing low carbon technologies (i.e. demonstration to market and scale up stages); and programmes to encourage the uptake of low carbon technologies (i.e. adoption and diffusion stage) – see Annex 1 for details of programmes examined.

A range of outcome measures were identified in the programme documentation, and these are set out in Table 1. We have sought to define and categorise these measures to reflect their focus, and we return to this issue in the final section. Categories in Table 1 cover:

- general R&D and technology-related outcomes, i.e. those not specifically associated with the low carbon nature of the innovation
- low carbon-specific R&D and technology outcomes
- financial and commercial effects that could be used to demonstrate productivity-related benefits, principally through commercial routes
- low carbon outcomes that have an environmental focus, e.g. through carbon reductions, air quality etc.
- low carbon outcomes that could be used to demonstrate productivity-related benefits (either for firms or societal cost reductions).

Table 1: Summary of key outcomes

General R&D/ tech outcomes	Low carbon R&D / tech outcomes	Financial/ commercial effects that can be related to productivity	Low carbon outcomes with environmental focus	Low carbon outcomes that can be related to productivity
• Increased R&D capacity and skills • Increased supply chain collaboration (incl. on tech and innovation) • New/improved collaborations between research and industry • Attracting investment in innovation and R&D	• New energy products/ services advanced towards the market • New tech that solves energy/ resource efficiency issues and GHG emissions • Patents for low carbon technologies • Demonstration of innovative low carbon technology	• Increased GVA • Improved business performance measures (e.g. turnover and profitability) • Job creation (incl. high value jobs) • Increased exports • Attracting investment in capital	• Reduced CO2 and GHG emissions • Energy consumption reduction • Increased carbon capture • Increased use of renewable energy • Environmental benefits such as improved air quality	• Energy consumption reduction • Reduced use of natural resources (or preservation of resources)

Source: SQW, drawing on the programme documentation reviewed

Three key points are noteworthy in respect to the **low carbon and productivity measures** identified in the documentation reviewed that was available (acknowledging that we did not have access to all documentation):

- **The material focused on outcomes associated with innovation and technology development, and the resulting effects on commercial outcomes.** Even though the documentation reviewed related to low carbon innovation programmes, only some explicitly connected low carbon outcomes with the development of innovations or technologies.
- **A range of environmental benefits were stated in documentation, though only a small number of programmes identified specific low carbon indicators and sought to develop and measure metrics associated with these.** These outcomes included greenhouse gas emission reduction (using CO2) and energy consumption reduction (kWH). In many cases, it was too early in the programme cycles for evidence to be available on effectiveness in relation to environmental measures. Indeed, for programmes at earlier stages of the innovation process, there were relatively few explicit low carbon outcomes identified for assessment (e.g. environmental effects) nor clarity on how these might be assessed at a more appropriate point in future.
- **Where financial and commercial outcomes were identified, the link to productivity was implicit rather than explicit.** For example, links from employment creation were rarely made in terms of the value of those jobs; and whilst the commercialisation of innovations was reflected in turnover effects, it was not considered in terms of the potential higher value of innovations.

The review also identified issues in **how the indicators above are positioned in the overall programme logic:**

- There is often **a leap in the logic** between innovation-focused outcomes (such as new products and services brought to market) and low carbon effects that these innovations are then anticipated to bring about through adoption. The review found limited consideration of intermediate *steps towards* low carbon effects, such as assessment of market demand, effective adoption and scale-up.
- **The routes to impact are often not clearly articulated.** Productivity impacts are occasionally associated with the growth of *innovative firms* (e.g. via high value job creation) but potential benefits associated with the take-up of low carbon products/services for *adopters* are largely absent in the programmes reviewed.
- Logic models and theories of change do not effectively consider **connections and causal relationships *between* low carbon and productivity outcomes**, even in adoption programmes where an assessment of these types of outcome is more plausible.

The nature and objectives of an innovation programme clearly matter in this context, and influence the extent to which innovation, low carbon and productivity outcomes can be mapped and measured.

There is less consideration or assessment of low carbon outcomes where programmes are not operating at adoption stages. This means that success is measured by the development of innovations and technologies, but less so on whether they make a difference to ultimate low carbon objectives. Challenges, particularly for earlier stage innovations, include: the long timescales to these effects that are beyond evaluation plans; the lack of evidence on the scale of potential environmental benefits, such as how innovations may contribute to reduced emissions; and the uncertainty of how far innovations may be adopted, which makes assessment reliant on layers of assumptions and potentially unreliable forecasts.

Reflecting these challenges, the focus on low carbon effects was more apparent for adoption focused programmes, which sometimes included tools relating to measuring low carbon outcomes. For example, as discussed in more detail below, the Industrial Energy Transformation Fund programme included specific measurement tools for assessing and reporting the benefits of adopting low carbon technologies. However, the review suggests low

carbon outcomes are not linked explicitly to potential productivity effects, except for references to energy efficiency. For example, such benefits were not linked to either reductions in inputs for individual businesses or wider sectors, or more widely in terms of the reduced use of natural resources for society.

How could low carbon outcomes be considered in terms of their contribution to productivity, e.g. through composite measures or mixed approaches?

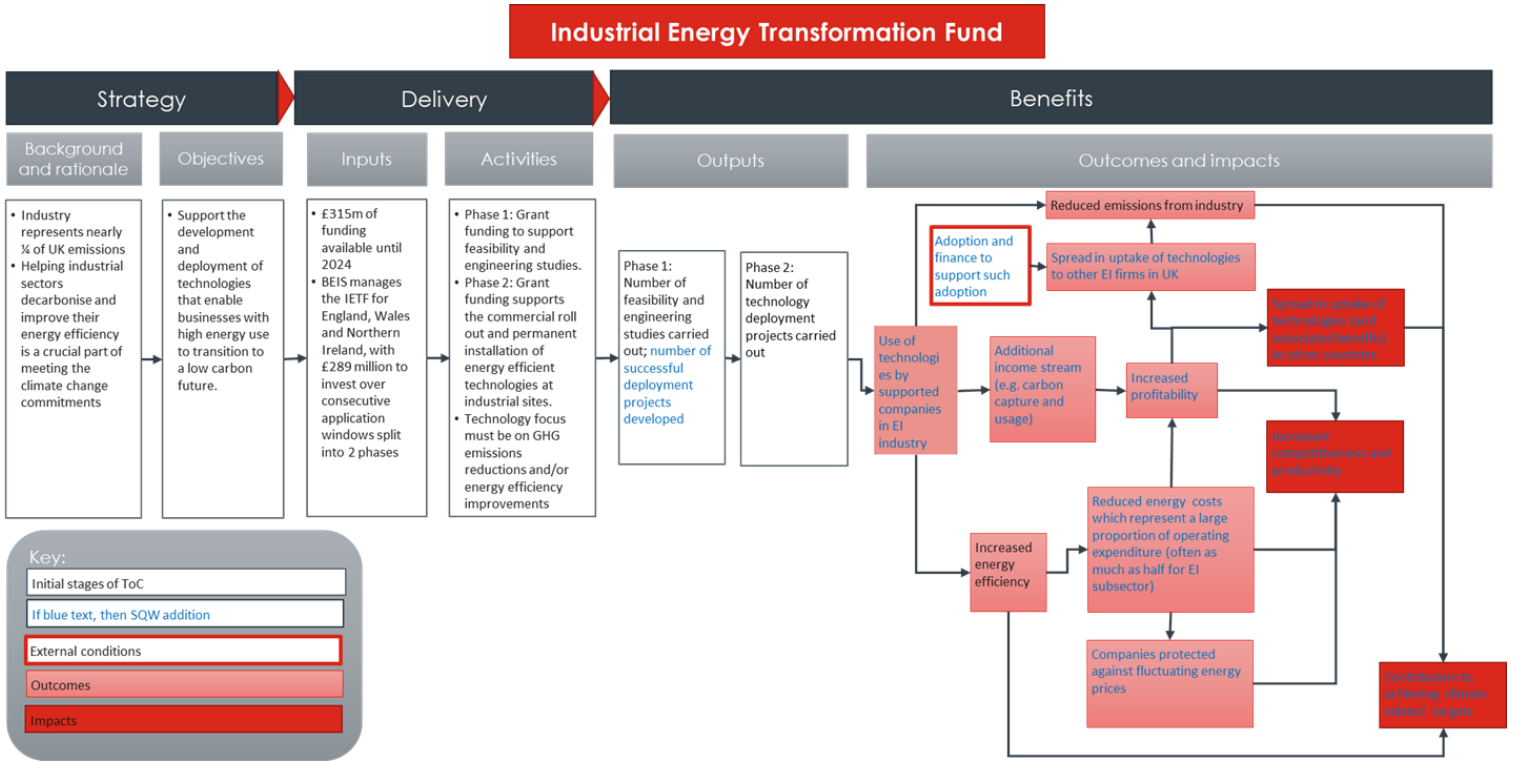
Some of the issues identified above could be tackled through greater development of the programme logic, and potentially through use of different assessment or forecasting tools.

Extending the programme logic

Two examples are provided in the subsequent pages, the first covering the Industrial Energy Transformation Fund (IETF, a programme designed to increase business investment in energy efficiency measures and low carbon technologies, i.e. at the adoption stage), and the second covering the Innovation Fund (which funds earlier stage technologies and innovations that could contribute to low carbon targets).

These two examples show how extending the programme logic can establish more clearly, including through setting out key assumptions, the anticipated links to a wider range of outcomes. These outcomes could cover both low carbon and productivity-related effects, and the logic models could set out where there may be relationships between them, including any possible areas of causality that could be tested further:

- In the case of IETF, the extended logic illustrates assumptions underpinning how continued adoption of low carbon technologies or energy efficiency could translate into productivity benefits, as well as how possible spillovers might lead to wider diffusion and so further low carbon and productivity-related effects.
- In the case of the Innovation Fund, extending the logic through assumptions around widespread take-up would be anticipated to lead to productivity improvements through higher value added (of innovative goods and services sold) and reductions in resource inputs by firms taking up technologies and society more widely.

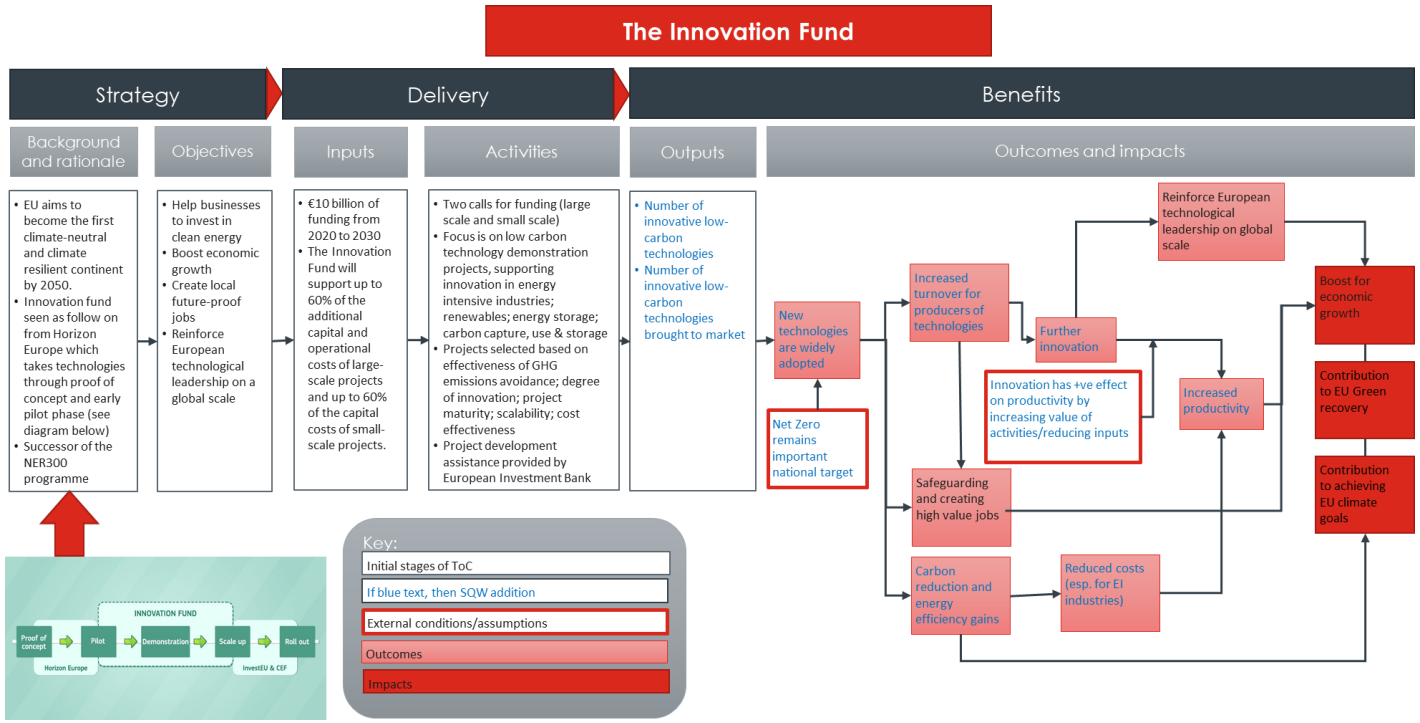


Logic: the programme documentation references two key outcomes: i) reduced emissions from industry; and ii) increased energy efficiency. Our extended logic model (above) demonstrates how these two outcomes interrelate to impact on other low carbon outcomes (e.g. climate related targets) and also productivity outcomes (e.g. through reductions in resource inputs). Intermediate outcomes are important in this relationship, including the continued use of technology by energy intensive firms (beyond the support), and the translation of reduced energy costs into reduced overall operating costs thereby helping to increase competitiveness and productivity. These outcomes may lead to wider adoption as other firms seek to remain competitive. As more companies adopt the technology the impacts on emissions reductions and energy savings will be more widespread, thus contributing to carbon reduction targets.

Key aspects: designed to help businesses cut their energy bills and carbon emissions through investing in energy efficiency and low-carbon technologies. Provides financial support to businesses with high energy use to: undertake energy efficiency and decarbonisation studies; implement energy efficiency projects; and deploy decarbonisation technologies.

Measurement: the energy related benefits of each project are calculated using a Project Benefit Calculator. This captures information on energy consumption, fuel bills, production levels and GHG emissions.

Source: SQW, drawing on competition collection, available: https://www.gov.uk/government/collections/industrial-energy-transformation-fund [Accessed May 2021]



Key aspects: early-stage innovation at demonstration phases; supports development of *"highly innovative technologies"* and *"flagship projects"* within Europe that can stimulate significant reductions in emissions; intended to deliver €10 billion of funding in 2020-30 for large- and small-scale projects with a focus on energy intensive industries, renewables, energy storage, and carbon capture.

Logic: our extended logic model (above) demonstrates how the Innovation Fund may bring about productivity and carbon outcomes. It shows that widespread adoption of the developed technologies is key to achieving these outcomes. As the technologies are more widely adopted, the creators of the technology would be expected to experience increased demand and turnover. This will lead to further spending on R&D. The resulting innovation is assumed to positively affect productivity by increasing value added and/or reducing required inputs. These factors both contribute to boosting economic growth and contributing to the EU's green recovery, and so to achieving the EU's climate goals. This is also helped by the direct carbon reduction and energy efficiency gains resulting from the widespread adoption of the supported technology.

Measurement: programme documentation does not refer to how the energy/carbon related benefits of the programme will be assessed. The time to carbon and productivity outcomes may be long, resulting in measurement challenges.

Source: SQW, drawing on online overview of the Fund, available: https://ec.europa.eu/clima/policies/innovation-fund_en [Accessed May 2021]

Assessment and forecasting tools

At a broad level, Defra's guidance on Natural Capital approaches[1] provides a common and balanced framework to assess and value the natural environment alongside social and economic benefits associated with natural assets. There are a number of natural capital methods, and an increasing number of tools to enable the implementation of these methods.

In terms of low carbon innovation programmes, the IETF programme uses a specific Project Benefit Calculator that captures information on aspects such as energy consumption and GHG emissions, thereby enabling effective measurements of low carbon outcomes. This reflects the nature of the programme, because for programmes focused on adoption (such as the IETF) the ability to measure low carbon outcomes makes demonstrating the relationship with productivity more straightforward. The long timescales to outcomes for earlier stage programmes such as the Innovation Fund have more significant challenges, because of uncertainties over take-up and the scale of benefits.

There are tools and guidance documents that could assist with assessment, including some that could help overcome the challenges associated with uncertainties in take-up and scale.

Measuring GHG emissions / energy usage at organisation level: Defra's guidance sets out the general principles for how to measure and report greenhouse gas emissions at the organisation level.[2] It is based on the GHG Protocol, the internationally recognised standard for the corporate accounting and reporting of GHG emissions. The guidance considers both gross and net GHG emissions (in terms of tonnes of CO2) within three scopes: (1) direct emissions (e.g. emissions from an organisation's own processes), (2) indirect emissions from energy (e.g. consumption of purchased electricity) and (3) other indirect emissions (e.g. purchased material). A more detailed approach to assessing and reporting environmental impact is provided by HM Treasury's updated Environmental Reporting Guidelines (2019). This provides a step-by-step guide to reporting environmental impacts of organisations. The first step is determining the boundaries of the organisation – this must include emissions from activities for which they are responsible and is broadly in line with Scope 1 and 2 outlined above. Under this guidance, companies are required to report on various GHG emissions in terms of CO2 equivalent. As well as GHG emissions and energy usage, organisations may gather data and report on other environmental KPIs relating to water, waste, materials and resource efficiency, and biodiversity/ ecosystem services.

Measuring GHG emissions at technology/product level: There is a lack of government guidance on measuring the GHG emissions (and benefits) at the level of products, services or technologies, particularly those still under development.

The Carbon Trust also offers guidance on assessing the GHG emissions related to a particular product.[3] The "Product Carbon Footprint" is the total sum of GHG emissions (in CO2 equivalent) produced throughout a product's lifecycle. It includes the emissions of suppliers, manufacturers, distributors and customers related to the manufacturing and use of a product. This does, however, still rely on the availability of quantified data as inputs to the assessment process (e.g. litres of fuel consumed per product unit).

However, some tools are available from other organisations which could be relevant for public policy, including from the impact investment community. One of these tools is the online CRANE

[1] Defra (2020) Enabling a Natural Capital Approach: Guidance
[2] Defra (2009) Guidance on how to measure and report your greenhouse gas emissions
[3] Carbon Trust (2018) Carbon Footprinting Guide

tool which helps to assess the emissions reduction potential of climate technologies.[4] The output of the tool is a customised report for the emissions reduction *potential* of a technology in any of the following areas: buildings, electricity, manufacturing, CO2 removal, and transportation. Use of the tool requires inputs from the user on: primary inputs, target market, established market (which the new technology will contribute to/replace), related market[5], and the 'figure of merit' (a measure of how the technology might offer improvement over existing solutions, with suggested units provided in tool's guidance materials). The CRANE tool therefore takes some steps in reducing the uncertainty around take-up and scale of a technology, and provides greater transparency and consistency in the assessment of potential impacts. The output report provides an estimate of the reduction in GHG emissions as a result of deploying the technology of interest.

Monetising environmental costs/benefits of emissions reductions/energy savings: BEIS provides supplementary guidance to the previously mentioned HM Treasury Environmental Reporting guidance, regarding the valuation of energy use and GHG.[6] It follows a three-step process: (1) estimate the changes in energy/fuel use by type of energy/fuel; (2) convert the changes in energy/fuel use into the corresponding changes in CO2 equivalent by multiplying by the energy/fuel-specific emissions factor; and (3) multiply the estimated changes in CO2 equivalent by the relevant carbon price. BEIS provides a toolkit for this purpose. Within this guidance there are also details on the potential monetisation of societal gains and losses from energy efficiency installations and renewable energy projects.

Reflecting on the points above, for organisations there is a range of guidance, including from government, on emissions measurement and the monetisation of this. However, **in terms of low carbon innovation programmes, especially those seeking to support the development of new technologies, products and services, this guidance is often not helpful**. This is because the existing guidance does not directly inform on measuring the *potential* impact of an innovative product or service, which relies on information or at least estimating: 1) the (potential) uptake of the technologies; and 2) how adoption affects aspects such as emissions from a pre-adoption to post-adoption state.

Recommendations

What are the implications for ex ante appraisal of programmes, and monitoring and evaluating success?

This final section makes recommendations and considerations for appraisal, monitoring and evaluation stages of programme development and review.

Recommendation 1: the underlying logic should be developed fully for programmes to incorporate the range of effects and assumptions underpinning the routes to these effects. These can then be appraised and/or evaluated to provide a more rounded view of (potential) value from programmes.

[4] The CRANE tool was developed in the USA by the Prime Coalition, working with Greenometry, Rho AI and Clean Energy Trust. This was supported by NYSERDA, the John D. and Catherine T. MacArthur Foundation, and Massachusetts Clean Energy Center. See: https://cranetool.org/

[5] A related market is a low GHG market that is expected to grow as a result of the growth of another technology or market e.g. new battery technology does not directly decrease emissions but it may facilitate the growth of the renewable energy market.

[6] BEIS (2020), Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal. Available: https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal [Accessed May 2021]

The graphic below includes an illustrative generic example relating to innovation programmes that aim to support the development and commercialisation of new low carbon products and services, and areas where the logic could be strengthened. Key points are as follows:

- To address the leap in logic from innovation-focused outcomes (such as new products and services brought to market) and low carbon effects that these innovations are then anticipated to bring about, there should be more explicit consideration of underlying assumptions and intermediate outcomes. This could include testing whether follow-on investment has occurred, and the extent of effective adoption and then diffusion. In addition, to estimate the actual or potential scale of the low carbon and environmental effects, forecasting tools could be used, including using benchmarks for carbon or energy savings and sensitivity analysis (such as Monte Carlo approaches).
- Logic models should be clear on the connections between low carbon and productivity outcomes, both for the innovative firms *and* those adopting the new products/services. This may require further research to better understand the (potential) causal relationships between the two.
- Linked to the point above, the assumptions underlining logic models may need greater consideration of the wider system in which a programme operates and how this might influence the extent to which key intermediate outcomes are achieved.

These issues should be considered more explicitly throughout the policy cycle, from design (e.g. in the development of a programme's theory of change, and evidencing underpinning assumptions), delivery (e.g. in how the implementation of programmes designed to develop new technologies is aligned with wider support to facilitate business scale-up and/or adoption in practice) and evaluation (e.g. in the assessment of 'leading indicators' that can provide early evidence on steps towards intended impacts).

Recommendation 2: As part of an approach that reflects the broad effects of innovation programmes on economic and social welfare, it is important to capture the different types of outcomes, and the potential relationships between them.

Our own review categorised outcomes in terms of R&D and technology development, specific low carbon R&D and technology development, financial and commercial effects that could be related to productivity, low carbon effects with a focus on environmental benefit, and low carbon effects that could be related to productivity effects. This categorisation in part reflected the background to and purpose of the study. It may be useful to consider the following types of outcomes, drawing to some extent on capitals approaches, including a natural capital approach:

- Innovation/knowledge outputs, e.g. R&D, technology development, and product, process and service development.
- Financial and commercial, e.g. turnover, private investment, exports, profitability, cost reductions.
- Human, e.g. employment creation.
- Social and natural, e.g. environmental savings and benefits, and energy use.

These can be related to productivity in a holistic sense, including societal (not just private) inputs. For example, turnover and employment effects, as well as any positive environmental output could be used to demonstrate the value created. Environmental savings and energy reductions could be used to demonstrate the reduction in resource input. In addition, there may be other indirect effects through health benefits (e.g. from improved air quality) on productivity

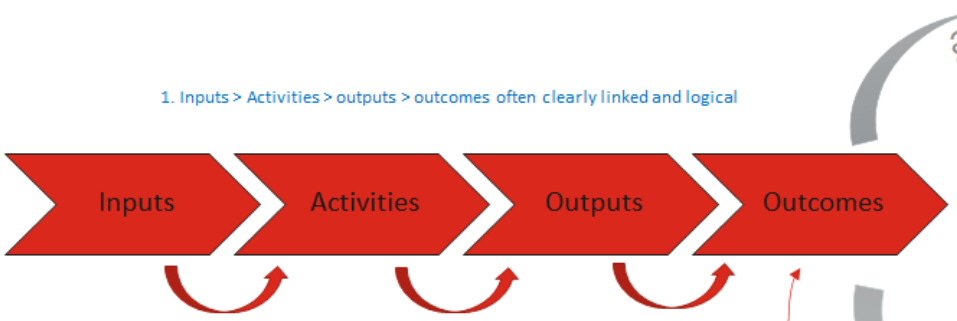
Recommendation 3: Within proportionate demands for programme management, beneficiaries and user groups, more attention should be given to measuring and estimating the downstream effects of low carbon innovations, in particular on societal and environmental benefits.

There is a need for greater guidance and support to enable those *developing* low carbon innovations to estimate, measure and communicate intermediate outcomes and their potential impact in the future. In addition to being able to evaluate the impact of such innovation programmes more effectively, this matters for other reasons, in particular to help innovators demonstrate their potential to investors (e.g. those interested in sustainability outcomes) and/or the market (e.g. by demonstrating to potential customers the environmental and financial benefits that adoption could lead to). This review has highlighted the difficulties earlier stage innovations encounter in quantifying the scale of low carbon benefits that a new product/service could deliver. This quantification is the first key step needed in order to draw on tools and guidance (including government guidance) that can help to estimate emissions reductions or energy savings. Without being able to do this first step, existing tools and guidance are of limited use.

A better understanding of, and ability to assess, intermediate outcomes and future potential impacts of new technologies would help to address this gap. We have identified tools in related areas, such as in impact investing, that could be useful in this public policy context. The Crane tool is a particularly helpful model, which supports the development of assumptions relating to the type of technology, its potential geographical reach and over what timeframe, market segmentation and the expected rate of diffusion within that market. Such tools, along with techniques such as Monte Carlo analysis, could offer a basis of estimating benefits where there remain uncertainties.

Finally, a more rounded assessment of impacts arising from innovation programmes would be helpful, taking account of different types of outcomes and encouraging more explicit recognition of the causal relationships and synergies between low carbon, productivity and wider societal outcomes. Various approaches could be useful here, such as a natural capital model or the use of balanced scorecards. To inform assumptions underpinning this type of approach, further research is likely to be needed on the ways in which low carbon outcomes can influence productivity performance at a micro and macro level.

Innovation programmes to support firms in developing and commercialising new low carbon products/services



1. Inputs > Activities > outputs > outcomes often clearly linked and logical

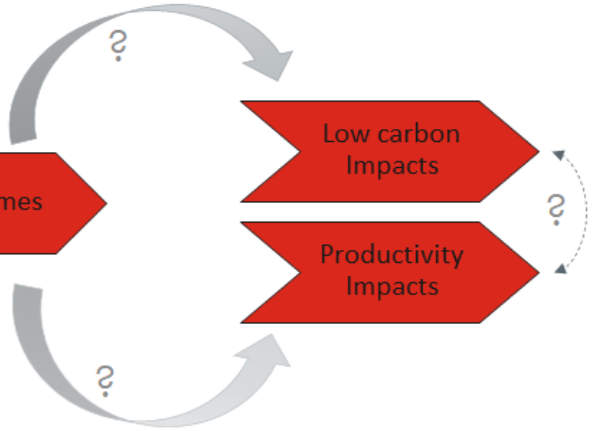
2. Judging effectiveness is focused here:

Outcomes focused on **innovation-related outcomes**

- E.g. measurable effects such as products, commercial benefits
- Some, though rare, references to *low carbon* innovation outcomes
- Productivity outcomes typically inferred from the performance of innovative firms, e.g. from added value of new products and sales, or through high value jobs

3a. Often a '**leap of logic**' to assume potential translation into low carbon impacts through adoption, but:

- Routes to these and the assumptions are often missing around: (a) continued R&D investment/securing follow-on finance; and (b) diffusion and adoption (at scale)
- Not assessed or forecast, rather simply 'anticipated in the future'
- There are difficulties/uncertainties in evidencing potential low carbon impacts – issues relating to how to measure, forecast and attribute effects



3b. Links to productivity based on assumptions that innovation outcomes will lead to productivity benefits via the **business involved in the R&D (but often implicit rather than explicit):**

- Skills/jobs associated with high value innovation activity (initially in the R&D phase … then arising from business growth as product reaches the market and is adopted)
- Innovation increases value of products/services sold

Requires greater consideration of underlying assumptions and intermediate outcomes, especially relating to adoption, in theory of change development and assessment

Requires guidance/use of measurement and forecasting tools to support assessment of potential low carbon impact and market take up. Could be lessons from impact investing, appraisal and risk-adjusted forecasting tools.

Consideration of different routes should be examined, e.g.:

- More productive business activity from lower energy use.
- Lower societal inputs from reduced carbon intensity and less damage to natural assets.
- Indirect impacts of carbon reductions on workforce health.

4. Low carbon < > productivity impacts rarely connected

- Especially the link between adoption of new low carbon products and productivity benefits *for the adopters* (and economy/society more generally)

Annex 1

Table 2: Programmes reviewed

Programme name	Overview	Key documents reviewed
Energy Catalyst (IUK)	Energy Catalyst is designed to accelerate the innovation needed to end energy poverty. Provides financial and business advisory support and facilitating new partnerships.	• Process Evaluation of the Catalyst Programmes • Framework Evaluation ITT
Innovation Fund (EC)	Provides capital investment for low carbon technology demonstration projects in specific industries (e.g. renewables, energy intensive industry, energy storage).	• Programme overview/ material available online.
The Low Carbon Vehicles Innovation Platform (IUK)	Grant support for projects in the automotive sector which will accelerate the introduction of vehicle-centric technologies to low carbon vehicles.	• The Low Carbon Vehicles Innovation Platform: Impact Review 2015
Transforming Food Production (ISCF)	Aims to (1) accelerate the development and adoption of integrated precision approaches that will improve the productivity and resilience of primary food production systems (2) set the sector on a trajectory to net zero emissions by 2040. Structured around seven strands which each target a different stage of the R&D process and different in scale, duration and timing.	• Evaluation Framework (DRAFT)
Transforming Foundation Industries (ISCF)	Seeks to make the foundation industries (FI) internationally competitive and minimise their environmental impact through supporting collaboration, stimulating investment and de-risking innovation investment.	• Evaluation Framework (DRAFT)
Industrial Decarbonisation (ISCF)	Supports the development of low-carbon technologies that will increase the competitiveness of industry and contribute to the UK's drive for clean growth. Provides funding to invest in developing technologies such as carbon capture and storage and hydrogen fuel switching.	• Industrial Decarbonisation Challenge Draft Logic Model • Industrial Clusters Mission
Energy Entrepreneurs Fund (under BEIS Energy Innovation Programme)	A competitive funding scheme to support the development and demonstration of state-of-the-art technologies, products and processes in the areas of energy efficiency, power generation and heat and electricity storage.	• The Energy Entrepreneurs Fund Guidance Document
Clean Growth Innovation Fund (Innovate UK)	Provides funding for innovative projects that can speed up the development of solutions to decarbonise, digitise and decentralise energy to help achieve a sustainable energy transition.	• Competition overview/ material available online.

Programme name	Overview	Key documents reviewed
Carbon Capture and Utilisation Demonstration (CCUD) innovation programme (BEIS)	Provides funding to design and construct carbon capture and utilisation demonstration projects.	• Phase 1 Final Report • Phase 2 Call for submissions guidance • Phase 3 call for submissions guidance
EIC Accelerator (EC)	Provides grant funding and investment to SMEs to develop "game-changing" innovations. It aims to foster impact investing by supporting the development and market roll-out of innovations that can tilt socio-economic systems towards a more sustainable path.	• EIC pilot - work programme
Low Carbon Innovation Fund (University of East Anglia)	Provides equity finance for small and medium sized enterprises (SME's) in the East of England that are contributing to the low carbon economy.	• Final Evaluation
Catalysing Green Innovation (OLEV & IUK)	Provides investment to business-led innovation projects that enable UK supply chain and manufacturing capability growth in power electronics, machines and drives (PEMD).	• Competition overview/ material available online.
Industrial Energy Transformation Fund	The Industrial Energy Transformation Fund (IETF) supports the development and deployment of technologies that enable businesses with high energy use to transition to a low carbon future.	• Competition overview/ material available online.

Source: SQW, drawing on programme information

References

BEIS (2020), Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal

Carbon Trust (2018) Carbon Footprinting Guide

Cook, J. and Vorley, T. (2021) 'Recovery and resilience: how can innovation policy support the response' IN McCann, P. and Vorley, T. (2021) *Productivity and the Pandemic*, Edward Elgar

Defra (2009) Guidance on how to measure and report your greenhouse gas emissions

Defra (2020) Enabling a Natural Capital Approach: Guidance

HM Government (2019) Environmental Reporting Guidelines: Including streamlined energy and carbon reporting guidance

Innovate UK (2019), *Delivery Plan 2019*

Owen, R., Harrer, T., Lodh, S., Pates, R., Pikkat, K. and Mair, S. (2020) *Redefining SME Productivity Measurement and Assessment for a Low Carbon Economy*, Productivity Insights Network