

Building the next generation of cleantech champions

UK landscape overview

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Introducing CleanTech for UK

The UK is home to a thriving innovation scene, strong overall investment, and what at first glance might seem to be a mature cleantech ecosystem. It is one of the most important markets for cleantech globally, with investment in 2022 reaching £2.8 billion, and a doubling of overall investment between 2019 – 2020, driven by large growth rounds in energy and clean transport.

However, global cleantech competition is heating up, and the rest of the world is moving fast. Ambitious policy measures, such as the US Inflation Reduction Act and the EU's Green Deal Industrial Plans are being rolled out at great speed, creating the potential for explosive demand increases.

To fulfil the legally binding climate targets and maintain competitive advantage in the face of this increased global ambition, the UK needs to empower its next generation of cleantech champions. However, the UK's excellent R&D and strong cleantech investment scene have not yet translated into lasting results in terms of creating cleantech companies at scale.

Cleantech for UK aims to pave the way for a new generation of global cleantech champions. This would fast-track the transition to clean, resilient energy supply and would position the country as a leading destination for cleantech investment – bringing with it, sustainable economic growth and a source of high-quality, geographically diversified jobs across the UK.

Acknowledgments

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We would also like to thank the cleantech experts from the United Kingdom and beyond who contributed their insights to this report. A full list of contributors is included at the end of the document.

Abbreviations

ARIA – Advanced Research and Innovation Agency

BBB – British Business Bank

BEIS – Department for Business, Energy and Industrial Strategy

DESNZ – Department for Energy Security and Net Zero

EIS – Enterprise Investment Scheme

GDP – Gross domestic product

HMT – HM Treasury

IRA – USA Inflation Reduction Act

LEP – Local Enterprise Partnerships

R&D – Research and development

SEIS – Seed Enterprise Investment Scheme
SMEs: Small and medium-sized enterprises

SMEs – Small and medium-sized enterprises

TRL – Technology readiness level

UKIB – UK Investment Bank

VC – Venture Capital

WMCA – West Midlands Combined Authority

Glossary

Angel Investor – is a high-net-worth individual who provides financial backing for small start-ups or entrepreneurs, typically in exchange for ownership equity in the company.

Cleantech – Cleantech refers to new technology and related business models offering competitive returns for investors and customers while providing solutions to global challenges. This report uses Cleantech Group's proprietary taxonomy, that reflects categorisation of technologies and use, and strives to include technologies that: provide superior performance at lower costs, reduce or eliminate negative ecological impact, improve the productive and responsible use of natural resources. The taxonomy does not include companies such as food delivery companies, vehicle marketplaces or autonomous driving.

Offtake Agreement – an arrangement between a producer and a buyer to purchase or sell portions of the producer's upcoming goods. It is normally negotiated before the construction of a factory or facility to secure a market and revenue stream for its future output.

Seed funding – Seed capital is the money raised to begin developing an idea for a business or a new product. This funding generally covers only the costs of creating a proposal.

Series A – the first large round of venture capital investment in a start-up that follows initial seed capital. A start-up will generally draw this level of financing only after it has demonstrated a viable business model with strong growth potential.

Series B – the second round of funding for a business through investment, including private equity investors and venture capitalists.

Spending review – a spending review tends to occur on a three-year cycle in the UK and is carried out by HM Treasury. It is the process of conducting in-depth assessments of existing public expenditure to identify opportunities to reduce or redirect spending from low-priority, inefficient, or ineffective spending.

Executive summary

The UK ecosystem supporting cleantech is strong and receives more investment than any other country in Europe:

- **UK is breaking records for cleantech investment**, with investment in 2022 reaching £2.8 billion, and a doubling of overall investment between 2019 – 2020, driven by large growth rounds in energy and clean transport.

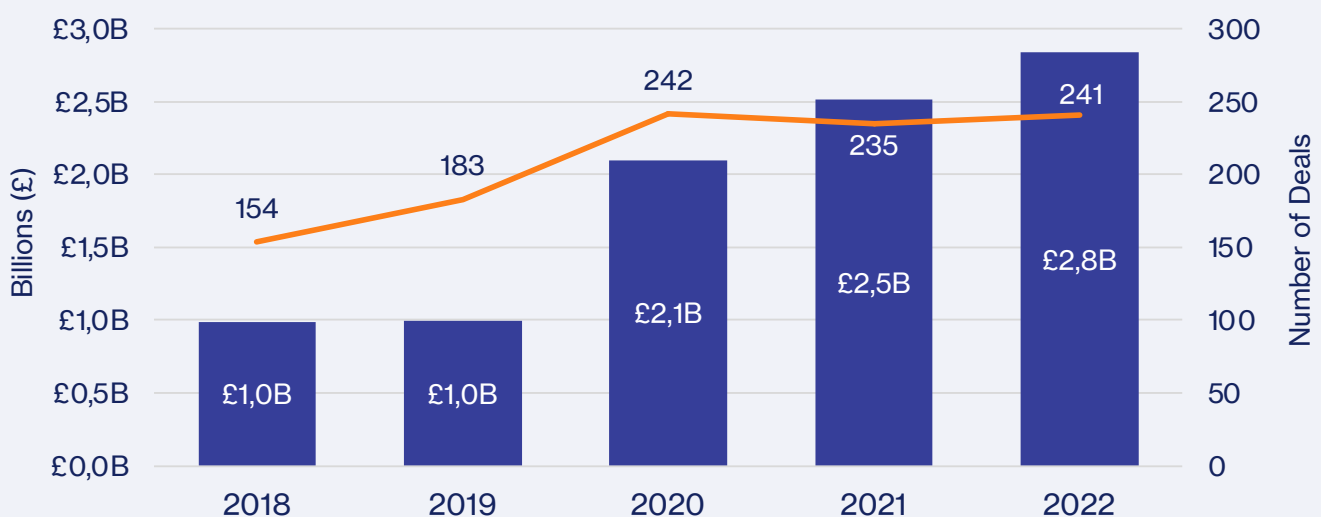


FIGURE 1: TOTAL INVESTMENT PER YEAR OVER THE LAST 5 YEARS IN CLEANTECH AND THE NUMBER OF DEALS DONE IN EACH YEAR. INVESTMENT AND THE NUMBER OF DEALS DONE HAS RISEN EACH YEAR SINCE 2018.

Source: Cleantech Group

- **2022 cleantech venture capital (VC) investment was more diversified sector-wise than in previous years**, with strong gains in materials & chemicals and resources & environment. Energy and transportation continued to dominate the top deals of the year, with international investors participating in all four of the largest cleantech funding rounds.

However:

- **The UK market remains significantly smaller than other major international blocks:** it makes up a third of the size of the EU and China and is a tenth the size of the US market. However, when counted per capita, the UK is second only to the US. The UK's smaller market size compared with other major international blocks will be further compounded if the UK fails at delivering an equivalent to the American Inflation Reduction Act or the EU's Green Deal Industrial Plan. These new stimulus measures in the USA and EU are expected to have an outsize impact on demand, which will lead to future growth in those markets.

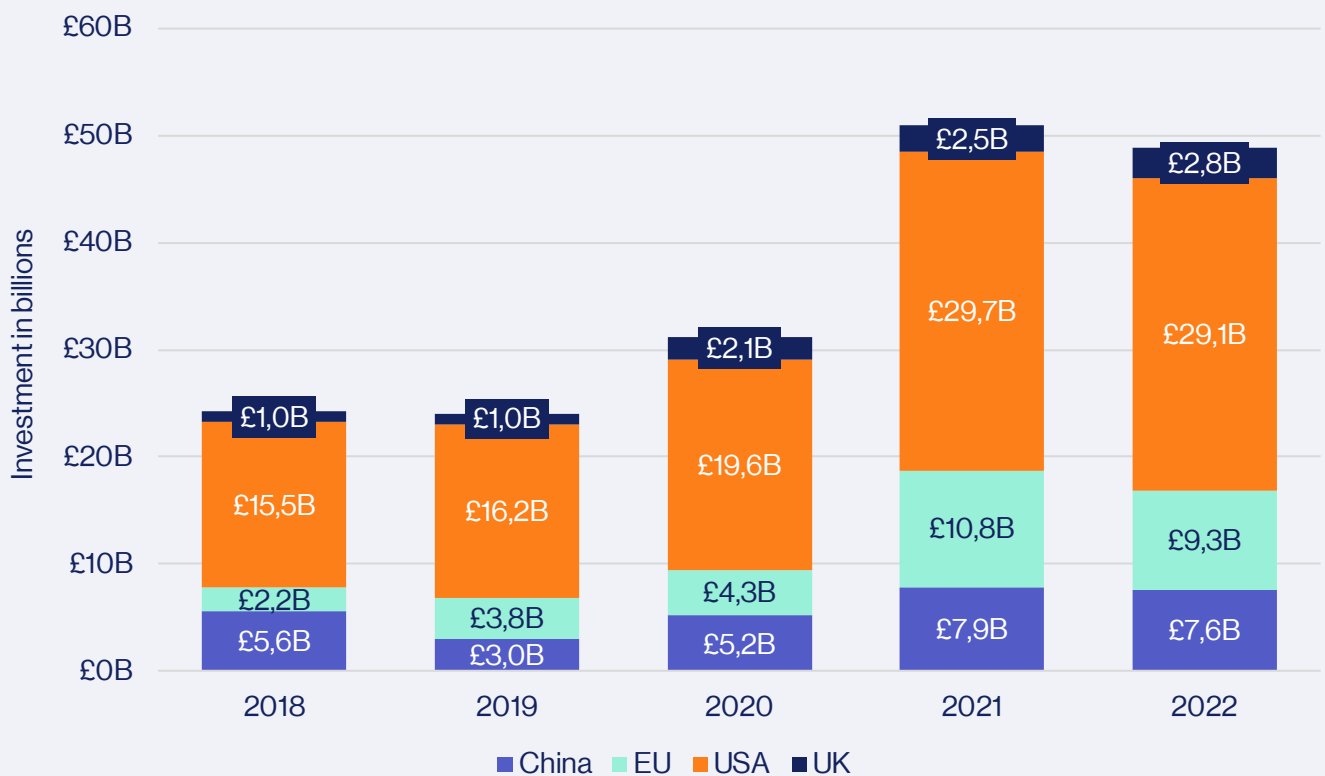


FIGURE 4: INTERNATIONAL COMPARISON OF INVESTMENT. THE UK IS A SMALL PLAYER COMPARED TO THE TITANS, CHINA AND USA.

Source: Cleantech Group

- **The UK would have to spend a total of £33 billion on cleantech over the next 10 years to spend the GDP equivalent of the Inflation Reduction Act.** The IRA commits to spending an estimated \$369 billion¹ in Energy Security and Climate Change programs over the next ten years. To understand the magnitude of this number in the UK context, the UK GDP equivalent has been calculated. The IRA is equivalent of 1.45% of US GDP (2022 figure GDP used: \$25.46 trillion²). UK GDP in 2022 was £2.2 trillion. To meet the 1.45% GDP equivalent, the UK would thus need to spend £33 billion. The UK government committed £30 billion in the 2021 spending review for net zero³.

That said, the \$369 billion is an estimated figure from the Congressional Budget Office, and a part of the incentive scheme includes uncapped tax credits. Goldman Sachs have estimated the cost of the program to be much higher: placing the programme's true size, tax credits included, at \$1.2 trillion dollars by 2032. That number would equate 4.7% of US GDP. For the UK to reach that GDP equivalent, it would need to spend £107 billion. Regardless of the exact cost of the US programme, however, it is expected to unleash another \$3 trillion in investment by private investors⁴.

The UK faces issues that hamper its ability to reach its full potential:

- **Insufficient long-term certainty in public funding:** There are notable gaps in public support at pre-seed stage (TRL 1-3) and first commercialisation onwards (TRL 6+). The three-year spending review budget planning cycle leads to uncertainty over the long term, which reduces the leverage of public-private investment, as it increases the risk premium on private sector engagement.

¹ https://www.democrats.senate.gov/imo/media/doc/inflation_reduction_act_one_page_summary.pdf

² [https://www.bea.gov/news/2023/gross-domestic-product-fourth-quarter-and-year-2022-third-estimate-gdp-industry-and#:~:text=Current%2Ddollar%20GDP%20increased%209.2,\(tables%201%20and%203\)](https://www.bea.gov/news/2023/gross-domestic-product-fourth-quarter-and-year-2022-third-estimate-gdp-industry-and#:~:text=Current%2Ddollar%20GDP%20increased%209.2,(tables%201%20and%203))

³ <https://commonslibrary.parliament.uk/research-briefings/cdp-2023-0124/>

⁴ <https://www.foxbusiness.com/energy/inflation-reduction-act-cost-us-1-2-trillion-goldman-sachs-says>

- **Lack of finance for demonstration, commercialisation and late-stage:**

Cleantech scaleups encounter difficulties financing from demonstration onwards. Building the first few projects or building the manufacturing capability for hardware tends to both be risky and require large amounts of long-term capital with the reward not clearly compelling enough for investors. This has led to a scarcity of funds at the Series B+ and growth stages beyond with the expertise to evaluate the feasibility of cleantech concepts, or the mandate and firepower to invest in them. Innovators also face difficulties obtaining debt funding for CAPEX and working capital.

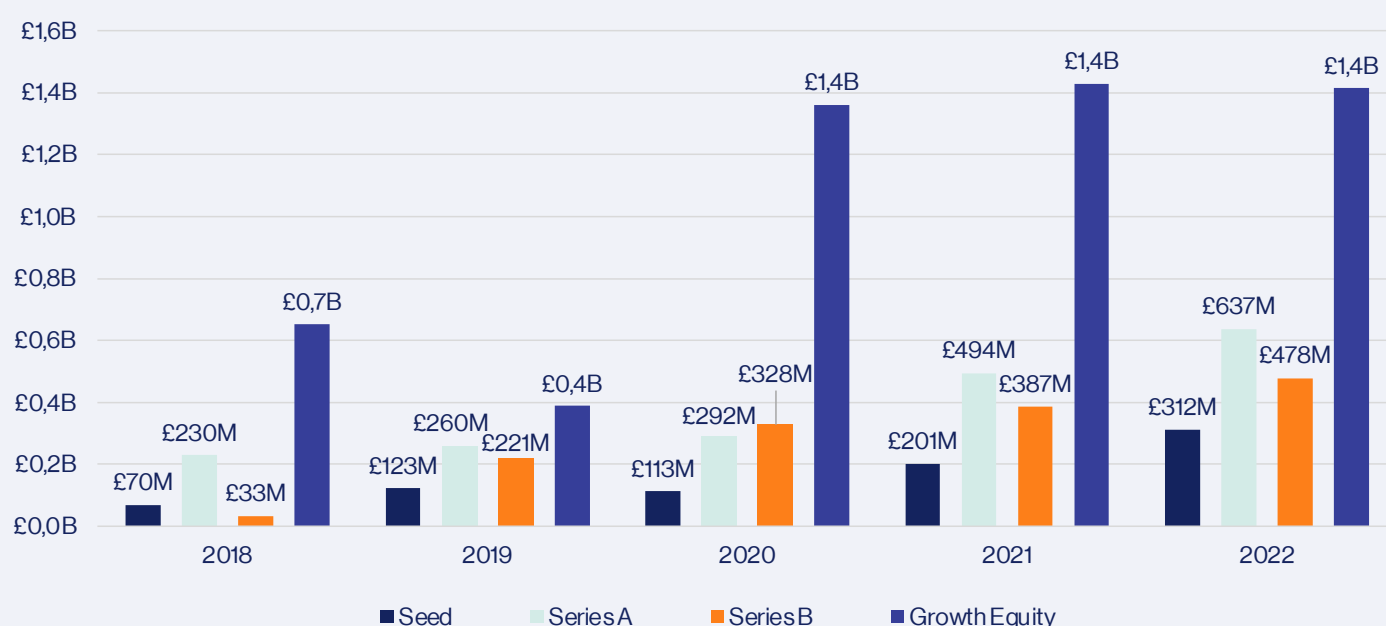


FIGURE 11: TOTAL INVESTMENT IN £ BY STAGE BETWEEN 2018 AND 2022, INDICATING THE GAP AT SERIES B.

Source: Cleantech Group

This may constrain the choice of viable business models, or force start-ups to finance plant investments such as first-of-a-kind production facilities with equity. Worse yet, as is happening, it allows UK start-ups to be lured overseas, as other countries have programmes in place to specifically finance this critical development stage. Oxford PV is an example of a company which spun out from the University of Oxford, but now has manufacturing facilities in Germany because they couldn't find the right help in the UK⁵. While the latest wave of large new growth funds such as Decarbonization Partners and Just Climate have the potential to fill this gap, they are investing on a pan-European basis and have yet to make a UK investment.

⁵ <https://oxford.techtribe.co/oxford-pv-transforms-photovoltaics-with-step-change-in-solar-cells-efficiency/>

- **Concerted nurturing of regional clusters beyond the golden triangle is needed:** Cleantech start-ups and investor activity is heavily concentrated around the 'golden triangle' of London, Oxford and Cambridge. Whilst it is important to continue to support these centres of excellence, support for emerging innovation clusters should be increased. Further, coordination and collaboration should be ramped up to support a networked system across the UK. This would facilitate businesses to be created in one part of the country and grow to scale elsewhere in the country.

Recommendations to ensure the UK remains an economic superpower



- **Create a new all-encompassing industrial strategy and delivery plan which provides incentives and long-term clarity and will keep the UK competitive with the USA and EU.** The UK has a strong track record of doing this. The offshore wind sector is a prime example of what a strong policy environment and subsidy regime (in the form of contracts for difference) can achieve – a 50% cost reduction and the largest installed capacity in the world.



- **Design public funding mechanisms targeted at de-risking projects to attract more private investment into first commercialisation.** Innovative government funding mechanisms can help reduce the perceived risk of first commercial stage investments, making them more likely to attract private investment. At the early stage of the scale-up journey, equity-based support, such as blended finance funds, can support investment. This is still seen as a strong de-risking option due to the high degree of credibility for the due diligence processes of public institutions. For later stage investment, there are various de-risking options that can be used to crowd in private investment such as blended finance funds where the public capital takes a first loss position, or subsidised loans or loan, project finance and offtake contract guarantees. The UK has a strong history with guarantees for exported goods through UK export finance, and this could be replicated domestically through the UK Infrastructure Bank and British Business Bank.



- **Other de-risking mechanisms which stabilise and provide predictability to revenue streams should be utilised across sectors.** Government intervention to provide a stable revenue for projects in the form of contracts for difference, feed-in tariffs and power purchase agreements have been instrumental in supporting a developing sector and should be utilised to de-risk projects and attract private investment.



- **Offer more financial support and access to policymakers for accelerators, venture builders and other innovative early-stage support services:** Accelerators provide an important service to the ecosystem, and do not have an easy business model, especially if they don't take equity in the start-ups they support. More financial support is needed for the most promising propositions including for non-traditional structures such as venture builders and studios.



- **Increase the number of grants available without the need for match funding:** Early-stage SMEs and those trying to build demonstrator projects are disadvantaged when applying to public grant bodies because there is often a requirement for matched funding, which they either can't afford to do or can't find investors willing to invest on match funding terms.



- **High-value IP generated by universities across the UK must be supported:** The UK is home to world class universities and cleantech companies are often based on university research. The spinout stage is critical to ensuring that the value of these new ideas is harnessed through the adoption and availability of new technologies. It is essential that university-based innovators are appropriately supported to commercialise their research, taking into account different needs and settings. The University Spin-out Investment Terms Guide is a comprehensive guide to helping universities commercialise research quickly.



- **Increase international cooperation and associate to Horizon Europe:** international collaboration is vital for making the transition to net zero quicker, cheaper and easier for all through faster innovation, greater economies of scale and bigger incentives to invest. The UK has experienced delays in associating to Horizon Europe and the government has put forward the option of a UK equivalent if the delay persists, but the best outcome for R&D would be to associate.



- **Reverse the changes done to the functioning of tax credits:** Changes in the R&D tax credit system, which commenced in April 2023 will have a significant negative impact on early-stage companies focused on innovation and if this isn't addressed, start-ups will relocate to other geographies. Loss-making SMEs will see their benefit reduce from 33% to 18.6% and profit-making SMEs will see their benefit reduce from 24.7% to 21.5%. The tax credits for SMEs should be returned to the 33% for loss-making SMEs and 24.7% for profit making SMEs as a minimum. Noting the government made the changes to try to combat fraud, it should try to reduce complexity in the

system and increase enforcement to discourage fraud rather than changing the level of incentive.



- **Include all decarbonisation technologies in the scope of the Seed Enterprise Investment Scheme and Enterprise Investment Scheme (EIS):** HMRC must ensure that SEIS, EIS and other venture capital schemes are not exclusive of decarbonisation and climate resilience technologies that could benefit from EIS's tax relief for investors. Currently new generation energy operators and green hydrogen produces are excluded from the schemes. The government's increase in the SEIS and EIS investment limits from April 2023 is welcomed.

Introduction & purpose

The UK has a long history of promoting and supporting sustainable and low-carbon technology. Early adoption of renewable technologies such as wind and solar began in the 1970s. Since then, successive governments have supported the development of clean technologies or 'cleantech' through financial incentive schemes and legislation. More recently, the UK became the first major economy in the world to pass legislation requiring a net zero greenhouse gas emissions target by 2050. However, subsequent efforts to define how the UK will achieve this target have been criticised. In a landmark climate court case, the High Court judged that the government breached the Climate Change Act by delivering an inadequate strategy to achieve the net zero target. Despite this, investment in the UK cleantech sector has experienced significant growth and evolution over the years thanks to the ambitious policy environment and consistent public funding available to support projects - strengths which have helped maintained investor confidence during periods of uncertainty.

Whilst the UK has enjoyed success in this sector, the challenge to meet legal targets and maintain our competitive advantage in the face of increasing global ambition will require a gear shift in the development of cleantech champions.

The purpose of this report is to review the current level of investment into the cleantech ecosystem in the UK, as well as to make policy recommendations in support of faster advancement and adoption of cleantech.

The UK's cleantech
innovation scene
has potential to
accelerate for
greater impact



Cleantech innovation delivers faster than average growth and investment

The UK is home to a mature cleantech ecosystem, a thriving innovation scene and a strong overall investment culture. The job market is buoyant; the ONS estimated that across the UK there were already over 410,000⁶ jobs in low carbon businesses and their supply chains, with their turnover estimated at £42.6 billion⁷ in 2019. While official estimates expect this number to double by 2030⁸, many high-growth start-ups grow at rates of at least 20% per year, which equates to 5 times that number over the same period.

Figure 1 (see below) charts the level of venture capital investment over the last five years, and the number of deals done in each of those years. UK cleantech investment reached a record-breaking £2.8 billion in 2022, ahead of most European countries. This was especially remarkable, given the sharply cooling global venture capital climate. However, as we will see later in this report, it has emerged that at certain points in the life cycle of a start-up, it's notably more difficult to attract investment.

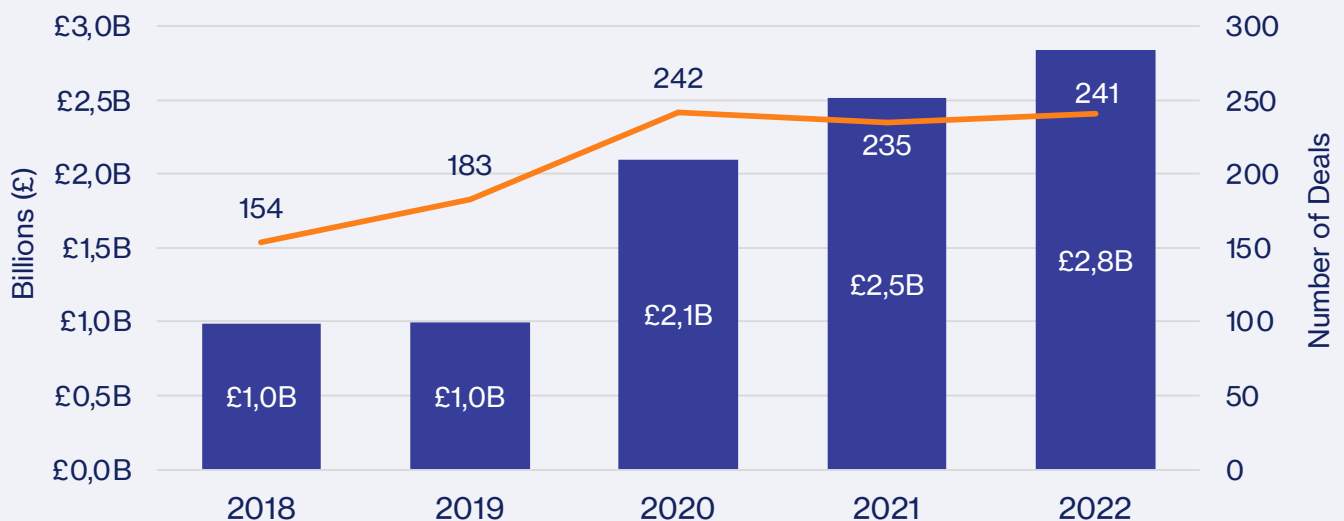


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6 ONS (2021), Low Carbon and Renewable Energy Economy (LCREE) Survey direct and indirect estimates of employment, UK, 2014 to 2019.

7 ONS (2021), Low Carbon and Renewable Energy Economy (LCREE) Survey direct and indirect estimates of employment, UK, 2014 to 2019.

8 HM Government (2021) Innovation Strategy: Build Back Greener.

2022 brought larger average deal sizes and increased sector diversification

Figure 1 also shows that investment doubled between 2019 and 2020, driven by large deals in the energy and transportation sectors (see figure 2 for sectoral analysis). This trend continued through 2021. Although investment amounts increased, since 2020, deal volumes remained relatively stable at just over 200, indicating larger average deal sizes.

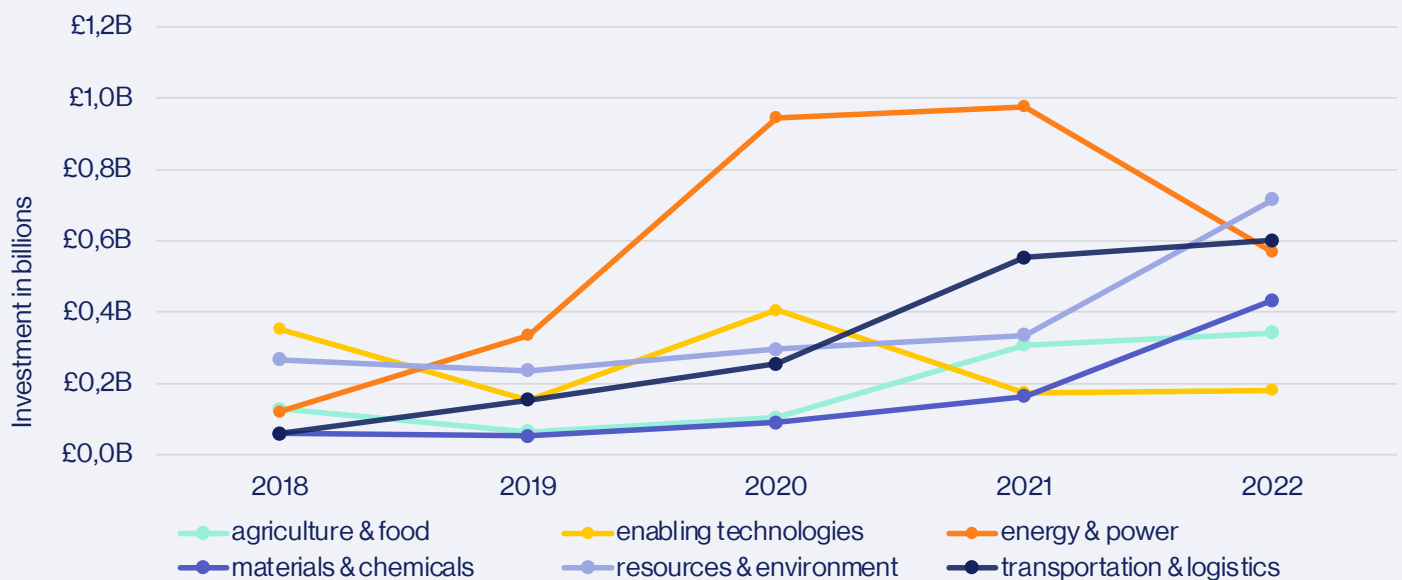


FIGURE 2: INVESTMENT AMOUNT BY SECTOR OVER THE PAST 5 YEARS. INVESTMENT IN RESOURCES AND ENVIRONMENT HAVE DOUBLED BETWEEN 2021 AND 2022. INVESTMENT IN THE ENERGY AND POWER SECTOR DROPPED TO MORE AVERAGE LEVELS AFTER 2 YEARS OF EXCEPTIONALLY LARGE DEALS.

Figure 2 details the sector breakdown of investments. There were a couple of exceptional deals in 2020 and 2021 driving the large peak in energy & power investments seen in the graph. Two investments into Octopus Energy were over £300 million each. The sharp rise in investment in resources and environment in 2022 was driven by two deals over £75 million, one in Oxford Nanopore Technologies and one in TopHat, a prefabricated housing manufacturer.

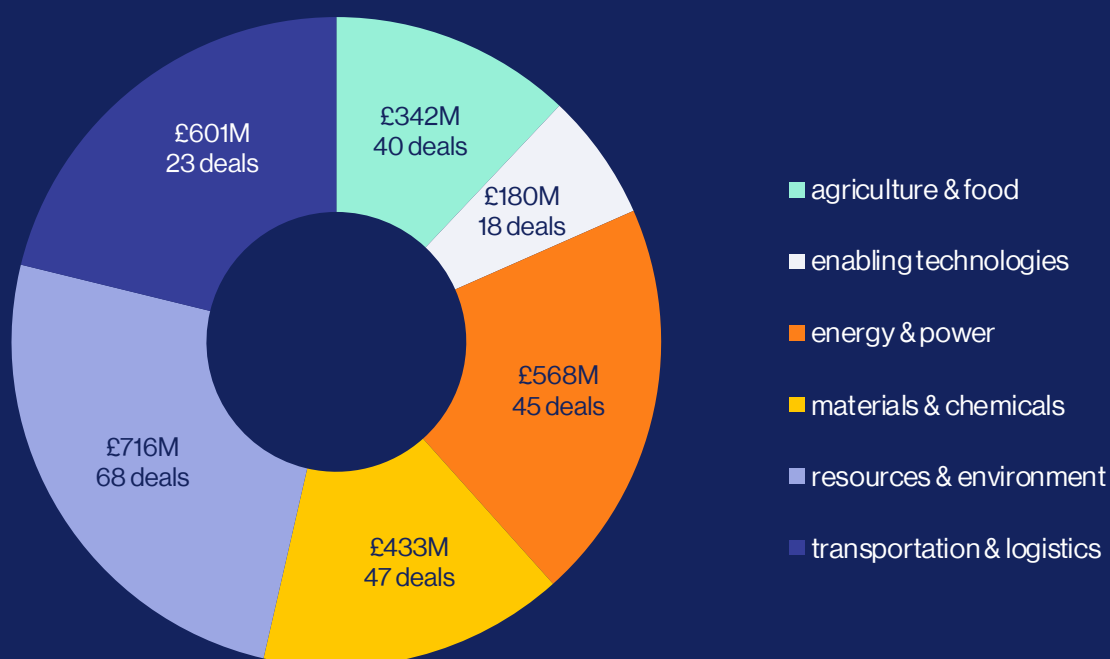


FIGURE 3: SECTOR SPLIT IN 2022 SHOWING THAT INVESTMENT IS EVENLY SPLIT AMONGST DIFFERENT SECTORS

Materials & chemicals and resources & environment sectors saw strong growth during 2022, leading to a more even sector split than in previous years (see figure 3).

Although the rise in size and amount of investment level of UK cleantech is record-breaking, its actual size is still small compared to the entire tech sector, which secured a total of ~£24 billion⁹ in VC investment in 2022. Of that total sum, cleantech received just 8.5%.

⁹ <https://www.gov.uk/government/news/uk-tech-sector-retains-1-spot-in-europe-and-3-in-world-as-sector-resilience-brings-continued-growth>

There are three global cleantech investment giants, and the UK is not one of them

The UK market remains significantly smaller than other major international blocs: it is roughly a third the size of China and the EU, respectively, and it's less than a tenth the size of the United States. That said, the UK is second only to the US in cleantech spending per capita. The US spends £91 per capita, the UK spends £41, the EU spends £20, and China only spends £7 per capita.

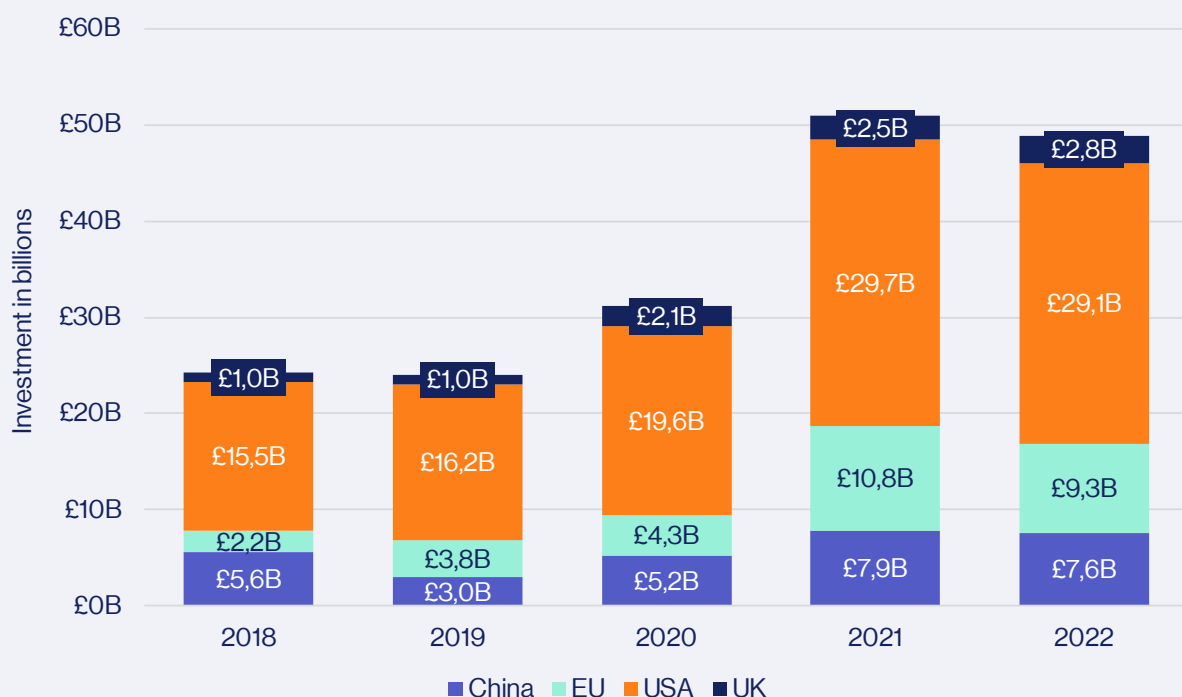


FIGURE 4: INTERNATIONAL COMPARISON OF INVESTMENT. THE UK IS A SMALL PLAYER COMPARED TO THE TITANS, CHINA AND USA.

VC-backed startups are fundamental in the quest for net zero

- The IEA estimates that half of the projected abatement in CO₂ emissions required to reach net zero by 2050 will need to come from technologies that are currently not commercialised, highlighting the crucial role that disruptive innovations will play in the race to decarbonise the planet¹⁰.
- Large corporations have pulled back from fundamental innovation in recent years; patents associated with mature firms have the lowest citations to science. As mature firms prefer smaller, more incremental innovation, disruptive innovation is less likely to come from incumbents.
- VC-backed start-ups are more likely to have top-cited patents than mature firms; 3x more likely to have a Net Zero patent in the top 10% of citations, and 5x more likely to have Net Zero patent in the top 1%, highlighting the vital role VCs play in developing new, high-quality disruptive innovations¹¹.
- VC still dwarfs established companies in terms of the percentage of cleantech patents. However, that percentage has decreased from 70% in 2012 to 55% in 2020.
- Given the significant innovation potential of VC-backed start-ups, more VCs need to invest in start-ups to support the innovations required to meet Net Zero goals.

¹⁰ Net zero by 2050 - a roadmap for the global energy sector. International Energy Agency, 2022.

¹¹ Innovating to Net Zero: Can Venture Capital and Start-ups Play a Meaningful Role? Ramana Nanda, 2022

More VC investment needed to scale global champions

Figure 5 charts the total number of deals done at early-stage and late-stage investment between 2018 and 2022. It shows that the ratio of early-stage to late-stage is fairly consistent over time (although statistical analysis shows only a weak correlation), with the number of late-stage deals on average only 30% that of early-stage deals. The data suggests that approximately 70% of companies cannot grow past the early-stage and either stagnate, get acquired or go bankrupt.

This data seems consistent with the wider UK picture for start-ups. A report from Beauhurst¹² found that only 23% of UK start-ups makes it to the scale-up stage within 5 years, 20% failed, 54% stagnated and 2% exited.

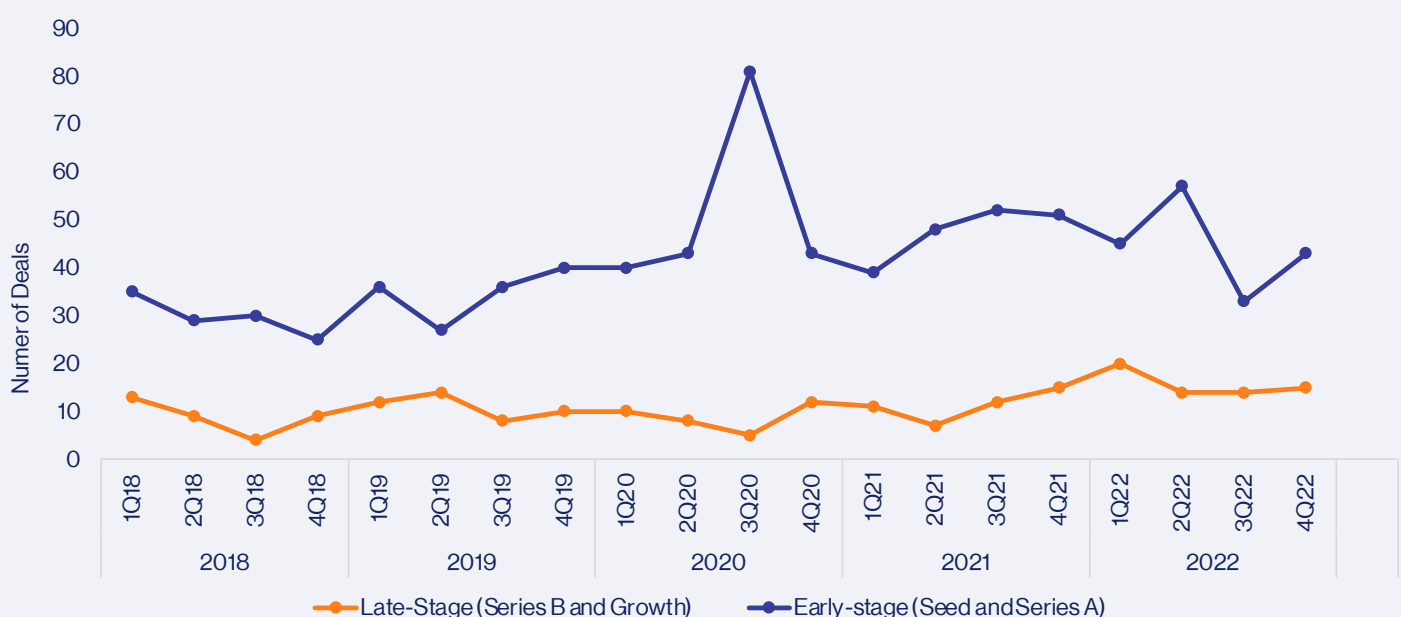


FIGURE 5: GRAPH SHOWING THE NUMBER OF DEALS DONE AT THE EARLY-STAGE AND LATE-STAGE BETWEEN 2018 AND 2022

Figure 6 shows investors who have announced three or more qualifying UK deals over the time period we evaluated for this study (2018-2022).

For seed and series A, there were several active angel and VC investors, both pureplay cleantech and generalists, over the time period. Early-stage VC investing is a specialist activity, and thus, the same firms tend to do multiple deals. Venture builders such as Carbon 13 and Deep Science Ventures, as well as university tech transfer offices also make investments at the pre-seed and seed stages. Unlike software as a service investment, the size of pre-seed/seed investments needs to be optimised as cleantech requires hardtech, large amounts of capital and ability to scale progressively. Bigger pre-seed/seed cheques can help provide the runway needed to get to the value inflection points and keep focus on tech & business development rather than multiple fundraising rounds.

For Series B and above there were fewer investors who made serial investments; of the deals analysed, IP Group's Kiko Ventures was the only specialist cleantech investor making serial late-stage investments. Corporate Venture is also more active at the Series B and growth stages. There are many other active late-stage investors with a presence in the UK, and the pattern of late-stage investments shows there are many, many investors who do just one or two deals. These, though, are not shown in figure 6, as they have not announced three or more qualifying UK deals over the time evaluated for this study.

Decarbonization Partners (a joint venture between Blackrock and Temasek) and Generation Investment Management's Just Climate are two new entrants focussed on later-stage investments. However, they are investing on a pan-European basis and have yet to make a UK investment. The UK needs a strong investment offer at all stages to ensure we can continue to get innovation to commercialisation.

High-impact climate innovations almost always require large-scale production capacity. This is daunting for a UK start-up, not just because of the financing gap identified but because the UK has diminished the scale of its industrial base since the 1980s. We therefore lack skills and experience to execute ambitious scaling plans domestically. Ambitious start-ups can grow more rapidly in economies which are home to good industrial bases and the associated financing and skills ecosystems. The UK needs to 1) have a good definition/framework for what good looks like at Series B and beyond to attract British funding; 2) create incentives to encourage local investors and ensure they have the region's future in mind; and 3) create a couple of homegrown cleantech giants to prove the potential and encourage a strong investment ecosystem for scale-ups.



FIGURE 6: TOP CLEANTECH INVESTORS IN THE UK 2020-2022

International investors are getting in on the biggest deals

The biggest deals of the year were diversified across sectors and saw participation from mainly international investors. The investments were all growth equity (see figure 7).

Cleantech activity across the UK

Cleantech investment activity is heavily concentrated in London, Oxford and Cambridge with 126 VCs active in the sector there. The area also has the highest concentration of cleantech start-ups. Insiders consider that start-ups founded in this region are more sought-after than companies in other regions and therefore command a valuation premium of £2-5 million at pre-seed stage. Conversely the Entrepreneurial Support Organisations (ESOs), such as accelerators, are more widely dispersed with significant activity in Scotland and the East of England as well. Figure 8 illustrates the cluster density across the UK.


















	Company	Sector	Company HQ	Investors	Investment amount
1	 GRIDSERVE sustainable energy	Transportation & Logistics	Buckinghamshire	MITSUBISHI HC CAPITAL  	£200M
2	 octopusenergy	Energy & Power	London	 CPP INVESTMENT BOARD	£181M
3	 carbon clean	Resources & Environment	London	 Essex ventures  Marubeni  saudi aramco energy ventures  Chevron  WAVE  Investment Managers  TC Energy	£122M
4	 iduna	Transportation & Logistics	London	 octopus ventures	£109M
5	 growup	Agriculture & food	London	 GENERATECAPITAL	£108M

FIGURE 7: TOP 5 CLEANTECH DEALS DONE IN 2022

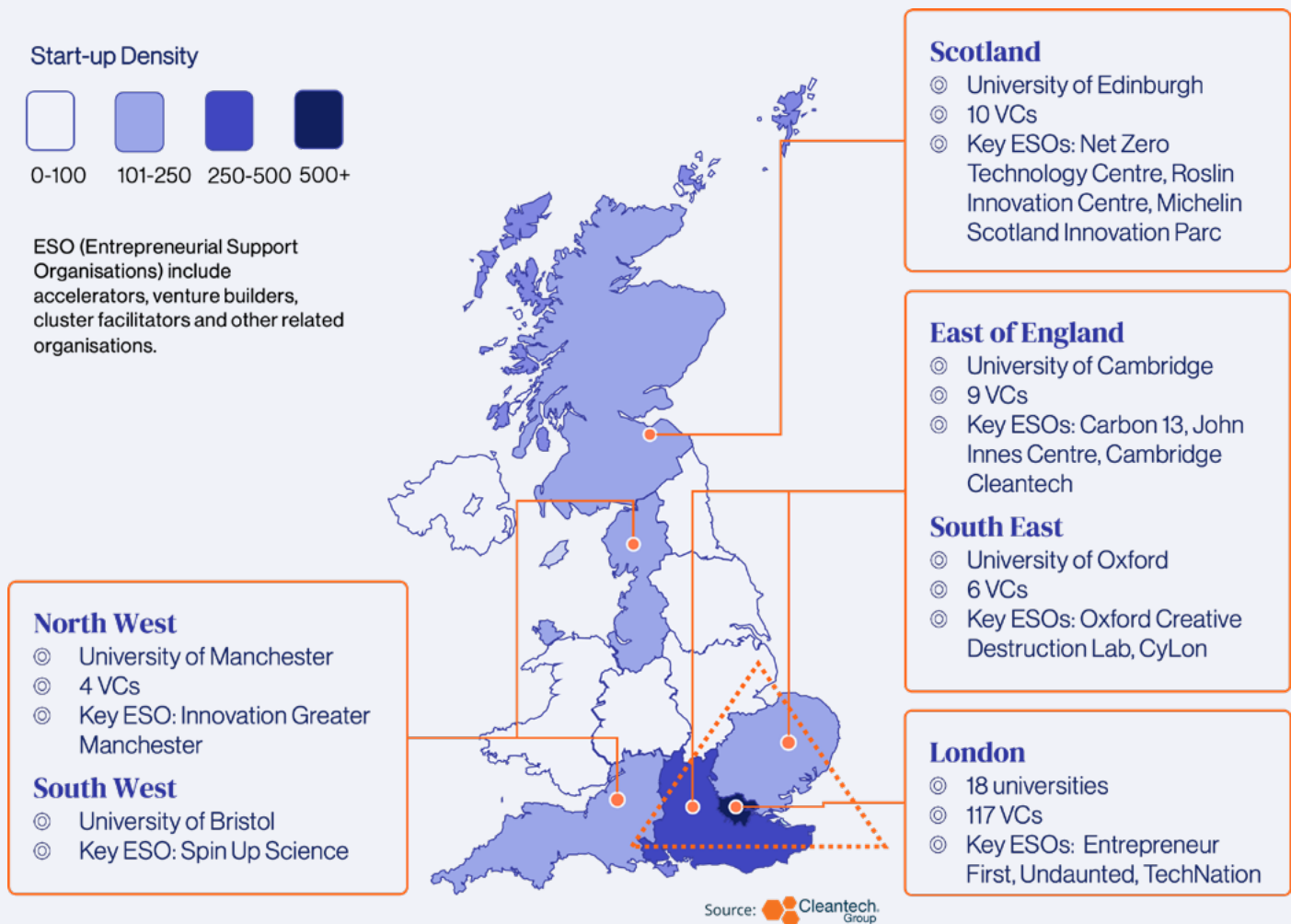


FIGURE 8: MAP OF EMERGED CLEANTECH CLUSTERS IN THE UK. LONDON, CAMBRIDGE AND OXFORD HAVE THE MOST START-UPS AND VCS

Clustering can help to drive start-up activity

Cleantech start-ups, especially those based on hardware innovation, have specific needs: they take longer to commercialise, may need more patient capital, require specialist skills and are often germinated in university or research labs¹. Clusters gathering top level universities, cleantech-specific venture financing, and supporting organisations such as accelerators are correlated with increased start-up activity when comparing them to areas without a cluster. Emerging clusters gathering a major city, top level universities, cleantech-specific venture financing and supporting organisations such as accelerators are correlated with increased start-up activity when comparing them to areas without a cluster (see figure 9). The Scottish Cluster has seen added impetus recently with the launch of the Energy Transition Zone in Aberdeen and government funding announced for the Acorn CCS project at St Fergus.

Industrial and conventional clusters

Belfast

- The Belfast Region City Deal has sparked potential for a new cleantech cluster.
- The i4C Innovation Centre at St Patrick's Barracks regeneration site, Ballymena will provide a physical base and support to increase levels of SME innovation and commercialisation activity
- It will also provide skills and training solutions in the cleantech sector including the Hydrogen Training Academy.

HyNet North West Cluster

- HyNet North West is the UK's leading industrial decarbonisation cluster.
- Plans to deliver 80% of the UK's clean power target for transport, industry and homes by 2030.
- Plans to produce nearly 50% of the total hydrogen needed to meet the UK's net zero target.
- Winner of the CCS Infrastructure fund as a Track 1 cluster for CCUS projects

West Midlands Cluster — Energy Capital of the UK

- Midlands Energy Consortium (Nottingham, Birmingham, and Loughborough universities)
- Energy Research Accelerator (ERA)
- Energy Innovation Zones: Tyseley and Birmingham, Coventry and Warwickshire, Black Country



Scottish Cluster

- Energy Transition Zone, Aberdeen
- Hydrogen & CCS: Acorn CCS producing clean hydrogen, Fife Hydrogen Hub
- Power Carbon Capture: Peterhead Carbon Capture Power Station
- The Edinburgh Climate Change Institute
- One of the "Super Places" of low carbon growth technology investment to revitalise the birthplaces of the 1st industrial revolution

East Coast Cluster

- 2018: Transportation, Clean Maritime Innovation, Offshore wind-on turbine electric vessels
- Potential hub for hydrogen generation. BO has already signed MOUs with a multiple potential customers for a proposed plant
- Winner of the CCS Infrastructure fund as a Track 1 cluster for CCUS projects

Cambridge Cluster

- Oldest cleantech cluster in the UK
- The Greater Cambridge Cleantech Strategy & Action Plan provided the business case & garnered public support for its creation in 2009
- Particular strengths lie in Building Technologies, Recovery and Recycling, Alternative Fuel Vehicles, ICT in Cleantech, Biomass and Renewables.

London

- Home of the UK's largest concentration of cleantech businesses. London and the South East represent 42% of all UK cleantech sales
- 1/3 of green patents originate from London

Oxford Cluster

- Specialisations in Low Carbon Mobility, Built Environment, Circular Economy
- Oxford Greentech started as part of the OxFutures programme, which was a £3.2m project to boost low carbon economic development in Oxfordshire. Now it functions as its own separate entity.

FIGURE 9: THE MAP ILLUSTRATES THE EMERGED CLUSTERS OF CLEANTECH ACTIVITY ACROSS THE UK, WITH IMPORTANT CLUSTERS RIGHT ACROSS THE LENGTH OF THE UK.

Intelligent, concerted and patient construction and nurturing of regional clusters is needed

Innovation clusters emerging across the UK all need a coherent, innovative funding approach. This must serve to open up and manage access to university know-how and networks which are central to driving invention and innovation communities. Funding for the city to open access to co-working spaces and supporting access to regional expertise would create the basis for early-stage investment and later growth. Furthermore, easy access to a local community of angel investors and VCs is important to accelerate start-up growth. Coordination between clusters and hotspots in their hinterland is needed to maximise the potential of innovation discovery and growth. Coordination and sharing across these regions would multiply impact and leverage the complementary strengths they have.

Ambitious high
level policy
strategy and
comprehensive
public support
landscape

Ambitious but incomplete policy strategy

In June 2019, the UK became the first major economy in the world to pass legislation requiring government to reduce the UK's net emissions of greenhouse gases by 100% relative to 1990 levels by 2050. In 2021 the government committed to two additional interim targets: decarbonisation of the power grid and reduce emissions by 78% by 2035 and published its Net Zero Strategy: Build Back Greener. The strategy outlined policies and proposals for decarbonising all sectors of the economy to achieve the 2050 net zero target enshrined in law. However, in 2022, ClientEarth filed a landmark climate case to the High Court to challenge the government on the lack of detail and the absence of a delivery plan in the strategy. The High Court judged that the strategy didn't meet the government's obligations under the Climate Change Act to produce detailed climate policies that show how the UK's legally binding carbon budgets will be met. The government was subsequently ordered to inform parliament how it would deliver its proposed emissions reductions. Powering Up Britain along with the other documents published in 2023 is the compliance with that order. The new plan is the government's vision for the future of energy in the UK and details its plans for both energy security and net zero growth.¹⁵ There are also further delivery plans expected to be published later this year. This has created some uncertainty and inconsistencies in the government's messages to investors and innovators.

Northern Ireland¹⁶, Wales¹⁷ and Scotland¹⁸ have also set their own ambitious plans for reaching net zero, and Scotland has legislated to reach net zero by 2045.

To support the government's policy, several publicly funded programmes have been launched, delivered through government departments and non-departmental public bodies:

- **Net Zero Innovation Portfolio (NZIP):** Launched by The Department for Energy Security and Net Zero's predecessor, the Department for Business, Energy, and Industrial Strategy (BEIS) launched this as a successor to the Energy Innovation Programme, which will invest £1 billion from 2021 – 2025 across 10 industries, including electricity systems and industrial decarbonisation¹⁹

15 MISSION ZERO - Independent Review of Net Zero. Rt Hon Chris Skidmore MP. Page 26

16 <https://www.economy-ni.gov.uk/publications/energy-strategy-path-net-zero-energy>

17 <https://www.gov.wales/net-zero-wales>

18 <https://www.netzeronation.scot/about/campaigns/scotland-is-taking-action#Sec1>

19 Industries include: Advanced CCUS, Bioenergy, DAC, Disruptive technologies, Energy storage and flexibility, Offshore wind, Buildings, Hydrogen, Industrial Decarbonisation, and Nuclear (AMR).

- **Net Zero Hydrogen Fund:** The Department for Energy Security and Net Zero and Innovate UK manage this £240 million fund aimed at developing low carbon hydrogen production
- **UKRI's Industrial Strategy Challenge Fund:** includes the £210 million Industrial Decarbonisation Challenge (led by Innovate UK) and the £90 million Transforming Food Production Challenge
- **The Advanced Fuels Fund:** newly announced by the Department for Transport, will allocate £165 million to support UK sustainable aviation fuel projects
- **UK SHORE:** also under the purview of the Department for Transport, has seen £206 million allocated to advance the UK towards a decarbonised shipping sector
- **Guilt Free Flying:** The Department for Energy Security and Net Zero, the Department for Transport and industry launched a £113 million investment in hydrogen and all-electric flight technologies to unlock guilt-free flight²⁰
- **Emerging Energy Technologies Fund:** announced by The Scottish Government, this £180 million fund will invest in the hydrogen and carbon capture and storage sectors from 2022 – 2026²¹.

Furthermore, in the **Green Finance Strategy**, published alongside the Powering up Britain strategy, the government has committed to looking at new blended finance opportunities.

²⁰ <https://www.gov.uk/government/news/over-110-million-to-unlock-zero-emission-guilt-free-flights>

²¹ <https://www.gov.scot/policies/renewable-and-low-carbon-energy/emerging-energy-technologies-fund/>

Public Support is lacking at pre-seed and first commercialisation

Public financial support in the UK is often centred around competitions and programmes which provide grant funding to winners (see figure 10). The grant framework is especially helpful for technologies at the early-stage TRL3 up to TRL 6. However, the very early stages are less well covered, as is the growth stage from first commercialisation onwards.

When asked, start-ups highlighted the difficulty of securing public support at the pre-seed stage. Some innovators, which had unsuccessfully applied to several government competitions, believed their technology was still too early-stage (TRL 1-3; researching ideas in a laboratory) for the scopes of public grants, while others mentioned the inability to get grants without first having built a prototype.

There is a corresponding scarcity of private investment at these stages. We explore the specific support needs of these stages further in sections three and four of this report.

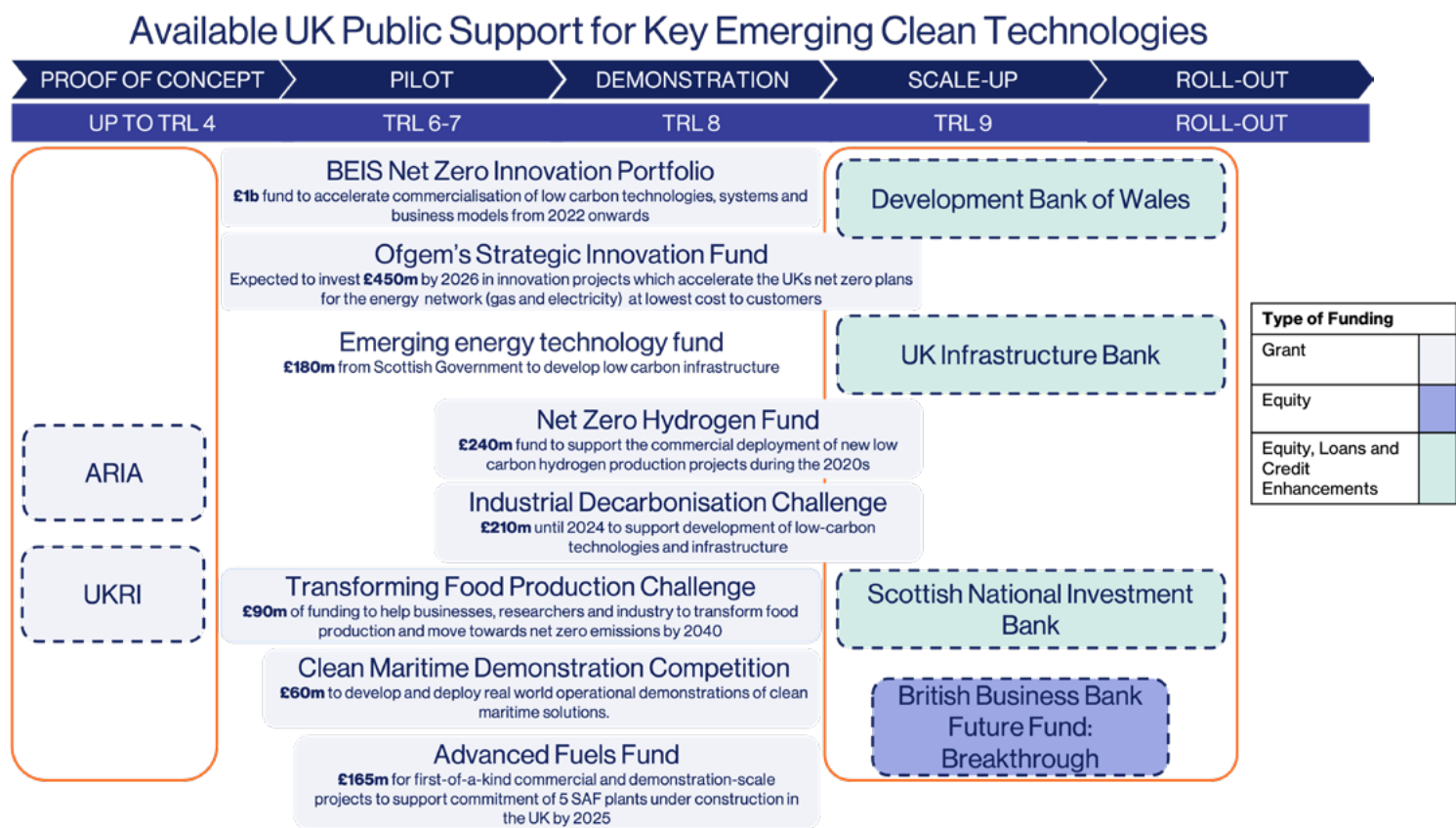


FIGURE 10: PUBLIC FUNDING POTS AVAILABLE FOR CLEANTECH (NON-EXHAUSTIVE)

Climate Launchpad

The ClimateLaunchpad is an annual green technology competition run by Climate-KIC Europe across more than 30 countries to recognise the most promising early-stage business solutions to climate mitigation and adaptation challenges. Those eligible to enter the competition get training, support and mentorship to develop their ideas and the winner of the competition gets prize money. This type of programme provides a vital alternative support option for cleantech innovation.

Grants work best at pre-revenue stages

Grants offer valuable support to pre-revenue companies, helping them to test and de-risk their technology without the resource drain of fundraising, and without diluting equity. Public grant money also helps attract private investment, as there is real credibility behind the validity and scrutiny of government programmes in rewarding innovators, which also helps speed up the due diligence process for investors later down the line. A DESNZ official confirmed that companies that received DESNZ grants later received more VC funding, and similar results have been documented from the US Department of Energy's Small Business Innovation Research programme.²² Government grants can also help incentivise large corporations to innovate more via riskier R&D, as it allows large companies to do R&D for riskier technologies that normally wouldn't be approved under their corporate structure.



The British government funding - from DESNZ and its predecessors - has played an important role in Carbon Clean's growth, helping us accelerate the commercialisation of our technology. In particular, the three tranches of government grant funding, totalling £5 million, reinforced the credibility of our business and technology to investors, which was vital for securing initial private investment. We have now raised a total of \$195m in private capital.

Aniruddha Sharma, Chair and CEO
Carbon Clean

Efficiently delivered grant programmes

Cleantech start-ups appreciate the efficiency of the UK's grant programmes, compared to other countries and regions, but noted that the sheer number of programmes can be difficult to navigate. These programmes generally require projects to deliver a degree of match funding: for every pound of government money received, the innovator must match a percent of that pound. The amount of match funding depends on the business and the stage of development of the innovation; an SME may get up to 80% grant funding and match the remaining 20%, while a larger company may only get 50% grant funding and must match the remaining 50%. Government departments deem match funding important as it obliges innovators and companies to have an interest at stake in their technology and business.

Many government programmes receive at least a 1-to-1 match for their public investment. NZIP, for example, expects at least £1 billion in match funding from industry, while the Industrial Decarbonisation Challenge received £290 million from industry – 138% more than what government invested.²³ Match funding requirements reduces the risk for the grant provider but it can limit an early venture's growth, given that it can be difficult for start-ups to access the cash required to match the government funding.



ZeroAvia has benefited greatly from UK grant programme support, primarily through the Aerospace Technology Institute. The forward thinking approach and focus on climate tech has led to match funded projects that have delivered world first achievements in the UK. The application process compares favourably against those in other regions, with few barriers to entry. The support and guidance on offer to help smaller, innovative applicants is helpful and can help democratise the process.

Dominic Weeks
ZeroAvia

Government agencies use a wide range of metrics to evaluate the effectiveness of their grant programmes; this may include TRL progression, or reduction of the green premium.²⁴ Grants and competitions are often structured to promote technological advancement, allowing innovators to access subsequent funding as they progress their company's technology. For example, the Net Zero Innovation Portfolio builds on technologies previously developed by its predecessor, the Energy Innovation Programme, to advance these technologies along the TRL scale.

²³ DESNZ official and Innovate UK

²⁴ DESNZ NZIP official

Public sector climate investment vehicles or direct investment can make up for gaps in risk capital

The Advanced Research and Invention Agency (ARIA) was set up by Government to invest in high-risk research endeavours that reach beyond traditional boundaries. It is based on the US's Advanced Research Projects Agency model. Its independence was scribed into a Memorandum of Understanding with the Secretary of State for the DESNZ so it has autonomy and operational freedom to invest in impactful but high-risk research. As ARIA is still a very young agency, it is not clear yet how much of a role they will play in cleantech, but they have the operational freedom to fund some really exciting research in this space.

Scottish Enterprise, the national economic development arm of the Scottish Government, invest specifically in sectors where early-stage risk capital is lacking. They provide grants, equity and debt finance, operating a co-investment model with the aim of increasing private funding into early-stage innovation. Scottish Enterprise credits these interventions with contributing to a seven-fold increase in the Scottish risk capital markets since the start of its activity. Although not specifically focussed on cleantech, Scottish Enterprise acknowledges that the early-stage funding gap is more pronounced with regards to cleantech, when compared to other sectors and plan to increase their activity at this stage to address the gap. They are currently among the most active pre-seed and seed investors in the UK with 11 cleantech deals since 2020.²⁵

The Seed Enterprise Investment and Enterprise Investment Scheme are powerful catalysts for early-stage investment

The Seed Enterprise Investment Scheme (SEIS) and Enterprise Investment Scheme (EIS) are government incentives designed to help companies raise money to grow by offering tax relief to individual investors.

Under SEIS, an investor can invest up to £150,000 and receive tax relief of 50%. Under EIS, a company can raise £5 million each year to a maximum of £12 million and the investor will receive 30% tax relief.²⁶ Based on conversations with innovators and investors, SEIS and EIS have been well received by the cleantech community as mechanisms to help incentive early-stage investment. Furthermore, EIS has influenced investment firms to develop strategies around the scheme. Parkwalk Advisors, an EIS investor focused on university spinouts, raises between £50- £70 million every year to invest in innovative start-ups, and currently has ten cleantech companies in its portfolio.

Since 2015, SEIS and EIS eligibility has not been extended to electricity generation activities. This exclusion was implemented to ensure that the scheme remains targeted towards smaller, high-risk companies instead of more mature, lower-risk investment opportunities.²⁷ However, this exclusion is now slowing the growth of a new generation of net zero energy innovators.

We spoke to a green hydrogen producer which uses the green hydrogen for off-grid power generators, displacing diesel, and have run successful demonstrations in outdoor events and movie production sets. However, SEIS / EIS's power generation exclusion prevents them unlocking key early-stage funding which slows their ability to scale. Another green hydrogen producer remarked how their inability to get SEIS / EIS investment likely lowered the value of their early-stage investment round.

²⁶ <https://www.gov.uk/guidance/venture-capital-schemes-apply-for-the-enterprise-investment-scheme>

²⁷ <https://www.gov.uk/government/publications/income-tax-exclusion-of-energy-generation-from-venture-capital-schemes/income-tax-exclusion-of-energy-generation-from-venture-capital-schemes>

The R&D tax relief scheme is an important source of cash flow for innovators

Another beneficial government mechanism supporting cleantech innovation is the R&D tax relief scheme. SMEs can claim tax relief if they are conducting a project which fits the standard definition of R&D. They must claim through their annual company tax return.²⁸ Larger companies can claim expenditure credit if the project costs are eligible and meet the standard definition of R&D through their annual company tax return.²⁹ Several innovators emphasised the importance of this scheme in encouraging innovation and providing a source of cashflow. However, the R&D tax scheme for SME's is changing with reduced benefits from the 1st April 2023 and will likely have a significant detriment to early-stage SMEs. Loss-making SMEs will see their benefit reduce from 33% to 18.6% and profit-making SMEs will see their benefit reduce from 24.7% to 21.5%.³⁰

Horizon Europe Funding

Horizon Europe is the EU's key funding programme for research and innovation with a budget of €95.5 billion. At least 30% of the budget is spent on projects related to climate change. The UK was one of the largest recipients of Horizon 2020 (the predecessor scheme to Horizon Europe) funding between 2015 and 2020. Ongoing delays to the UK's association to the programme post EU Exit has impacted not just the funding for researchers and innovators but also their ability to collaborate and share ideas with the UK's previously closest partners for science. It has also impacted the talent pool of the UK, with some researchers choosing to relocate to the EU or third countries so they can continue to participate in Horizon Europe.

The UK's financial contribution to Horizon had previously been protected for R&D by the government. However, the Department for Science, Innovation and Technology recently gave back to HM Treasury, £1.6 billion of the £6.5 billion marked for association.

Collaboration is a key driver of success in cleantech development so the UK should continue to pursue association and look to strengthen global collaboration more broadly.

28 <https://www.gov.uk/guidance/corporation-tax-research-and-development-tax-relief-for-small-and-medium-sized-enterprises#how-to-claim>

29 <https://www.gov.uk/guidance/corporation-tax-research-and-development-tax-relief-for-large-companies#how-to-claim>

30 <https://www.gov.uk/government/publications/research-and-development-rd-tax-reliefs-reform>

Spinout to demonstration: optimising the spinout process



An abundance of high-quality, early stage, cleantech ventures is the foundation of a thriving ecosystem, as this ensures sufficient supply of start-ups which will go on to become the scale-ups and success stories of tomorrow. Although the UK's ability to produce start-ups is strong, especially in the golden triangle, the pre-seed public funding gap combines with a variety of other factors to reduce the country's ability to rapidly research, develop, and scale the innovative technologies needed to reach net zero by 2050.

More transparent and consistent spinout support could massively capitalise on the world class IP produced by UK universities

The UK is a global leader in innovation, consistently ranking within the top five most innovative countries in the world³¹, while also being home to some of the best universities on the planet. Innovation and the subsequent commercialisation of research from universities are indispensable for the UK's net zero objectives. Research centres such as the John Innes Centre (specialising in plant science, genetics, and microbiology) in Norwich and the Roslin Institute (specialising in animal research) in Edinburgh have been highlighted by entrepreneurs as innovation powerhouses with incredible scientific talent. Investors point to universities such as Liverpool, Sheffield and Manchester as untapped sources of high-quality IP.

³¹ Global Innovation Index (https://www.wipo.int/global_innovation_index/en/); The United Kingdom has ranked within the top 5 globally since 2012



The UK is home to some of the top research centres for plant science, genetics, and microbiology in the world. To fully realise the commercial opportunity, they need to be effectively joined with business-oriented centres. Coupling science and business is key in forming vibrant entrepreneurial hubs.

Gilad Gershon, CEO

Tropic Bioscience

Many UK universities have structures and support mechanisms in place to nourish innovators. Within the golden triangle, universities and tech-transfer offices work with academics to nurture innovative ideas into commercially viable businesses. Outside the golden triangle, universities across the UK like University of Edinburgh, University of Bristol, and Aston University also have infrastructure to support spinouts. Several universities also support entrepreneurship programs, such as Imperial College's Enterprise Lab.



The entire concept of Grid Edge came out of Aston university. Spinning out from a university forced us to solve the biggest problems [in electricity systems]; the university provided incredible support at the early stage, and many investors saw our university affiliation as valuable in subsequent funding rounds.

Paul McCorquodale, CEO

Grid Edge

However, the lack of standardised practices for technology is a major constraint on ability to produce spinouts. As each university follows its own protocols in terms of equity stake, IP rights, and support provided to innovators, terms vary drastically between different establishments. Through our conversations, we found the range of equity that universities take in spinouts spans from 5% to 66%.³²

Opinions diverge on the effectiveness of universities' capabilities to successfully commercialise innovation. Many start-up founders who benefitted from university spinout services praised their university and its tech transfer office, highlighting how universities help guide innovators' understanding of grants, investment ecosystems and business support to launch. Others believe that universities are too academically oriented and not focused on the delicate balancing act of commercialising research. Interestingly, in some cases, experiences with start-up support differed dramatically amongst innovators who received backing from the same university.

A common criticism is that universities take too high a stake in equity and IP rights, especially compared to US counterparts like MIT and Stanford, whose technology transfer officers take substantially less equity (5-10%).³³ Excessive dilution at early-stage can lead to problems in obtaining follow on funding at the right valuation, essentially cutting off a start-up's oxygen supply. Moreover, highly variable terms lead to long negotiations – in some cases up to two years – time and resources which would be better spent on growing the business. These issues can lead start-ups into spinning out early to retain ownership of future IP. If the company's technology is not fully proven it may not be sufficiently de-risked for investors, again jeopardising the start-up's financial future.

These criticisms however do not necessarily take into account the very different funding structure of UK universities, compared to US universities. Universities in the UK are primarily funded through public funding, and without that funding, the early-stage R&D may not have taken place. Any financial benefit from spinouts supports the public funding received by universities and can be an important source of finance for the university.

Furthermore, as pointed out by Parkwalk Advisors, UK universities tend to do more work supporting in incubation, acceleration, and business support, compared to US universities which remain relatively hands-off.

32 Low end figure of 5% identified by IP Pragmatics study; <https://www.keconcordat.ac.uk/wp-content/uploads/2020/11/Equity-stakes-final-report-18.12.2020.pdf>. Other figures and averages calculated from Cleantech Group conversations

33 <https://www.ifm.eng.cam.ac.uk/research/uci-policy-unit/uci-news/uci-report-on-university-approaches-to-spinout-equity/>

Beyond incubation (physical products have physical equipment needs)

Cleantech start-ups who are creating physical products and solutions need appropriate spaces to test mechanical and biochemical processes, create prototypes and demonstrate their solutions. A key advantage of the golden triangle is the availability of affordable laboratory space for young start-ups, although as demand increases, the pressure on this space is increasing, with little opportunity to build new space. There is also some national capability with opportunities to share equipment across universities through national databases.³⁴ Additionally, the Catapults play a role in providing space and equipment to start-ups. Further, the Energy Transition Zone in Aberdeen has announced the development of an energy incubation and scale-up hub for early stage and scaling companies in clean energy technologies. This will offer industrial and collaborative work space as well as ecosystem support.

Elsewhere, investors are often only willing to finance lab space if the innovator has something to show, which is difficult for start-ups at the earliest stages, who are still working on lab prototypes. University laboratory space remains prohibitively expensive for unaffiliated start-ups; innovators researching at a university will often stay with their supervisors until they raise their first round of external funding to maintain access to lab space.

Agricultural innovators have even more diverse needs: for example, barn space to test livestock solutions. These kinds of facilities are usually in remote locations, which means that start-ups cannot benefit from the network effects which help accelerate scale up.

The UK urgently needs more affordable laboratory and demonstration space to support new start-ups.

³⁴ UK university and research organisation equipment and facilities portal: [Equipment \(data.ac.uk\)](https://equipment.data.ac.uk/) The EPSRC national infrastructure portal: [Facilities and resources – EPSRC – UKRI](https://facilitiesandresources-epsrc-ukri.org/) NERC facilities and resources: [Using NERC facilities and resources](https://usingnercfacilitiesandresources.org/)

Venture Builders and accelerators are working to fill the pre-seed gap

A new type of programme brings together cofounders to ideate, test propositions, and, if selected, receive funding to build a prototype and launch their start-up. These types of programmes or accelerators play an important role in providing support and coaching for new start-ups. One of the most successful examples is Undaunted.

[Undaunted](#), formerly The [Centre for Climate Change Innovation](#) (CCCI), is a collaboration between Imperial College London and the Royal Institution dedicated to supporting the successful creation and scale up of climate start-ups in the London and the UK for global impact. The Greenhouse is a climate tech accelerator at the heart of Undaunted that works with early-stage climate innovators to advance their technology by at least one on the TRL scale over the 12-month programme. Unlike other accelerators, which often take up to 10% equity in a start-up, Undaunted do not take equity in start-ups on their programmes, which they feel widens the pool of potential participants and makes graduates more attractive to follow-on investment. The Greenhouse accelerator and its predecessor programmes at Imperial have accelerated 140 start-ups since its inception nearly 12 years ago, with 94% still operative today, and with an additional 60 currently in the programme. As such, it is the oldest and most successful specialist accelerator in the UK. Innovators graduating from the accelerator have raised over £800 million of follow-on capital, created 1,500 jobs, and are now present in over 30 countries, underlining accelerators' crucial role in promoting and funding early-stage cleantech innovators.

Other active accelerators include (list is not exhaustive):

- [Carbon13](#) is a venture builder focused on companies that transform global systems for a Net Zero future. It has funded 44 cleantech start-ups at seed and Series A. Carbon13 pushes its companies to achieve their minimum target of emissions mitigation potential of 10 million tonnes of CO₂ per year when at scale.
- [Unreasonable Group](#) is a Colorado based international company that supports a Fellowship for growth-stage entrepreneurs. They have invested 70 UK cleantech ventures.

- [Bethnal Green Ventures](#) is an early-stage tech for good investor and have supported 24 cleantech ventures.
- The publicly funded TechX Clean Energy Accelerator at the [Net Zero Technology Centre](#) in Aberdeen, Scotland, provides up to £100k funding and full service support to early-stage start-ups (TRL 2-6) over a 15 week taught programme. The grant is repayable under certain circumstances with the aim of creating an evergreen fund.

Slightly newer to investment into cleantech is Entrepreneur First who have funded 6 UK cleantech start-ups at the seed and Series A stage since 2020.³⁵ Another venture builder with a different methodology is [Deep Science Ventures](#); they identify a specific opportunity within a deep tech sector and build a team with the right technical competencies to best address it.

Since 2019 the Net Zero Technology Centre (NZTC), based in Aberdeen, has funded Deep Science Ventures to create cleantech start-ups which shortly after incorporation enter into NZTC's TechX accelerator where they benefit from a £100k grant, mentoring, business and technology support, tutoring from experts, and NZTC's industry network. Although not specifically cleantech focussed, Deep Science Ventures is one of the most active pre-seed/seed investors in UK cleantech, investing in 6 start-ups in the programme funded by NZTC since 2020, including Supercritical.³⁶

“Deep Science Ventures provided us with an invaluable starting point. Their reputation as a reputable venture builder, combined with the support we received from the Net Zero Technology Centre’s TechX accelerator program, paved the way for us to successfully secure a seed round with Anglo American. This support was instrumental in expediting the development of our ultra-efficient, high-pressure electrolyser.

Matt Bird, CEO
Supercritical

³⁵ Cleantech Group data

³⁶ Cleantech Group data

- TechNation's net zero cohorts provided a valuable addition to the cleantech ecosystem over the last few years, offering valuable connections as well as acceleration to the start-ups supported. They were also setting up a first-of-a-kind scaleup programme, which could be very beneficial given the specific gaps identified in the UK. TechNation was acquired by Founders Forum in May 2023, at the time of writing it was not clear exactly how their programmes would be continued.
- [Spin Up Science](#) runs a programme which pairs PhDs with new founders. The scientists provide technical expertise, helping to de-risk and accelerate the technology development. In turn, they get exposure to entrepreneurial thinking, which encourages more researchers to make the leap and become founders (it also prevents early failures by helping other would-be entrepreneurs understand that the founder's life is not for them). Spin Up Science also coordinates a network of angel investors from all over the UK. It has been running since 2018 and has supported several cleantech start-ups.

Newer emerging accelerators tend to be focused on a specific sector.

Additionally, another gap that start-ups face in commercialisation is customer discovery. Understanding their target market(s), their challenges and how their technology can provide a solution can help start-ups validate /de-validate from the early-days and developed their technology informed by the industry and actual needs. Octopus Ventures has launched a programme called 'Evolution to Entrepreneurship' Programme to help start-ups discover their market.

There has been an enormous flourishing of new accelerator programmes recently. This expansion is great news in terms of early level support, provided it is clear to founders what the benefits are for them.

Leveraging the power of angels

There are several angel investors with expertise in cleantech. For example, Sustainable Ventures has founded 10 companies, invested in 30 and supported the development of over 250 more. Cambridge angels invests across the UK but gives primary consideration to opportunities in the Cambridge. Green Angels Syndicate specialises in early-stage cleantech investments. Green Angels Syndicate has 34 companies in their portfolio, all of which remain active.

Intentional start-up creation: the role of the venture builder

Rhizocore Technologies is an Edinburgh-based start-up which produces locally adapted mycorrhizal fungi to enhance tree planting success. Rhizocore's technology reduces the mortality rate by 30% for replanted forests, reduces need for fertiliser and improves resistance to drought. Founder Toby Parkes joined Deep Science Ventures via the Food & Agriculture Science Transformer (FAST) programme, an initiative between the venture studio and the University of Edinburgh, after completing a PhD in molecular plant pathology, developing at least 15 concept companies in the field of agriculture and ecosystem regeneration. He went on to found Rhizocore following a rigorous impact analysis measuring potential to scale for impact. Deep Science Ventures provided pre-seed funding and early commercialisation support, and the company also received grant funding from Scottish Enterprise. Rhizocore is based in the [Roslin Innovation Centre](#). Thanks to early conversations with customers, the company had an order book even before being incorporated.

Bold funds are breaking the early-stage mould

Private investors may be slower to invest at the very early start-up stages because of the high level of uncertainty associated with nascent technologies.³⁷ Bold early-stage VC investors break this mould, leveraging technical expertise, flexible investment structure and early-stage investment mandates to facilitate pre-seed and seed-stage cleantech investment.

Zero Carbon Capital, founded 6 years ago, capitalises on the founders' scientific backgrounds and innovation experience to address this financing gap. Zero Carbon Capital invest at the earliest stages. With seven pre-seed and seed deals since 2020, they are among the most active early-stage pureplay cleantech investors in the UK.³⁸

The Clean Growth Fund (CGF) is a £101 million venture capital fund that is targeting the UK's most promising, clean growth companies that are pioneering carbon emissions reductions in the areas of power, buildings, industry, transport and waste at Seed and Series A stage. Clean Growth Fund uses its technical prowess and deep networks in cleantech innovation to successfully invest. With 6 Series A between 2020 – 2022, Clean Growth Fund is one of the top investors in the UK at this stage, as well as an active seed investor (4 deals at end 2022). Moreover, all their portfolio companies that have received follow on funding have had a valuation uplift.

Needed: more and all of the above

The high investment, intense R&D, and novel markets required for cleantech commercialisation require significantly longer holding periods than most VCs are accustomed to. Many cleantech investors and innovators state that it takes 10 to 15 years, on average, to develop and grow a cleantech company. This is well outside the average time from initial investment to IPO for successful UK VC-backed companies, which tends to be slightly longer than 5 years.³⁹ Cleantech investment would benefit from investors that deploy flexible and longer-term fund structures.

³⁷ https://www.ecb.europa.eu/pub/conferences/shared/pdf/20170626_ecb_forum/Mazzucato_SINTRA_Paper.pdf

³⁸ Cleantech Group data

³⁹ Analysis of UK VC Financial Returns, British Business Bank - <https://www.british-business-bank.co.uk/finance-hub/wp-content/uploads/2019/10/BBB-VC-Financial-Report-FINAL-VERSION-17Oct2019.pdf>

Demo to scale: addressing the rollout gap



The valley of death is a problem for cleantech ventures everywhere

A company commercialising a new solution must invest in production facilities, scale up its sales infrastructure, and perhaps also expand internationally. Investors are often wary about financing this stage of expansion. Technology risk may be proven by this stage, but market risk remains, especially for disruptive solutions. Hardware companies in early scale up phases need specific forms of support aimed at commercial de-risking to encourage private investment.

The commercialisation financing gap

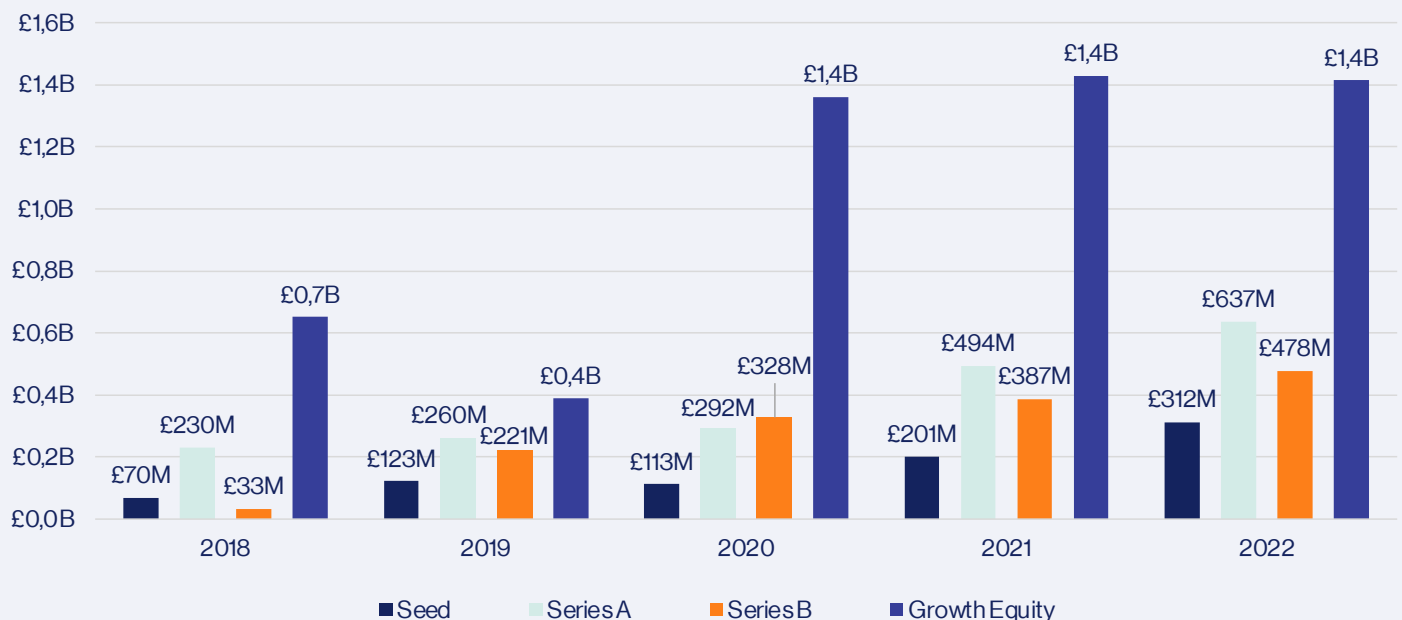


FIGURE 11: TOTAL INVESTMENT IN £ BY STAGE BETWEEN 2018 AND 2022, INDICATING THE GAP AT SERIES B.

The public funding system offers excellent support to innovators between the prototype to demonstration phases. Venture builders, accelerators, and select early-stage investors partially fill the pre-seed and seed stage funding gap.

The biggest hurdle comes at the first commercialisation stage. Unlike in other sectors, cleantech investment rounds do not map neatly onto start-up stages: first commercialisation projects generally take place somewhere around the time a company is raising a Series B round, although they may also occur later or earlier in the funding cycle. Perhaps not coincidentally, our data, supported by what we heard from our interviewees shows that Series B is also the least active investment stage in the UK, both in terms of number of deals and amounts invested (see figure 11 and 12). In a healthy ecosystem, we would expect to see investment amounts increasing progressively as companies progress along the start-up lifecycle. It is possible that we will see an increase in series B investment as more companies at series A develop and grow. The companies analysed for this report showed that time taken to get to each stage varies, but on average it takes 2 - 3 years to go from seed to Series A, 2 years to go to Series B and 1-2 years to go from Series B to Growth Equity. It should also be noted that some companies carry out more than one round of funding at each stage, adding to the time spent at each stage. However, if the current gap at Series B isn't addressed, it may affect the pipeline for investment at growth equity stage and we will likely see a drop off at that stage too.

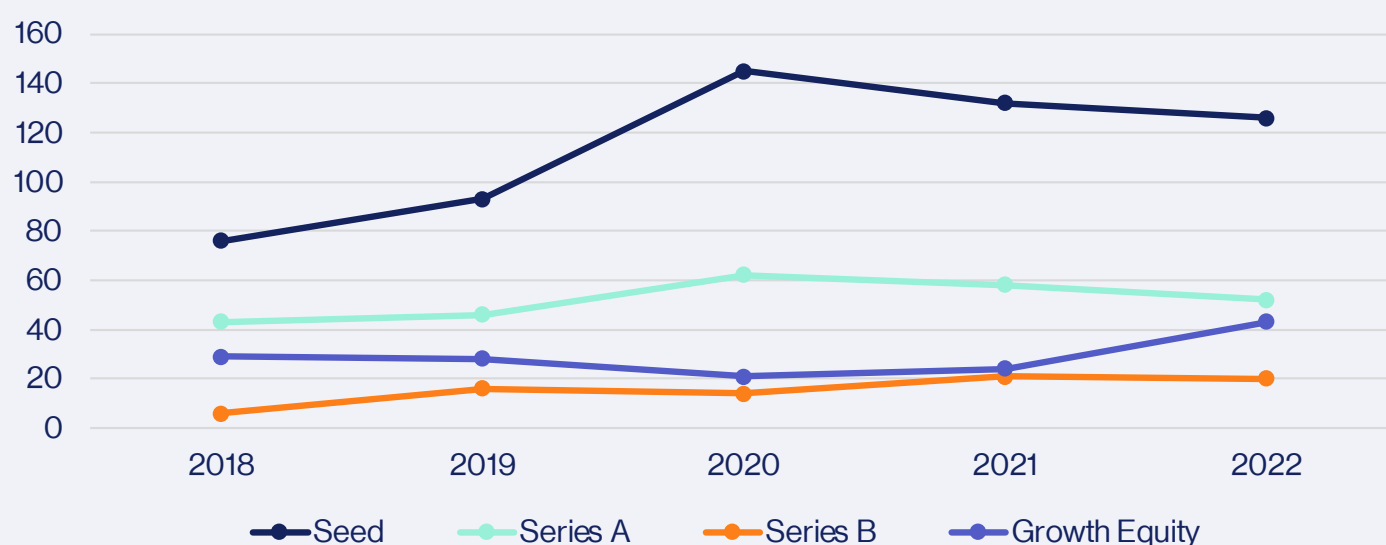


FIGURE 12: NUMBER OF DEALS DONE BY STAGE BETWEEN 2018 AND 2022.

Investors are deterred by the combination of unproven markets plus high CAPEX costs

Grants are beneficial to demonstrate technologies, but it is difficult to prove these technologies in practice until they are sold at a commercial scale. Cleantech innovators, investors, service providers, and experts called attention to the lack of investment appetite for first commercialisation stage, as well as pre-revenue cleantech companies. Scaling a hardware-based cleantech business is highly capital intensive, and few investors are willing to invest the amounts required to bring these companies to market, when there are uncertainties about demand and adoption needed to scale.

Kiko Ventures: One of the UK's leading serial climate investors

London-based Kiko Ventures, part of the IP Group, deploys technical expertise and a flexible fund structure to overcome the risk and time horizon challenges specific to cleantech investing.

Kiko invests in seven-figure cleantech deals throughout Europe across all, from seed to growth equity. They are particularly active from Series A onwards. The entire Kiko Ventures team are experts in cleantech, giving them the technical prowess needed to understand breakthrough technologies. Kiko is a balance sheet investor as opposed to a closed fund investor, allowing them to invest at various stages and amounts without having a hard exit after a 10-year timeline. Kiko Venture's investment methodology enables them to be amongst the most active cleantech investors in the United Kingdom: between 2020-2022, Kiko participated in three Seed stage, five Series A, five Series B, and two growth equity deals.

Emerging, larger growth funds have a role to play – if the UK can provide the right opportunities

There is a clear lack of large funds investing in UK cleantech. Between 2018-2022, there were 50 deals of \$50m and over in the UK, 12.5x less than the United States, 2.6x less than China, but equal to Germany, which is largely experiencing the same lack of large cleantech funds (figure 13).

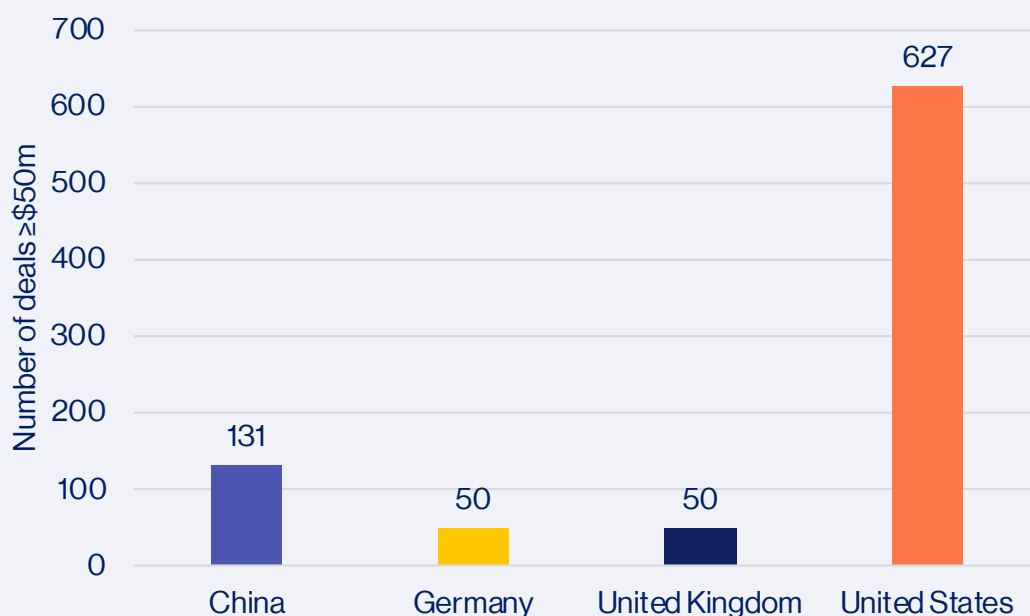


FIGURE 13: NUMBER OF DEALS COMPLETED WORTH \$50 MILLION OR MORE BETWEEN 2018 AND 2022.

A new class of emerging, large and specialised climate funds with global mandates could help fill this gap in the UK and beyond.

Just Climate, launched by Generation Investment Management in 2021, has raised over \$1 billion to invest in high impact solutions in asset heavy industries such as heavy industry, buildings and mobility. They target the companies which are too

mature for conventional VC, and too asset-heavy for conventional commercial capital, with a broader aim of demonstrating to the world that this underserved asset class – essential for decarbonisation – is investible.

Decarbonization Partners, a newly launched joint venture between Blackrock and Temasek, has committed US\$600 million to invest in companies and proven technologies that will reduce and potentially eliminate carbon emissions.⁴⁰

Decarbonization Partners provides capital towards first commercialisation for companies that have already launched a successful pilot or demonstration and need to scale, with a ticket size of \$50 million plus. These funds have global scope and will invest in the UK, only if the British ecosystem produces sufficiently high-quality scale-ups.

British Patient Capital (BPC) has the potential to play an increasingly important role in financing late venture and early growth rounds for cleantech companies given its mandate. BPC is a commercial subsidiary of the British Business Bank. It was set up after a study of the UK's investment ecosystem found substantially less investment activity at Series B and beyond, with US companies getting 2-3x more investment than their UK counterparts. While BPC has traditionally operated with a Fund of Funds model, the newly mandated Future Fund: Breakthrough is a £375 million fund which will invest directly in R&D-intensive scale-up companies in deep tech and health science, including cleantech. Future Fund: Breakthrough is specifically designed to address the equity funding gap for growth stage IP-intensive companies. The fund targets companies looking to raise at least £30m, with BPC generally investing 30% of the ticket, to finance first commercialisation and first-of-a-kind projects. BPC values commercial or offtake agreements when taking their investment decisions, highlighting the role that government schemes such as CfD's and public procurement can play (see Section 4c). Furthermore, BPC looks to leverage technical and scientific co-investment expertise. While a relatively new player in direct investments, The Future Fund has made public only one cleantech investment to date, compared to 5 deep tech and 5 health science deals. As net zero is a clear government priority, British Patient Capital should increase its investments in cleantech and should look at its criteria for deal selection carefully to facilitate that investment.

40 <https://www.blackrock.com/corporate/sustainability/blackrock-temasek>

It's not just about equity: debt financing is an issue too

A common barrier to growth for asset-heavy innovators is the difficulty in obtaining appropriate financing for first-of-a-kind commercial-scale plant. Innovators often cannot get project financing unless they have commercial or offtake agreements; conversely, customers are unwilling to sign commercial agreements unless they know the innovator can deliver the contracted product or service, which require a first commercial plant. Some innovators resort to funding CAPEX investments with equity, however this is expensive, dilutive for the founders and slows growth because raising an equity round is a lengthy and time-intensive process.

Moreover, equity investors are often wary to sign deals if companies have not already secured debt financing for expansion. Alternatives like venture debt have demanded interest rates of up to 13% for cleantech innovators, which is also unfeasible.

“Many cleantech innovators need both debt and equity financing at the same time. Venture Capital Fund managers need to have strong relationships with the debt community in order to better line up equity and debt financing for scaleups.

Beverley Gower-Jones
Clean Growth Fund

This phenomenon may constrain business models from the outset: some companies are forced to abandon hardware-as-a-service business models because they cannot obtain appropriate financing, even though they have a waiting list of eager customers.

“It is challenging to get debt financing for a project unless you have an operating plant and a strong offtake agreement, so while building your first of a kind commercial plant, you are limited to equity funding. Once you have that plant up and running, you can start to raise debt finance.

Gabriel Oke

Binding Solutions Limited

Contracts for Difference as a commercial de-risking mechanism

The UK's Contracts for Difference⁴¹ (CfD) scheme is recognised as a model for successful market development, especially in the offshore wind sector. CfDs are long-term offtake agreements, guaranteeing a fixed price over the duration of a project, which could be a twenty-year period.

By guaranteeing a certain amount of revenue for a defined amount of time, a CfD reduces the commercial risk of an electricity generation project enough for it to be able to attract private investment. Since introducing the scheme in 2015, the UK has supported more than 5.2GW installed offshore wind capacity, and price per MWh fell by 65% between 2015 and 2019.⁴²

⁴¹ <https://www.gov.uk/government/publications/contracts-for-difference/contract-for-difference>

⁴² <https://www.windpowermonthly.com/article/1735661/uk-opens-landmark-renewable-energy-cfd-auction-no-cap-offshore-wind>

Revenue support schemes such as CfDs have the potential to accelerate the rollout of other technologies by giving sufficient market confidence to overcome the investment gaps. The fifth CfD allocation round (AR5), which closed in April 2023 has a budget of £205 million. Emerging technologies such as green hydrogen and sustainable aviation fuels could also be supported by similar schemes which would provide them with revenue certainty.

The role of the UK Infrastructure Bank in facilitating private investment flows

The UK Infrastructure Bank, launched in June 2021, is endowed with £22 billion to deploy, including £10 billion in guarantees. The bank's mandate is to drive economic growth and tackle climate change, supporting economic infrastructure across five priority sectors including clean energy, with a minimum ticket size of approximately £25 million. By Q3 2022, UKIB had done 10 deals worth £1.5 billion, with an additional £4 billion of private capital crowded in.

Unlike other government enterprises that undergo a lengthy incubation process before launching, the UKIB is building its intervention capabilities as it grows. This places it in a unique position to adopt new measures as its institutional knowledge develops. UKIB is currently analysing the role it can play in deploying catalytic capital, as well the type of guarantees it can deploy to best support its mandate. It would be desirable to see UKIB move down the risk ladder to become one of the prominent actors able to financially de-risk cleantech through catalytic capital tools such as loan guarantees, direct loans, and first-loss capital.

Catalytic capital and credit enhancement tools are already used by other UK institutions to facilitate cleantech investment. The Green Finance Institute was established in 2019 to push collaboration between the public and private sector with respect to green finance. It designs and works with partners to implement financial products to de-risk investments by financial intermediaries, particularly long-term institutional investors, into climate infrastructure.⁴³ One specific example under development is the Battery Investment Facility (BIF), which seeks to blend public and private capital to de-risk investments in innovative SMEs across the battery supply

43 <https://www.greenfinanceinstitute.co.uk/programmes/green-finance-guarantee-facility/>

chain. The Green Finance Institute also works to support green finance through enabling measures, such as handbooks to inform investors, regulatory support such as the UK's Green Taxonomy, and knowledge exchange through research and training.

Catalytic Capital consists of a broad range of tools (guarantees, first-loss capital, insurance, etc.) in which the bearer assumes greater financial risk to incentivise participation of investors that would have otherwise not invested, is vital to unlock financing for first commercial projects.

Canada and the United States have successfully deployed loan guarantees and direct loans to facilitate private investment, earning financial gains at the same time. Of the \$32 billion that the Department of Energy's Loan Program Office has dispersed, \$13.61 billion has been repaid, along with \$4.21 billion in interest, which exceeds losses by more than \$3 billion. Projects supported have also created 37,000 permanent jobs.⁴⁴

Other examples of first-loss capital deployment include⁴⁵:

- FMO (Dutch Development Bank) set up fund has three investor classes for equipment financing for SMEs in Tanzania: A, B, and C. Any losses were first borne by investor C, then B, then A; any gains are first delivered to A, then B, then C. Once all investors have received a return of capital + 10%, all further proceeds are shared by investor B and C.
- Multi-layered debt structure with senior debt, sub-debt, and first-loss capital for grocery stores in underserved areas in the United States. Some investors invested exclusively in the senior instrument, while other investors invested across the debt structure (The California Endowment divided placed 25% of its investment first-loss capital and 75% in subpar debt; JP Morgan Chase Foundation invested \$2.5 million in first-loss capital and JP Morgan Chase invested \$30 million in senior debt).

44 <https://www.energy.gov/lpo/articles/getting-know-loan-programs-office>

45 Catalytic First-Loss Capital; Global Impact Investing Network

The Role of Export Credit Agencies in Financing Cleantech: Export Development Canada Case Study

Export Development Canada (EDC) started its cleantech strategy in 2012 and quickly realised that no project finance was available for smaller-scale projects (+\$20 million). EDC decided to work with earlier-stage companies that, while riskier, were at an inflection point where the project finance provided would allow these companies to commercialise and scale.

The most common financial tools used by EDC include loan guarantees, performance guarantees, and direct loans. EDC's Export Guarantee Program guarantees 75% - 100% of a loan of up to USD 10 million with a Canadian financial institution, allowing companies to access lines of credits and term loans that commercial banks would have otherwise deemed too risky.

Furthermore, their Account Performance Security Guarantee provides a 100% guarantee to financial institutions which issue a letter of guarantee ensuring suppliers get paid for the goods or services it provides to a company in the event the company cannot pay itself. EDC also provides credit insurance, protecting up to 90% of a company's losses if not paid by a customer, and allows the company to extend their payment terms.⁴⁶

The EDC works across all cleantech verticals, including (but not limited to) alternative proteins, energy storage, and renewable electricity. There are no fixed and definitive requirements to access EDC's programmes, as each project is reviewed based on merit. The would-be support recipient should have their technology proven at a pilot and demonstration scale, although the EDC recognises that project finance for cleantech carries some degree of technology risk. Other high-level considerations EDC analyses would include:

- The project/company's ability to scale.
- The market for the product (or the ability to get offset agreements).

- Anticipated revenues.
- Profile of other investors involved.
- Experience of the team.
- The economic benefit provided to Canada.

EDC's role in providing catalytic capital has been pivotal in promoting Canadian cleantech businesses: EDC has supported over \$20 billion in cleantech export business over the past 11 years for over 300 cleantech companies, with \$6.5 billion in 2021 alone. Despite the success, EDC recognises it is still challenging to incentivise commercial banks to enter the cleantech arena. Many banks are limited by their risk practices or knowledge about cleantech, and more work needs to be done in bringing the cleantech and financial intermediary communities together.

Aligning Demand

Until green premiums reduce, some vital technologies will be less attractive investment propositions than others. As these solutions must still be scaled to get to net zero, investors who take a long-term view are needed. Additionally, action in the following areas detailed below can help to create lead markets, reduce offtake risk and ensure that emerging solutions align with future demand. This in turn will increase the growth prospects and hence the investability of new, clean solutions.

Public procurement can create lead markets for clean technologies

Public procurement can play a crucial role in helping de-risk market uncertainties of cleantech technologies, therefore promoting investment. In many cleantech sectors, new firms typically sell to large incumbents with substantial market power and lower willingness to adopt new technologies, making it hard to command profit margins or even gain commercial traction. Government's involvement in commercialisation of cleantech through the role as a customer reduces market risk through willingness to pay for an early version of an emerging technology, creating markets for goods and services that would otherwise be outpriced by carbon-emitting alternatives.

There are several successful cases of public procurement accelerating the adoption of cleantech: the government of Germany played a critical role in committing to purchase electricity generated from renewables, which played a critical role in driving the growth of the industry and bring down photovoltaic prices, for example.

In 2019/2020 (the latest data available at the time of writing this report) the UK government spent £295.5 billion in public procurement from the private sector – about a third of public sector spending. Less than 1%⁴⁷ was spent on contracts directly related to net zero. With public procurement spending expected to remain high, it is important that cleantech companies work with government to leverage more of this spend. It is important to note that while the UK has a substantial procurement budget, it does not have the same absolute procurement capabilities as the US or EU. Continued collaboration with the EU on science and innovation is vital to ensure continued competitiveness.

Role of the first customer: mobilising the ecosystem

A first customer willing and able to pay a green premium for a cleantech solution is a fundamental part of developing new technologies and markets. A first customer's offtake agreement secures demand and enables the further development of said innovation. This importance of a first customer can be seen clearly in the two examples, Iberdrola-Fertiberia Partnership, and Agricarbon's partnership with First Milk.

Iberdrola and Fertiberia, headquartered in Spain, launched a joint project to develop 800 MW of green hydrogen electrolyser capacity by the late 2020s with an investment of €1.8 billion. This partnership, announced in 2021, was the first and largest agreement between a utility company and fertiliser company at that time. The green hydrogen will be used to replace natural gas in Fertiberia's ammonia production process. Crucially, the partnership owes its existence to offtake agreements. Iberdrola's ability to secure an offtake agreement from Fertiberia at a green premium created a viable business case for green hydrogen production and enabled the subsequent development of the green hydrogen value chain. The decarbonisation impact of the project will be enormous: the 800MW target would provide 20% of Spain's green hydrogen mandate of 4GW by 2030 (itself 10% of the EU's target of 40GW).

Agricarbon is a Dundee-based start-up providing solutions which measure the carbon content of soil. The company is developing a hybrid solution to reduce physical machinery needs and optimise the number of samples needed to obtain an accurate measurement. Thanks to an early contract with dairy farm cooperative First Milk, Agricarbon has been able to test their solution in a commercial setting from day one. The partnership gave Agricarbon access to around 700 dairy farms as first customers and putting First Milk ahead of the field in sustainability. The agreement allowed Agricarbon to scale faster and put resources into developing a better product rather than finding first customers, and led to a strategic partnership with Nestle, a First Milk customer. First Milk was also the lead investor in the Agricarbon's 2022 seed round.

Responsive regulation is needed to keep up with the pace of innovation

Cultured meat is a form of alternative protein grown under lab conditions. UK-based companies such as Cellular Agriculture and Roslin Technologies are developing solutions in this space. In most parts of the world, technological development in this field has outpaced regulatory structure: Singapore is currently the only country to have approved cultured meat as a food product. In areas such as novel foods ensuring safety is paramount, but innovators report unnecessary delays in many jurisdictions due to lack of clarity on requirements.

Case study: Bringing cultured meat to market, and example of regulation made for innovation

Singapore has optimised its regulatory process to be able to adapt for new products, including by appointing a liaison where innovative start-ups can send written queries and share inputs such as third-party lab test results and analysis, getting fast responses to help them determine the inputs needed to be able to certify their product.

Cleantech for regional economic regeneration



Across several metrics, The UK displays larger geographical differences than many other developed countries. This includes productivity, pay, educational attainment and health⁴⁸ so it is not surprising that some areas receive more investment in cleantech than others. Currently, investment activity is heavily concentrated around the 'golden triangle' of London, Oxford and Cambridge. With world-class universities and a critical mass of VC investors and Entrepreneurial Support Organisations (ESOs)⁴⁹ such as accelerators, these are the oldest and largest clusters of cleantech activity in the UK. Industry insiders consider that start-ups founded in this region command a premium of £2-5 million at pre-seed stage. However, universities such as Bristol, Edinburgh, Manchester and Liverpool are also producing high quality technical intellectual property (IP) and with more support for commercialisation, these also have the potential to become richer sources of innovation.

Clusters are driving regional cleantech innovation activity

The golden triangle and other geographical locations renowned for a successful industry sector (such as Silicon Valley in the USA and Pearl River Delta in China) demonstrate the importance of clusters. Clusters are geographical colocations of interconnected companies, and they drive competition, collaboration and innovation. In the UK, clusters are driving momentum outside of the golden triangle and there are several increasingly important clusters which are benefiting from university excellence, new VC funds co-located in the region (for example Northern Gritstone) and clusters of companies who are using the local expertise to drive innovation and growth.

The UK ecosystem contains two kinds of cluster:

1. Industrial clusters: these are located in industrial sites where government policy is driving decarbonisation efforts.
2. Local concentrations of innovation activity clustered around a specific sector.

The UK's industrial clusters are a unique example of systematic interventions to decarbonise high-polluting industrial sites. Because of the high investment amounts and the scale of the projects, these initiatives have tended not to include smaller

⁴⁸ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1052708/Levelling_up_the_UK_white_paper.pdf

⁴⁹ ESOs include incubators, accelerators and other organisations providing services to start-ups

innovators. However, there is evidence of indirect clustering of innovation in the regions around the projects. Hydrogen producers are choosing to locate near to demand, and sustainable fuels producers are attracted to the sources of CO₂ feedstock. Some industrial clusters are set to grow more quickly following the 2023 budget, which allocates an additional £20 billion of funding for CCS projects.

Elsewhere in the UK, more 'classic' cluster models, centred around a university, accelerator and risk capital providers, facilitated by effective local public policy, are correlated with increased start-up activity. These clusters deliver higher-than-average growth, leveraging regional comparative advantage.

A visionary early example of this cluster model can be found at the University of Edinburgh. The University hosted the Edinburgh Centre of Carbon Innovation, built in response to the UK and Scottish Climate Change Acts of 2008 and 2009. The existence of a physical hub in a prime location close to government institutions and commercial activity in the heart of the city, set the stage for a growth phase in cleantech innovation.

Notably, the UK's decarbonisation efforts in Scotland saw a domino effect with key ESOs such as the Michelin Scotland Innovation Parc and particularly the Net Zero Technology Centre's TechX Clean Energy Accelerator pushing for green hydrogen, industrial carbon capture and other technologies to accelerate the transition to a net zero energy industry. The region is now starting to become recognised as one of the "Super Places" of low carbon growth technology.

Most recently, the Northern Irish government signed the Belfast Region City Deal as of late 2022. Currently, they are building the i4C Innovation Cleantech Centre and a Hydrogen Training Academy in Ballymena. These interventions have sparked potential for a new cluster in a region which has historically seen low levels of

cleantech innovation.

West Midlands Combined Authority: deliberate cluster planning and development

Outside the government-led industrial clusters, and the golden triangle, the West Midlands area has been successful in creating a critical mass of innovation activity in cleantech and beyond. While similar success stories have been seen in Manchester and Glasgow, the West Midlands area is particularly interesting because it has been successful in promoting innovation outside of a big urban concentration.

West Midlands groups the three towns of Birmingham, Coventry and Wolverhampton. It is at the centre of the UK's power distribution network, with National Grid, Cadent and EON, as well as Xoserve all headquartered there. The West Midlands Combined Authority (WMCA) has just been announced as one of three 'Innovation Accelerators' and will receive a share of a new £100m fund from Innovate UK.

The cluster is strong in sectors such as energy, automotive and advanced manufacturing. The energy cluster has produced two notable high growth start-ups: the building energy optimisation platform Grid Edge, as well as the storage analytics platform Modo Energy. Although technically located in the East Midlands, nearby Rolls Royce also has a strong track record for innovative projects; current projects include Small Modular Reactors and the UltraFan high efficiency aero engine. Rolls Royce also has a manufacturing facility in Birmingham.

The support ecosystem includes a coalition of leading universities including Birmingham, Loughborough and Warwick; the central government-funded Catapult accelerator, and the West Midlands Innovation Accelerator. Local risk capital and other early-stage funding is available through Midlands Engine, Midven and Mercia.

The region also houses a strong automotive sector, and Impression Technologies serves this sector with its advanced aluminium technology. Local VC Mercia has been a key funder, financing several rounds from 2014 to 2018. The region is also successful in attracting external innovation: Swedish EV truck developer Volta

Trucks chose to locate product development activity in the cluster because of the concentration of local automotive expertise allowed faster time to market.



FIGURE 14: THE WEST MIDLANDS CLUSTER MAKE UP

The West Midlands Combined Authority evaluates cluster success in terms of quality jobs, FDI and above-average economic growth.

WMCA, successful in attracting foreign direct investment, and getting government funding as well as attracting foreign firms to locate there, points to several critical success factors which could help to replicate success in other places around the UK:

- The current landscape is a result of sustained commitment over several years, comprising a portfolio of interventions: sector-based and cross-sectoral, strategic and tactical, and involving a large amount and variety of different ecosystem actors.
- European Regional Development Funding was important in funding local innovation projects, important to preserve the innovation accelerator and BEIS funding which has substituted this now that EU funding is no longer available.
- The mayor has been instrumental in championing deployment of cleantech

innovation, the impact trickles down into wider economic policy and strategy development.

- LEPs worked together to coordinate efforts and distribute funding beyond the larger centres.
- WMCA has benchmarked regional strengths and growth potential against national averages for key clusters and plans to use this to prioritise future interventions.
- Support is tailored to the specific needs of each cluster: some need financial support, whereas others need visibility and credibility.

Cambridge Cleantech: leveraging IP excellence and hi-tech capability

Cambridge's cleantech cluster is one of the largest in Europe. Its innovation tends to be highly research-driven, with IP supplied by the University of Cambridge, university of Anglia, and Cranfield University. Information technology (IT) and life sciences clusters also exist in the Cambridge area, providing opportunities for interaction with cleantech initiatives. Within cleantech, the sub-sectors of energy systems management, grid services, materials science and built environment are particularly

strong. The cluster also benefits from a strong network of companies, nurtured by [Cambridge Cleantech](#).

A return to regional manufacturing

The golden triangle is excellent at IP generation, but the question remains where its



Existing industrial sites in the North of England could have advantages for FOAK plants with the access to offshore wind.

Andrew Symes, CEO
OXCCU

start-ups go when they get to the stage of mass commercialisation. One approach to this, which would be interesting to consider, would be to locate manufacturing facilities in other parts of the UK.

This would mirror a trend seen throughout Europe: Germany and Spain are both working on regional PV manufacturing facilities. In fact, Oxford PV moved to Germany at commercialisation, because of better availability of manufacturing facilities.

Better coordination between golden triangle tech transfer offices, local authorities in other parts of the UK, could build the links needed to kick start such collaborations. If tech transfer offices can build the relationships with the local authorities, then they can start to provide the local authorities with a pipeline of new companies and their requirements and act as a match maker between companies and local authorities. This would allow local authorities to entice new companies to areas which need an influx of skilled jobs and in turn would provide certainty to innovators and investors about next steps to growth.

This collaboration could start at the demonstration phase. As an example, let's look to carbon-to-fuel start-up, OXCCU, a spinout from Oxford University. Their multifunctional catalyst is currently at TRL 4, and OXCCU plans to work with the University of Sheffield's Translational Energy Research Centre (TERC) for commercial scale demonstration. Having access to TERC's reactor will cut at least one year from their development time, (as opposed to building their own. Links such as these could be extended to local authorities as innovators like OXCCU think ahead to commercial rollout and production.

Larger companies are well placed to leverage operational expertise to scale up clean technologies, either by collaborating with innovative start-ups, licensing IP, or developing in-house. Johnson Matthey, a multinational speciality chemicals and sustainable technologies company, recently announced an £80 million investment in a PEM fuel cell manufacturing facility in Royston, North Hertfordshire, and operates

Regional manufacturing success – myenergi

EV charging manufacturer myenergi employs more than 400 people in its Grimsby headquarters and is growing rapidly, with around 50% sales outside the UK. It's an example of how high growth cleantech start-ups can contribute to a new, green, regional regeneration.

“We tend to do high value tech manufacturing well in the UK. There is a good domestic supply chain for quite a lot of specialist manufacturing and componentry, which allows us to be agile when problems come up.

Tom Callow
myenergi

an assembly facility near Swindon.⁵⁰ Initiatives such as these not only bring jobs to less economically active parts of the UK, but also increase domestic share of the technology value chain, increasing supply chain resilience and agility.

Cleantech innovation provides an opportunity for regionally decentralised economic growth, and high growth start-ups like myenergi are leveraging this opportunity to provide economic returns and high-quality jobs. Another example is KrakenFlex, now part of Octopus Energy, whose Cheshire location gives them access to talent from the nearby universities of Liverpool, Manchester and Lancaster.

Emerging clusters and high-growth start-ups such as myenergi are hugely positive for the UK but there are a range of issues which need to be tackled to fix the golden triangle bias imbalance. Uncertainty around the levelling up strategy makes it harder for local authorities to formulate long term development plans which could kick start regional activity. Whilst this is the case for lots of industries, it is particularly important for cleantech because of the large amounts of manufacturing space required for the hardware, the skilled labour requirements and the need to transport hardware across the country.

UK Overview

Conclusion



This report has taken the views and experience of over 70 experts in the cleantech sector and drawn on Cleantech Group's proprietary data to provide a complete picture of the investment landscape in cleantech.

The report highlights the UK's strengths in cleantech which is attracting record breaking amounts of investment. It also highlights some of the work the government has done to support emerging cleantech companies both financially and through the bold legislative commitment to reaching net zero by 2050.

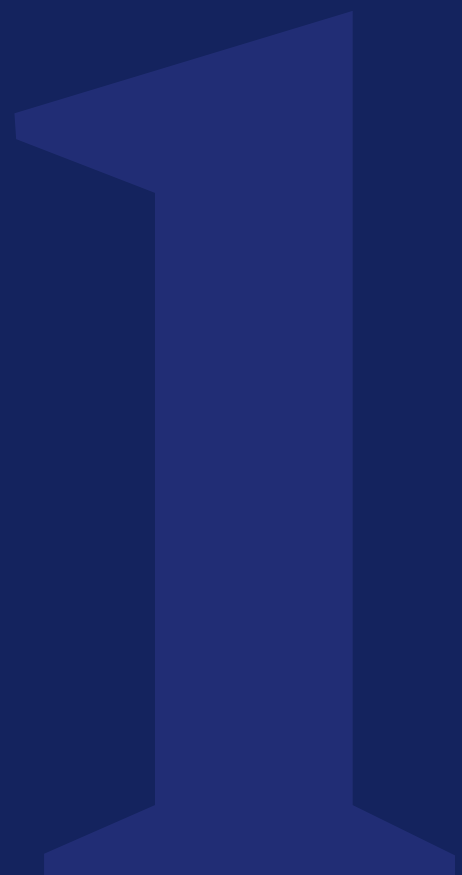
It is clear however, there are remaining gaps in both funding and policy, which, if plugged, would give the UK the competitive edge it needs to keep pace with other world leaders in cleantech.

Policy consistency, long term signals on public funding and international collaboration will be key to achieving the UK's climate goals, with the bonus of helping the UK to level up and reap the potential economic benefits of the innovation it is producing.

Detailed recommendations

- **Offer more support for accelerators, venture builders and other innovative early-stage support services:** Accelerators provide an important service to the ecosystem, and do not have an easy business model, especially if they don't take equity in the start-ups they support. More support is needed for the best ones, including for non-traditional structures such as venture builders and studios.
- **Increase the number of grants available without the need for match funding:** Early-stage SMEs are disadvantaged when applying to public grant bodies because there is often a requirement for matched funding, which they either can't afford to do, or find investors willing to invest on match funding terms. This is not a unique problem to the UK, but internationally, the programmes are more flexible.
- **Provide tailored support around technology de-risking and commercial feasibility analysis** that is informed by the industry and ideally in collaboration with industry from the early-stages to better set up cleantech companies for success.
- **Reverse changes in tax credits:** Changes in the R&D tax credit system commencing in April 2023 will have a significant negative impact on early-stage companies focused on innovation.
- **SEIS and EIS should include all decarbonisation technology:** HMRC must ensure that SEIS and EIS and other venture capital schemes do not exclude decarbonisation technologies that could benefit from EIS's tax relief for investors.
- **Associate to Horizon:** The UK has experienced delays in associating to Horizon and the government has put forward a UK equivalent if the delay continues, but the best outcome for R&D would be to associate.

Methodology and Contributors



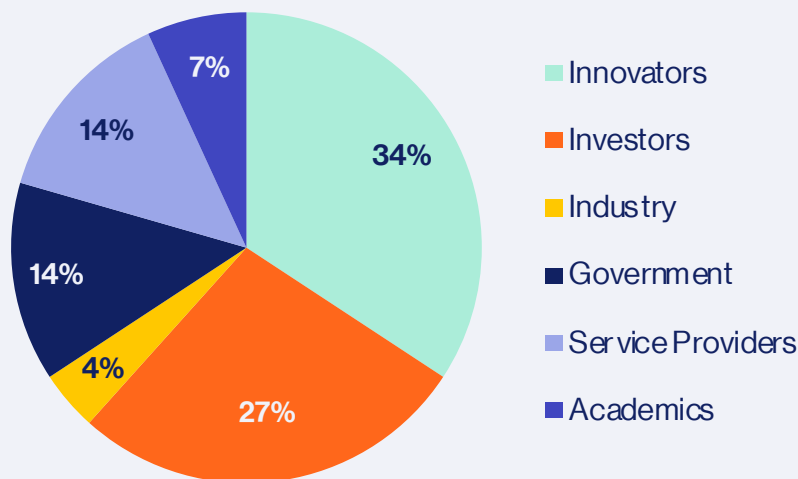
We interviewed more than 70 leading actors in the UK's Cleantech Ecosystem, including innovators (start-ups and scale-ups), investors, accelerators, academics, government officials, industry professionals.

We consulted academic papers, industry reports, and UK strategy documents.

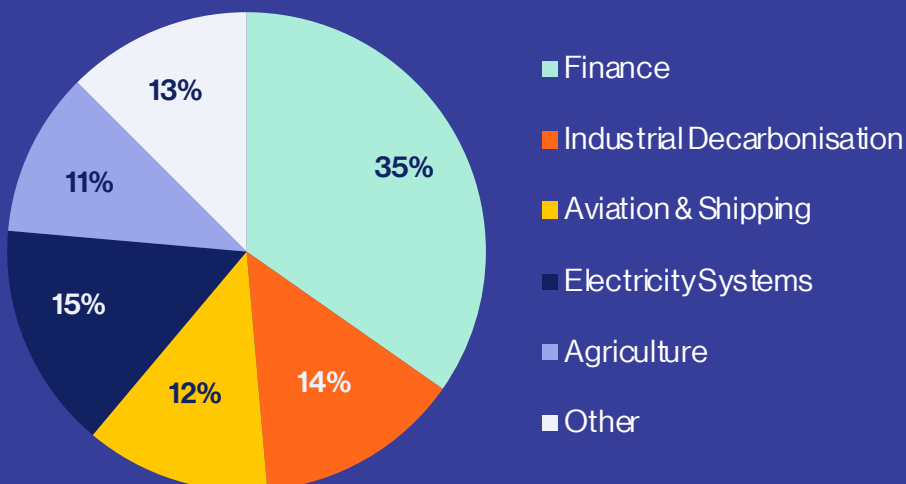
Ecosystem and investment data are from Cleantech Group's proprietary database "i3", which tracks cleantech start-ups, investors, ESOs and investment flows globally.

Investment into UK from global investors has been converted to £ using the average USD-GBP exchange rate for the year of investment.

Key focus sectors included agriculture, aviation & shipping, electricity system, industrial decarbonisation, and finance.



CONTRIBUTORS BY ROLE



CONTRIBUTORS BY SECTOR

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Thank you

Feel free to contact us with any questions you have

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