

Submission to the independent review of the UK Government's approach to net zero

November 2022

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About this report

This is a joint submission to the Net Zero Review team made by the Grantham Research Institute on Climate Change and the Environment, the Centre for Economic Performance, the Programme on Innovation and Diffusion, the Centre for Climate Change Economics and Policy and the Place-based Climate Action Network, all at the London School of Economics and Political Science. It is a response to the call for evidence made as part of the Independent Review of Net Zero commissioned by the Secretary of State for Business, Energy and Industrial Strategy and launched on 26 September 2022 to ensure that the delivery of the target is pro-growth and pro-business. Read more about the review, led by Chris Skidmore MP, at <https://www.gov.uk/government/news/chris-skidmore-launches-net-zero-review>. This report represents a lightly edited version of the written submission made to the consultation in October 2022, with minor revisions made to the headline points.

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Headline points

- **With the right set of coordinated policies in place, delivering net zero and achieving economic growth can be complementary.** Investing in net zero capabilities across the UK could enable growth and the creation of good jobs at the national level and also contribute to addressing regional disparities in economic activity in support of levelling up.
- **The UK is specialised in clean technologies overall and in some specific technologies within that category for which the estimated returns to public investment in innovation are especially high,** such as offshore wind, tidal stream and carbon capture, usage and storage (CCUS). Building on these capabilities can enable UK businesses to capture valuable parts of the growing global market for related technologies, products and services.
- **UK businesses can benefit from the shift to low-carbon energy, which reduces exposure to volatile fossil fuel prices, in turn having the potential to reduce costs and uncertainty.** Rising energy prices have pushed down the relative costs of decarbonisation, making an accelerated shift to renewables even more attractive.
- **The costs and benefits of the transition to net zero need to be distributed fairly across society in order to maintain public support in challenging times.** In particular, measures to decarbonise homes, such as energy efficiency retrofits and heat pumps, are unaffordable to many and will require government support for making the initial investments, in turn enabling access to the benefits of the low-carbon alternative for all.
- **Carbon pricing complemented with a broader package of policies and smart regulation to address the different challenges faced across sectors can enable the UK to meet its net zero target in a more economically efficient manner.** Both explicit and effective carbon prices in the economy will need to be fully aligned with net zero, crucially by rebalancing electricity and gas prices.
- **Significant fiscal rethinking is needed to respond to the current economic climate and to proactively manage the implications of the longer-term transition to net zero on the tax system,** including the expected loss of revenue from fuel duty. Any subsequent taxation to bring down the fiscal deficit should be equitable and targeted at those most able to afford it.
- **Maintaining energy security and delivering net zero by 2050 are complementary rather than conflicting priorities.** While the Government is rightly focusing on the affordability of energy to support households through the current cost of living crisis, increased support for investments in energy efficiency measures and action on behaviour change is needed at the same time.
- **The ongoing support to households and businesses through the current period of high energy prices needs to be targeted and linked to incentives to decarbonise.** Freezing prices without such incentives in place could dampen the price signal and deter investment in the transition away from fossil fuels. Sustaining the transition is crucial for the future resilience of the UK energy system.
- **An overall systematic approach to finance from the Government is needed for the UK to deliver the investment in net zero at the pace and scale required.** This includes providing policy certainty and stability, setting out how to reverse the consequences of the recent economic turmoil and the series of decisions (e.g. on fracking, solar PV and onshore wind) that are creating mixed signals on net zero.
- **There is a disconnect between the UK's highly global capital markets and the bottom-up needs of its localities and regions.** The Government can lead the efforts to bridge this financing gap and build a cohesive ecosystem to encourage place-based investments that can deliver local impacts, for instance by introducing local climate finance hubs.
- **Net zero requires an all-of-government effort to drive increased and well-targeted investments across innovation, infrastructure and skills.** Central coordination and oversight of the transition can ensure that every government department is doing its fair share towards net zero while preventing any policies that would unintentionally undermine the transition from being put forward.

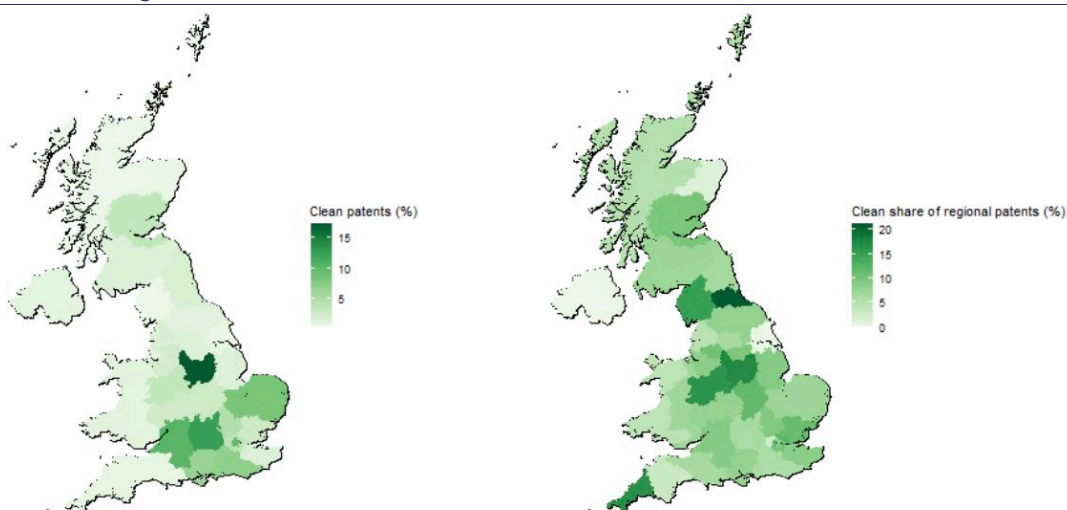
Overarching questions

Question 1: How does net zero enable us to meet our economic growth target of 2.5% a year?

With the right set of coordinated policies in place, delivering net zero and achieving economic growth can be complementary.¹ Analysis by the Climate Change Committee (CCC) estimated that the actions required to meet the Sixth Carbon Budget could deliver a boost to GDP of around 2% by 2030, alongside a 1% boost to employment (CCC, 2020). This growth opportunity is attributed to the expected multiplier effects of increased low-carbon investments, productivity gains and operating cost savings from the switch from high- to low-carbon technologies, health and environmental co-benefits of the transition as well as innovation or industrial opportunities, especially if UK businesses capture valuable parts of the growing global value chain for low-carbon products and services (ibid.). The UK is specialised in clean technologies, ranking fifteenth globally on a measure of comparative advantage in patenting in this area (Curran et al., 2022a). Within the overall basket of clean technologies, there are some in which the UK is particularly specialised and for which the estimated returns to public investments in innovation are particularly high. Examples include offshore wind, tidal stream and carbon capture, usage and storage (CCUS), as described in more detail in Question 7.

Ramping up net zero capabilities across the UK could not only enable growth and the creation of good jobs at the national level but also contribute to addressing regional disparities in economic activity in support of the Government's Levelling Up strategy. Analysis by the CEP and the Grantham Research Institute has shown that low-carbon innovation activity is well-spread around the UK (ibid.). Analysis of patents – a key innovation output – can identify areas of relative strength and opportunity for innovation-intense economies such as the UK. Notably, while a large volume of the UK's clean patents² tends to be around London and the South East, areas with a lower share of the UK's total patents tend to have a higher intensity in clean patenting (see Figure 1). Examples include Derbyshire and Nottinghamshire, Cornwall and the Isles of Scilly and Lincolnshire.

Figure 1. Regional share of total UK clean patents (left) and clean patents as a share of total region patents (right), 2015-2018



Notes: Patents by NUTS2 region (2015-2018). Five London regions are aggregated into inner and outer London due to an older disaggregation available in the patents data. **Source:** Curran et al., 2022a: analysis of PATSTAT.

¹ On the policies required to achieve this, please refer to our answer to Question 29.

² Clean patents include a range of climate change mitigation and adaptation technologies.

Using a new methodology that estimates the returns to public investments in innovation (including spillovers) we find that investments in clean technologies such as tidal and offshore wind in less innovation-intense regions have significant potential to boost local growth as they generate strong returns for those regions (and little leakage to other regions). Government support for these technologies in more innovation-intense regions also generates spillover effects for the rest of the country in addition to returns in the regions themselves.

Analyses of complementary datasets reveal further insights on how investing in existing net zero capabilities around the UK can help drive regionally balanced growth. First, less productive regions appear to be more specialised in clean goods and services,³ with firms producing products and services related to low-carbon heat and buildings particularly likely to be found in areas with lower regional productivity (such as East Wales, Southwest Scotland and South Yorkshire). Second, an analysis of firms within the UK's 'high-growth economy'⁴ (i.e. firms that have received growth finance or achieved rapid growth) reveals that areas outside London and the South East have a higher concentration of clean technology firms.

New analysis from the Grantham Research Institute provides further evidence on the regional distribution of the economic opportunities from the net zero transition, using comprehensive online job vacancy data in the UK between 2012 and 2021 (Cass et al., forthcoming), building on the approach of Saussay et al. (2022), who employ a granular approach to classifying green jobs. On average across the UK, low carbon jobs accounted for 1.1% of job advertisements from 2012 to 2021, and areas with the highest low carbon job ad share tend to be concentrated away from London and the South East. In particular, the low carbon share of job ads during this period was over 2% in some areas of Scotland, the South West, and Northern England.

We discuss further opportunities for UK businesses from the net zero transition in Question 3.

Question 2: What challenges and obstacles have you identified to decarbonisation?

Climate action needs to be both feasible in the immediate term and durable over time if the UK's net zero target is to be delivered successfully. This requires proactive consideration of challenges across economic, social and political dimensions and carefully designed policies to address them. We have identified a non-exhaustive list of challenges for the net zero transition:

- **Distributional impacts:** The costs and benefits of the transition to net zero need to be distributed fairly across UK households, businesses and the government. Without a strategic approach, there is a risk of creating disproportionate impacts for households based on income- and place-based dimensions. For example, many of the changes required to decarbonise homes (e.g. energy efficiency retrofits, heat pumps, electric vehicles) are currently unaffordable and/or disruptive for households to adopt (Corlett and Marshall, 2022). Even though these changes all have the potential to deliver operational savings once initial investments are made, government support is therefore necessary to enable low-income households in particular to benefit from this. Notably, heat pumps are not yet an economically viable proposition for consumers, in terms of either upfront or operational costs (GRI and ESC, 2022). The CCC (2022) estimated that, even under the record high gas prices at the time of their analysis in May 2022, the average heating bill for a heat pump was around 10% higher than for a gas boiler. This reiterates that government action will be required both for supporting households to make the initial investments in low-carbon technologies and for addressing price distortions that often penalise these technologies, in turn helping all of society to capture the benefits of the transition.

³ This piece of analysis uses data from 'The Data City' (thedatacity.com), which maps the net zero economy using textual information on firms sourced from their websites.

⁴ This piece of analysis uses data on the high-growth economy from Beauhurst (www.beauhurst.com).

The Government's chosen approach to passing policy costs onto consumers needs to ensure that funding net zero is fair in the first place, and that it is also perceived as such. This is especially important in the current cost of living crisis. Consumers are sensitive to changes in the cost of provisions such as energy, transport and food, as public protests demonstrate. Carbon pricing literature suggests that perceived (un)fairness is strongly linked with (low) public support for and/or acceptability of the policy (Maestre-Andrés et al., 2019; Bolderdijk et al., 2017). Recycling carbon tax revenues back to households and moving low-carbon policy costs away from a levy on consumer bills are among the options to be considered to address distributional impacts. Burke et al. (2020a; 2020b) demonstrate that redistributing carbon tax revenues back to targeted low-income and/or fuel-poor households can play an important role in delivering a just transition. Depending on the design of revenue recycling, such measures can even make carbon tax policy progressive (ibid.).

- **Workforce transitions:** Equipping the UK workforce with the capacity required to deliver a speedy transition to net zero, without leaving any workers or communities behind, will be a major challenge in the absence of a proactive strategy. Net zero will bring structural changes for the entire UK economy, with some sectors declining, some transforming and others growing. An effective workforce transition will be one that realises the potential to transfer skills and capability from high- to low-carbon industries at the right time and in the right places. Many of the skills needed in a net zero economy are already present in the existing workforce and can be transferred across a broad range of roles and/or sectors. In fact, analysis based on US occupations finds that non-green jobs generally appear to differ from their green counterparts in only a few skill-specific aspects, suggesting that most re-training can happen on-the-job (Bowen et al., 2018). One preliminary assessment has shown that just over two-thirds of jobs in oil and gas have skills that are at least partially transferable to low-carbon industries (Emden et al., 2020).

The presence of transferable skills in the workforce does not mean that skills will automatically flow towards low-carbon industry: proactive investment, including re-skilling and up-skilling programmes, will be crucial. Firms may be unable or reluctant to invest in training, and indeed on-the-job training in the UK has been in decline in recent years, so specific government measures will be required to unlock private sector investment for developing the UK workforce's net zero capacity (Li et al., 2020; 2021). New skills and knowledge will also be needed, of course; primarily in the specialist and technical aspects of new technologies like direct air capture. Filling skills gaps in these areas may require greater effort and specialised support, and there may be shortages, especially in the short-term, until necessary training and recruitment processes are in place.

Without careful planning on the social aspects, there is a risk that the net zero transition will entrench existing disparities in the workforce. Evidence to date (based on mapping granular classifications developed by the US Occupational Information Network to more aggregated UK occupations as available in UK Labour Force Survey data) suggests that 'greener' jobs are more likely to be held by older, male, white and more educated workers (Broome et al., 2022; Valero et al., 2021) and also appear to pay more (according to standard wage regressions, controlling for other observable worker characteristics such as experience and education). It will be important to ensure that high-quality jobs generated as part of the transition are available and accessible to people of any gender, ethnicity or background, creating a diverse pool of talent working towards net zero goals (Valero et al., 2021).

- **Fiscal implications:** The tax system will need to be aligned with net zero to drive the transition towards low-carbon choices, correcting distortions that often penalise low-carbon technologies and ensuring that the significant consumer savings from using many low-carbon technologies are enjoyed widely (CCC, 2022). While acting as a key driver, there will be implications from the transition for fiscal policy itself, which needs to be

managed proactively in order to sustain public service provision. The transition to net zero will be part of a wider structural transformation of the economy over the coming decades (including digitisation, for example). This could bring new revenue sources (e.g. carbon taxes), but there will also be losses: a transition to electric vehicles alone is estimated to put at risk around £35 billion per year of current Government tax receipts, the majority coming from fuel duty (CCC, 2020). HM Treasury's *Net Zero Review* in 2021 recognised the risk of loss of revenue from the fuel duty but did not set out a strategy for replacing this loss.

While the decarbonisation of the economy was already going to require fiscal rethinking, the scale of the challenge has been exacerbated by current fiscal pressures and the need to fill the 'black hole' in public finances, which is estimated to be of the order of £40 billion. Significant fiscal reform is now needed, which should reflect the current economic climate as well as the longer-term structural transformation that is underway and will accelerate during the transition to net zero. This could create an opportunity to form a new implicit social contract and address politically-charged areas like carbon taxes and road pricing. Any subsequent taxation to bring down the fiscal deficit should be equitable and targeted at those most able to afford it.

The UK has transitioned from a low interest rate environment, which provided the opportunity for cheap borrowing for productive, growth-enhancing investments including for net zero (Stern et al., 2020), into a higher interest rate environment, which might make this more challenging but still justifiable (Zenghelis, 2022).

- **Climate damages:** The increase in climate change costs and damages to the UK has already started to challenge efforts to decarbonise due to reduced GDP and increased attention and finance needed for disaster recovery. Under current policies, the total cost of climate change damages to the UK are projected to increase from 1.1% of GDP at present to 3.3% by 2050 and 7.4% by 2100 (Rising et al., 2022). The government can reduce these costs and challenges by making a concerted effort to integrate climate resilience and adaptation into its approach to delivering its net zero target.
- **Mobilising net zero finance:** Cutting across these challenges is the critical need to mobilise finance for the delivery of the UK's net zero and resilience goals across all parts of the country. There are a number of challenges preventing the increase in net zero investment required over this decade, as identified in a report chaired by the Grantham Research Institute's Nick Robins which accompanied the CCC's Sixth Carbon Budget (Advisory Group on Finance, 2020). One of the key challenges is the net zero target not yet being embedded in the financial system as an objective that shapes behaviour to the same degree as the management of climate risk (ibid.). The Government has adopted a number of the report's recommendations already, including the goal of making the UK the world's first net zero financial sector. However, more work is needed, particularly to connect the pools of capital committed to net zero with bankable projects in the nations and regions of the UK.
- **Market failures:** While growth opportunities might exist, it is unrealistic to assume that we can rely on the private sector to naturally choose the smoothest path to net zero given the presence of numerous market failures (over and above the greenhouse gas externality) and path dependencies in innovation systems (see Valero and Stern, 2021 for a summary). Different market failures point to different instruments, but the collection of policies must be coordinated and mutually enforcing. The innovation required for net zero involves radical change and system transformation in many cases, and will not happen at the necessary scale and pace without incentives, regulation, government spending and participation from civil society. A sense of direction is especially important where solutions are not yet known, and/or where markets do not yet exist.

Question 3: What opportunities are there for new/amended measures to stimulate or facilitate the transition to net zero in a way that is pro-growth and/or pro-business?

If the pathway to net zero is made just and inclusive, issues that are currently thought of as challenges to the transition can become pro-growth opportunities. Managed well, the transition can deliver a range of socioeconomic benefits in terms of quality job creation, ending energy poverty, and regional revitalisation. Indeed, the International Energy Agency's *Net Zero by 2050 Roadmap* (2021) estimates that the transition could create 30 million jobs across the energy system, with around five million job losses, and provide clean energy to 785 million people.

Within this overall frame we have identified opportunities for new or amended measures in the UK under several dimensions:

- **Accelerating the energy transition:** UK businesses can benefit from the shift to renewable energy that is inherent to the net zero transition as this shift can reduce the costs and uncertainties they face. Renewables are increasingly cheaper than fossil fuel-based sources of energy and are less exposed to price volatility. In 2020, the CCC had estimated that decarbonising the entire UK economy would cost less than 1% of GDP each year by 2035 (CCC, 2020). But the current context of high energy prices has pushed down the relative costs of decarbonisation, making an accelerated shift to renewables even more attractive (CCC, 2022). The CCC's updated estimates suggest that decarbonising the UK economy would now result in a *saving* of 0.5% of GDP in 2035, if gas prices remain very high (ibid.).
- **Support with the high costs of energy:** In the immediate term, both UK businesses and households are receiving support with energy bills. Businesses face limits in the extent to which they can pass on higher costs to consumers in the current environment, meaning there is a risk of redundancies or businesses going bust, with such risks varying by sector and business type (Valero, 2022).⁵ Beyond an initial six-month period, the Government intends to take a more targeted approach (Thomas, 2022). Ongoing support should indeed be targeted and also linked to incentives to decarbonise in order to enhance the longer-term effort to become less exposed and hence more resilient to high energy prices. Freezing prices without such incentives in place could dampen the price signal and deter investment in the move away from fossil fuels (Giles, 2022). Ways of funding such support fairly could include solidarity taxes on people who can afford it or windfall taxes on the excess profits of energy producers or generators (Brewer et al., 2022).
- **Reinforced industrial policies aligned with net zero:** Long-term and committed industrial policies focused on investment and innovation for net zero can yield significant growth and productivity gains for the UK (Stern and Valero, 2021). The UK already demonstrates comparative advantage in many areas that are relevant for the transition to net zero (as set out under Questions 1 and 7). More careful analyses of the UK's relative strengths and an understanding of the barriers to realising them is required for a pathway to net zero that can also drive growth and productivity. Targeted policies can be used to enhance identified areas of relative strength, including R&D grants, enhanced tax incentives for green investments, product standards and requirements in government procurement. More generally, the growth objective needs to be sustainable in the sense that it can be sustained over time, as well as from an environmental perspective. Policies that seek to increase growth or productivity at the national or local level (for example, investment zones) need to be designed with their direct and indirect impacts in mind, ensuring that no compromises are made on net zero or on the wider set of environmental regulations. The 2017 Industrial Strategy, which had 'clean growth' as one of its 'grand challenges', and the

⁵ See also ONS (2022) for an analysis of rising business insolvencies in the UK during the energy crisis.

Industrial Strategy Council, with its monitoring and metrics work, were positive steps towards implementing these types of frameworks.

- **Maintaining competitiveness:** It is important to maintain and protect the competitiveness of UK businesses internationally while implementing the necessary domestic climate policies. There is a longstanding concern among policymakers that ambitious climate policies may lead to a loss of business competitiveness (Dissou and Eyland, 2011). However, empirical evidence actually suggests that climate-policy-induced carbon leakage is uncommon, and the leakage that has happened is more likely to be a function of the broader determinants of international trade and investment (Grubb et al., 2022). Nevertheless, certain measures such as carbon border adjustments, consumption charges and carbon excise duty can help to address the risks of carbon leakage and ensure trade-exposed industries are on board with the transition. The UK could benefit from a more proactive approach to carbon border adjustments, including close multilateral cooperation with the EU and working towards a common approach with the EU Carbon Border Adjustment Mechanism (CBAM). Failure to do so could risk the UK being forced into adopting a policy without influencing the policy design and governance. There could also be a renewed case for formally linking the UK Emissions Trading Scheme (ETS) to the EU ETS for the advantages it would offer in terms of joined-up thinking on carbon leakage as well as to support market liquidity (Sato et al., 2022). Beyond price-based approaches, a wide range of other policies can address leakage and maintain UK competitiveness, such as product standards, green public procurement, subsidies and standards banning certain carbon-intensive products.

Question 4: What more could government do to support businesses, consumers and other actors to decarbonise?

Investment in a net zero economy needs to be frontloaded. The CCC estimates that annual low-carbon investment in the UK needs to grow five-fold from around £10 billion in 2020 to £50 billion by 2030, and continue at around that level through to 2050 (CCC, 2020). The private sector is expected to finance most of the transition as businesses, consumers and other actors decarbonise (CCC, 2022). Unlocking private sector investment is especially important in the current environment where the UK's public finances are severely constrained. However, the recent turmoil in government has created significant policy risk and lost opportunities for working with the private sector on net zero, likely deterring investment by UK businesses and by investors into UK businesses. Even before the latest developments in government, businesses had warned of a 'cost of doing business crisis' as the impacts of higher energy bills were being felt on top of the volatility and change due to Brexit and COVID-19 (Barnes et al., 2022). Furthermore, a series of recent announcements and proposals that have created mixed signals on net zero may blunt the investment signal that needs to remain focused on the longer-term transition. These include lifting the moratorium on fracking (which has now been reversed), the blocking of solar PV on farmland (the status of which is unclear given the change in Prime Minister), and a decision to maintain the effective ban on new onshore wind (shortly after plans to lift it were announced under the former Prime Minister).

Credible policy will be critical to bring down the cost of capital, overcome barriers such as capacity, and leverage as much private sector investment into the transition as possible. This will include ensuring that the expected reform of the energy market design presents an attractive case for investment into low-carbon solutions and enabling smart regulatory frameworks that support investment into known solutions and into innovation in new technologies, business models and processes. It is worth emphasising that it is not the absence of regulation that has greater potential to drive markets and growth, but rather the presence of smart regulation that is responsive to emerging developments. For example, Cael and Dechezleprêtre (2016) demonstrated that environmental regulations can induce innovation in low-carbon technologies. Furthermore, government policy and regulation will have an especially important role for enabling its commitment to make the UK the world's first net zero-aligned financial centre. An overall

systematic approach to finance, setting out how the UK government will reverse the consequences of the recent economic turmoil, absorb financing costs and manage and share risk will be needed if the UK is to deliver the investment required in this decade.

The UK has already positioned itself as a leader in green finance (Curran et al., 2022a) and its financial sector can support a just and inclusive transition to net zero through many possible channels. Financial institutions increasingly recognise that they have a key role to play in responding to the distributional and workforce challenges of net zero, and leading banks and investors are adopting policies to support a just transition to decarbonisation, for example through the Financing a Just Transition Alliance (Robins et al., 2021). Building on these commitments, banks can support the delivery of the just transition in the real economy by supporting their clients and reviewing their portfolio of financing products and services to ensure that they contribute to achieving net zero in a socially inclusive manner (Curran et al., 2022b). Banks can also innovate and develop products that support all client groups through a just transition. But they also face a number of challenges, notably with regards to decarbonising their mortgage books in a just manner (ibid.). Although there has been a recent emergence of green mortgages and green retail savings and investment products, banks need to overlay these emerging products with consideration of the social implications and affordability.

At a workshop recently conducted by the LSE on decarbonisation of the housing sector, we found that mortgage providers represent 11 million out of the 29 million households in the UK. To meet net zero goals in the housing sector, an inclusive approach is vital to encourage outright owners of housing to re-enter the market with attractive financial products that incentivise energy efficiency measures. A number of practical initiatives exist that are smart, collaborative and people-centred, such as the London Rebuilding Society and CosyHomes in Oxford, but these pilots need to be scaled up to deliver net zero in a pro-growth, pro-business manner through the just transition.

There are steps the Government can take to support the financial sector in decarbonising the housing sector:

- **Addressing the social risks of Energy Performance Certificate (EPC) league tables:** The Government needs to send consistent policy signals that encourage a socially inclusive transition to net zero. The EPC league tables might operate counterproductively to this objective and have unintended consequences that restrict banks from acting in an inclusive manner. In particular, given the tables encourage mortgage providers to factor EPC ratings into lending decisions, there might be a risk for those financially unable to make improvements to become 'property prisoners'⁶ in non-energy-efficient homes that become un-mortgageable and unsellable.
- **Implementing public finance schemes to build the supply chain:** Building an efficient supply chain for low-carbon housing solutions underpinned by firms delivering high quality output and a skilled workforce is vital to gaining the confidence of consumers looking to invest in retrofitting their homes. Although public finance for retrofits through social housing contracts is useful, the trickle-down results have so far been insufficient to meaningfully expand the sector. This outcome can, however, be achieved through large-scale, continued grant schemes. For instance, the Green Homes Grant was ultimately unsuccessful because of the short-term nature of the funding which did not give small retrofit providers the confidence to scale up production. Extending the scheme to function as a multi-year programme could have enabled the sector to build up effectively.

⁶ Homeowners who are trapped in their current mortgage and unable to switch to a new mortgage have been dubbed 'mortgage prisoners'. In the case of net zero pathways, property prisoners refer to people who cannot afford to upgrade their homes to reach expected EPC ratings required by regulation (normally above EPC rating 'C').

Question 5: Where and in what areas of policy focus could net zero be achieved in a more economically efficient manner?

The objective to meet the UK's net zero target in a more economically efficient manner draws special attention to carbon pricing, although this needs to be complemented with a broader package of policies and regulation to address challenges that are unique to each sector (Burke et al., 2019; GRI and ESC, 2022). Where the UK already has carbon pricing policies, a target-consistent approach is required. A target-consistent approach refers to setting the price of carbon with the explicit objective of determining the price pathway that cost-effectively reaches an agreed emissions or temperature target (see High-Level Commission on Carbon Prices, 2017; Stern et al., 2021; Kaufman et al., 2020). The UK ETS already is and will remain a key policy for pricing carbon to drive emissions reductions in a cost-effective way in the sectors it covers. Now, the emissions cap under the UK ETS needs to be adjusted to be fully consistent with the pathway to meet the UK's carbon budgets, its Nationally Determined Contributions and its net zero target by 2050. The UK ETS Authority has already consulted on aligning the UK ETS cap and trajectory with the UK's net zero target and is currently developing its final position on these issues. This effort to reinforce the role of the UK ETS as a key driver of net zero needs to happen in conjunction with consideration of the distributional impacts of the proposed changes, as discussed in Question 2.

Explicit pricing of carbon is only one of the levers to drive emissions reductions. In reality, the UK has a complex mix of policies (including taxes, subsidies, standards and regulations) which give rise to uneven and incomplete incentives to reduce emissions across the economy (ESC, 2018; Adam et al., 2021). Aligning the UK ETS with net zero would be most effective as part of a broader review of 'effective carbon prices' in the UK, i.e. how much a firm or an individual is paid or rewarded per tonne of carbon saved when they make a choice that lowers emissions (ESC, 2018).

Crucially, the Government needs to realise its commitment to rebalancing electricity and gas prices. Prior to the measures introduced as part of the Energy Price Guarantee, low-carbon policy costs were recovered largely through electricity bills, reducing the incentive for emissions reductions that could be achieved through electrifying heat and transport demand. In contrast, carbon emissions in residential gas use are not priced. The current period, in which low-carbon policy costs will be temporarily recovered from general taxation instead of from energy bills, can be used to provide longer-term clarity on this issue. Funding low-carbon policy through general taxation rather than household energy bills has been highlighted in the literature as likely being a fairer system (see Owen and Barret, 2020; Owen et al., 2022) and is also the approach recommended by the CCC (2022). While fairness should remain at the top of the agenda, the Government will need to ensure that relative prices actively incentivise low-carbon choices and ultimately make heat pumps cheaper to run than gas boilers. This can be achieved as part of the broader rethink of energy pricing in the UK that has already started, in conjunction with measures that will make low-carbon choices available to all, such as supporting households (low-income households in particular) to make the upfront investment in switching to heat pumps (CCC, 2022).

In addition to the major role for carbon pricing, achieving net zero in an economically efficient manner requires doubling down on energy and resource efficiency (discussed in more detail under Question 6 below).

Question 6: How should we balance our priorities to maintaining energy security with our commitments to delivering net zero by 2050?

Maintaining energy security and delivering net zero by 2050 are complementary rather than conflicting priorities. This was recognised in the UK Government's own *Energy Security Strategy* which stated that accelerating the nation's progress towards net zero "is fundamental to energy security" (BEIS and No. 10, 2022). One strategic action that can contribute towards both priorities is using energy more efficiently to reduce the overall demand for energy. This can be done by: (i) reducing energy waste; and (ii) adopting energy efficiency measures.

Immediate reductions in energy waste can be achieved with action across society such as turning off lights when not in use, using alternatives to the car, or driving more slowly (CCC, 2022). As these actions would only target *unnecessary* consumption of energy, they would not cause hardship among society, but they would require public awareness and coordination. In September 2022, the Climate Change Committee and the National Infrastructure Commission wrote to the Prime Minister recommending that the Government provide and promote a comprehensive energy advice service, observing that public awareness of what can be done to reduce energy use (either in homes or businesses) is too low (CCC and NIC, 2022). Many of these actions are low- or zero-cost and can lead to savings straight away, such as lowering boiler flow temperatures, which alone can reduce gas consumption by 6–8% (ibid.).

Countries across Europe are already actively encouraging their citizens to take energy saving measures, from keeping down household heating levels to moving appliance usage to off-peak hours (O'Carroll et al., 2022). In contrast, the UK government has been generally reluctant to include behaviour change as part of its efforts to maintain energy security or cut emissions, despite the current energy crisis, as seen in the initial blocking of a proposed public information campaign on energy saving (although this decision appears to be reversed [Vaughan and Gartside, 2022]) and the withdrawal of a report on behaviour change initiatives that was intended to accompany the Government's *Net Zero Strategy* (Laville, 2021), respectively. Given the strong environmental, economic and social case for avoiding energy waste, not engaging the public in this effort in a meaningful way appears counterproductive. Net zero is ultimately a complex transition, creating a strong case for the Government to focus on providing information and advice to households and businesses to help them navigate it. Lessons on effective ways of encouraging public behaviour change could be taken from the experience from the COVID-19 pandemic (House of Lords Environment and Climate Change Committee, 2022).

While the Government is rightly focusing on the affordability of energy to support households through the current cost of living crisis, increased support for investment in energy efficiency measures is needed at the same time, to shield households and businesses from the continued impacts of the current crisis, as well as potential periods of similarly high energy costs in the future. Upfront costs continue to pose a barrier to the uptake of energy efficiency improvements, although it is estimated that 63% of UK homes would need no more than £1,000 for retrofitting energy efficiency measures (CCC, 2020). Sustained high fossil fuel prices would actually make deeper energy efficiency retrofits more cost-effective (CCC, 2022). In fact, according to Lord Deben who chairs the CCC, even the post-summer period may not have been too late to start insulating homes for the upcoming winter, and measures to do so would attract cross-party support (Harvey, 2022).

Post-2013 policies on energy efficiency have repeatedly fallen short of what is required to meet the UK's climate targets, as recently seen with the failure of the Green Homes Grant, the insufficient commitments made in the Heat and Buildings Strategy, and the disproportionate focus put on supply- over demand-side measures in the *British Energy Security Strategy*. In fact, analysis by Carbon Brief suggested that UK gas imports would have been 13% lower if government support for energy efficiency and renewables had continued, rather than being rolled back by successive Conservative-led governments since 2013 (Evans, 2022). There are some existing policies and investments that can help to drive the uptake of energy efficiency going forward (including the various schemes under the Help to Heat funding and the VAT cut for

energy saving measures), but a more credible and long-term strategy is needed to make UK buildings across public, rented and owner-occupied sectors more energy-efficient. This could include expanding the Energy Company Obligation even further to include more households – a move that the industry has already expressed its support for (APPG for the Environment, 2022a) – as well as further funding and better targeted support for low-income households more generally.

In addition to demand-side measures to make energy use more efficient, maintaining energy security in a way that is consistent with achieving net zero emissions by 2050 will require changes to the UK's energy supply mix. Transitioning towards clean energy sources, including renewables and nuclear, will benefit energy security as well as climate goals, as it can contribute to reducing the UK's exposure to volatile fossil fuel prices (CCC, 2022). These sources are also more cost-saving now than previously, as the high prices of fossil fuels tilt relative prices in their favour (ibid.). Electrification (e.g. through the adoption of heat pumps and electric vehicles) is a major part of the transition away from fossil fuels. The CCC's balanced pathway to net zero brings a 50% reduction in fossil fuel consumption by 2035 and a significant reduction in total use of energy as a result of mass electrification, investments in buildings insulation and more efficient industrial processes. Similarly, the UK Energy Research Centre anticipates energy savings of almost 40% at the point of consumption under an electrification scenario for heating in buildings, largely due to the higher efficiency of heat pumps compared with gas central heating systems (Stewart et al., 2022).

If the stop-start nature of energy efficiency policy so far is replaced with a credible, long-term strategy, there may also be growth opportunities for the UK supply chain from the expanding domestic and global markets for low-carbon heat and efficiency. Analysis from the CEP and the Grantham Research Institute has shown that the UK is not currently a competitive exporter or innovator of products relating to heat and buildings overall, but it does specialise in several specific products such as heat pumps and insulation equipment (Curran et al., 2022a).

While a longer-term view of the UK's supply mix is necessary, and a wide range of options should be considered – along with the trade-offs they bring on the many economic, social and environmental priorities that need to be balanced – this should not happen at a time and in a way that risks undermining the investment signal towards low-carbon energy sources. In particular, it is well-established that fracking will not help with the current energy crisis (APPG for the Environment, 2022b) and the proposed restrictions of solar panels on farmland would at most have a minimal impact on food security (Mercer, 2022). Furthermore, production from the UK continental shelf is likely to decline over the coming decades (as assessments by the UK Oil and Gas Authority suggest) and the UK would still be highly dependent on imports of natural gas if consumption remains at current levels (Ward, 2022). Therefore, accelerating the development of the UK's domestic low-carbon energy sources appears to be a better focus than a renewed push for oil and gas exploration in the North Sea – not just for meeting the UK's net zero target but also for maintaining energy security.

The need for an accelerated shift to low-carbon energy is reinforced from a global perspective in recent analysis by the International Energy Agency (2022), which concludes that there is scant evidence to believe that climate policies have contributed to the run-up in energy prices: on the contrary, the analysis suggests that in the regions most affected by the ongoing crisis, higher shares of renewables were correlated with lower electricity prices, and more efficient homes and electrified heat have provided an important buffer for some (but far from enough) consumers (IEA, 2022).

Question 7: What export opportunities does the transition to net zero present for the UK economy or UK businesses?

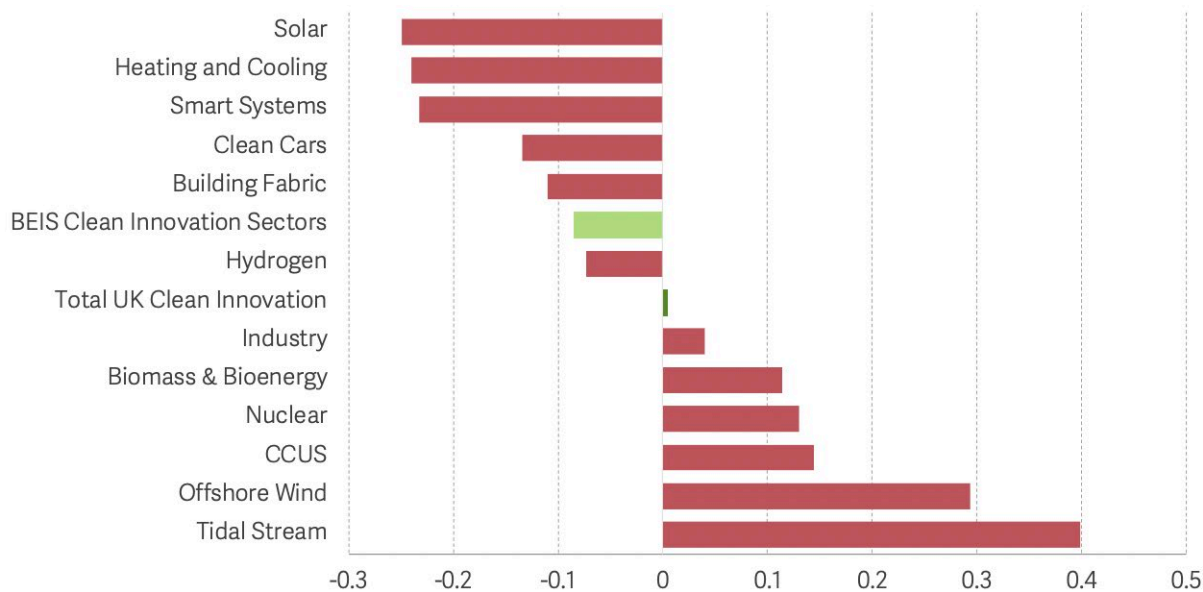
Recent work by the CEP, Grantham Research Institute and the Resolution Foundation has assessed the opportunities presented for the UK by the move to net zero, considering its pre-existing strengths in technologies, products and services that are relevant for the transition (Curran et al., 2022a).

The UK accounts for 2.5% of the global export volume of 'green' products, ranking ninth globally. The UK's share is similar to France, but significantly lower than China, Germany and the US (at 19%, 13% and 10% respectively). The green products that the UK is specialised in include a number of complex and more technologically sophisticated ones, which tend to be associated with higher future growth and diversification outcomes. Furthermore, among the green products in which the UK does not currently have comparative advantage, there are areas of opportunity as a number of complex products match the UK's existing capabilities relatively closely – including in renewable energy and environmental monitoring equipment.

The UK has innovative specialisation (measured by its comparative advantage in patenting) in clean technologies overall but ranks fifteenth globally on this measure, behind countries including Germany and France. The UK appears to be lagging behind on patenting intensity as well. Over the period 2015–2018 it produced over 10 clean patents per 100,000 workers, while Denmark, South Korea and Japan produced around four times as many. There is, however, significant variation in clean technology specialisation beneath these overall numbers.

Within the broad category of clean technologies, the UK is particularly specialised in offshore wind, tidal, nuclear, CCUS and bioenergy technologies (see Figure 2). Importantly, the expected 'national' returns from government support for innovation – including private returns for the innovator as well as direct and indirect knowledge spillovers for other UK innovators – are particularly high for tidal and offshore wind energy technologies. These both have estimated returns of nearly three times the average across all technology fields studied (including AI and robotics). This means that government support for these technologies is particularly likely to generate value that is retained in the UK.

Figure 2. Revealed technological advantage by selected clean technologies: UK, 2015–2018



Notes: Revealed Technological Advantage for the categories in Martin and Verhoeven (2022). Category 'clean cars' added. Total UK Clean Innovation refers to all patent families under the CPC class 'Y02'.

Source: Curran et al., 2022a: analysis of PATSTAT 2021, Autumn edition.

Looking at trade and patents data in combination reveals further insights on a number of key technology areas that are relevant for the UK's transition. While the UK has innovative specialisation in offshore wind, it is not yet a specialised exporter of wind-related products. Commitments to ramp up domestic deployment of wind power in the UK might generate new opportunities, including the potential to pioneer and export capabilities in floating offshore wind.

CCUS and nuclear are areas where the UK is specialised in both the exports of products, and innovation. CCUS, still limited in commercial application globally, can benefit from the UK's transferrable expertise and capabilities in oil and gas.

By contrast, on aggregate, the UK does not have comparative strengths in goods or technologies relating to clean cars or smart systems. But it does have digital strengths not fully captured in such data which apply across both of these areas, for example in the development of connected and autonomous vehicles or smart grids.

Finally, heat and buildings (encompassing heating and cooling technologies and building fabric) is an area in which the UK does not yet have comparative advantage overall, but is specialised in specific products (including heat pumps and insulation) that are highly relevant for decarbonising its building stock and where large-scale domestic deployment could generate new economic growth opportunities.

A broader view of the net zero economy using data from The Data City shows that the UK is heavily specialised in services relevant for net zero, including in sustainable finance, with around half of the 20,000 UK firms identified as specialising in clean activities being in the service sector. The largest single sub-category, representing nearly 40% of these firms, relates to demand-side management and digital, which includes AI and Internet of Things for energy management and smart systems, highlighting the interplay between clean technologies and digital technologies.

Questions for local government, communities and other organisations delivering net zero locally

Answers in this section are prepared on behalf of the Place-based Climate Action Network (PCAN), an ESRC-supported network that brings together the research community and decision-makers in the public, private and third sectors, with a focus on translating climate policy into action ‘on the ground’ in local communities. The Grantham Research Institute at LSE is among the host institutions of PCAN alongside the Centre for Sustainability and Environmental Governance at Queen’s University Belfast, the Edinburgh Centre for Carbon Innovation and the University of Leeds.

Question 24: What are the biggest barriers you face in decarbonising/enabling your communities and areas to decarbonise?

One major challenge to local decarbonisation efforts is the often missing intermediary layer (between local and national actors) to share knowledge on how to develop and consolidate decarbonisation project and programmes, match them to different forms of finance, and then share lessons with others to replicate. Strong evidence suggests that unlocking climate finance this way would both enable decarbonisation and deliver local environmental, economic and social benefits and generate effective financial returns (for example, see Innovate UK, PwC, Otley Energy and University of Leeds, 2022). While the world’s leading cities can typically afford to commission multi-disciplinary companies to support them through this process, the vast majority of places do not have access to the level of development capital required.

Question 25: What has worked well? Please share examples of any successful place-based net zero projects

The table below summarises a number of best practice case study projects that have successfully mobilised private finance towards local net zero interventions. Further details are provided in PCAN and Jacobs (forthcoming).

Project name	Description
Queens Quay Energy Solution	The Queens Quay Energy Solution, commissioned by West Dunbartonshire Council, is a water source heat pump and thermal store in Glasgow. A council-run energy company has been set up to operate and manage the system.
Thames Tideway	The Thames Tideway Tunnel is a 25km sewer tunnel running under London. It is the largest water infrastructure project ever undertaken in the UK and pioneered a new approach to using private investment to finance public infrastructure.
United Downs Geothermal Project	The United Downs Geothermal Project is the first geothermal power plant in the UK. It was funded using a combination of public and private finance, and the authority took a strategic enabling role.
Mayor’s Energy Efficiency Fund (MEEF)	The MEEF is a £500m initiative set up by the Greater London Authority to fund energy efficiency projects across London. Multiple banks have contributed capital and have agreed some pre-set thresholds enabling streamlined allocation of funds into multiple different project types.
Kirklees Warm Zone	The Kirklees Warm Zone project is one of the largest domestic retrofit projects to have been completed in the UK, insulating over 51,000 homes, including those under private ownership. The case study provides insight into how to secure the buy-in of communities.
Bristol City Leap	Bristol City Leap is a joint venture between Bristol City Council, Ameresco and Vattenfall. £424m in investment has been committed to delivering low-carbon infrastructure for the city in the next five years, with the total investment expected to reach over £1bn.

Source: PCAN and Jacobs (forthcoming)

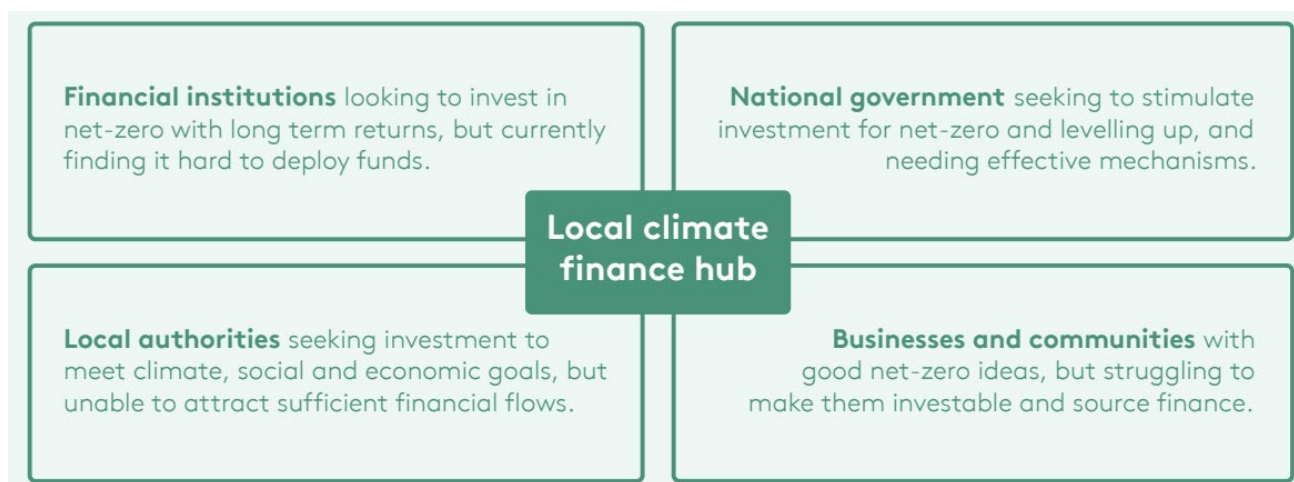
Question 27: How can the design of net zero policies, programmes, and funding schemes be improved to make it easier to deliver in your area?

There is a disconnect between the UK’s highly global capital markets and the bottom-up needs of its localities and regions. It is the Government’s role to lead the efforts to bridge this financing gap, using policy instruments and public finance initiatives to build a cohesive ecosystem to encourage place-based investments that are well-designed to deliver local impacts. This will need to channel private finance to local authorities to financially support net zero projects from ideation to delivery.

This form of cohesive ecosystem exists in the US, and it has enabled financial services there to reap viable returns while driving positive and meaningful local impact. The US Government played an important role in this through public policy subsidies and major legislative and regulatory changes, and by enabling blended finance models (Metro Dynamics and the Impact Investing Institute, 2021). These blended models use public subsidy, whether that is direct investment or tax incentives, to effectively catalyse private investment in projects aligned with community need (ibid.). All of these mechanisms have contributed to the private sector’s appetite in the US to grow as local opportunities for investment have developed.

Local climate finance hubs are a similar avenue available to the UK government to facilitate broad access to green finance for local communities. Local authorities and other place-based actors have a wealth of potential projects but find it difficult to develop and aggregate these to attract finance. What is missing is the ‘middle layer’ that can develop and consolidate projects and programmes and match them to different forms of finance. The national government and regulators can take several actions to overcome this disconnection between financial markets and the needs of localities. PCAN proposes to establish a network of local climate finance hubs around the UK to pilot, evaluate and enable rapid scale-ups of the practical steps needed to bridge these gaps. These platforms would support the development of programmes to meet the needs of local and national governments, communities and investors, as shown below (Robins et al., 2021).

Figure 3. Stakeholders of local climate finance hubs



Source: Robins et al., 2021

To be effective, these hubs should be locally embedded through place-based nodes to develop and maintain a pipeline of high quality, high impact projects informed by a deep knowledge of local opportunities, needs, capabilities and capacities and the benefits that can be realised from place-based projects; and centrally connected to expertise, knowledge and networks for finance and investments. This central hub can aggregate place-based projects into programmes and articulate them as investable proposals to connect to appropriate sources and models for investment.

The UK Government should consider how to support the formation of these hubs to build the necessary capability and capacity in local places to build a pipeline of low-carbon projects which can support private finance to deploy capital in a place-based, just and inclusive transition to a net zero economy.

Figure 4. The role of local climate finance hubs



Source: Robins et al., 2021

Questions for academia and innovators

Question 29: How can we ensure that we seize the benefits from future innovation and technologies?

This would require an innovation-led transition to net zero to be embedded in the UK's new economic strategy. Net zero is not a silver bullet for reversing the UK's stagnant living standards, weak productivity, low investment or large-scale inequalities across and within regions. Indeed, domestic implementation of climate policies and targets will not automatically lead to economic benefits or the equitable sharing of these benefits and costs. To achieve this, climate policies must be embedded in a new economic strategy for sustainable and inclusive growth.

As our analysis has shown, while the UK is well-placed to gain economic benefits from clean technological innovation, it is not yet the world leader, and it lags behind some of its comparators such as Germany and France in this area (Curran et al., 2022a). Other countries are increasing their commitments to net zero and related investments, for example as seen in the Inflation Reduction Act in the US. To maximise the chances that the UK benefits from future growth opportunities associated with the net zero transition, it must be embedded in a coordinated and system-wide policy approach to growth that stimulates increased and well-targeted investments across innovation, infrastructure and skills.

Given the current economic climate, and evidence from previous downturns, there are risks that company investment in innovation will suffer, particularly for those facing financing constraints (including SMEs). In this context, increased support for innovation (for example, via stronger tax incentives), potentially enhanced where it can be directly relevant for the transition to net zero, might be required. Given the strong economic rationale for government support for R&D (underpinned by the presence of innovation spillovers), and the strength of the UK's university research base, more could be made of the role of publicly financed R&D in achieving net zero, since research councils and funding bodies can and do emphasise decarbonisation as a key objective. In order to maximise spillovers from university research into industry, there is also a role for policies to improve the incentives for university-business collaboration and more focus on the role of the further education sector in providing the appropriate technical knowledge to enable the diffusion and commercialisation of ideas.

R&D and investment in innovation more broadly (including investment in other intangibles such as branding, design or organisational capabilities) are key to restoring productivity growth in advanced economies such as the UK (Bloom et al., 2019). There is strong argument to sustain the public R&D budget, and even consider increasing the current overall 2.4% target, despite the suggestion that this has already been met due to data restatements (Martin, 2022a) and difficult decisions on spending cuts expected to be detailed in the fiscal plan announcement on 17 November 2022 (Valero and Van Reenen, 2022). Public investment into R&D is particularly valuable given its role in generating spillovers into the private sector (Bloom et al., 2019), and our research has shown that the spillovers in clean technologies appear to be particularly high (Curran et al., 2022). Data from the IEA suggests that publicly funded energy R&D in the UK is currently lower as a share of GDP than it was in 1980, and that recent increases were driven by nuclear rather than renewables (see Martin, 2022b, Figure 2).

The benefits of increased support for innovation can be enhanced with parallel support for and investments in developing net zero capacity within the UK workforce. Worker and managerial skills are important for translating research and development activity into marketable products, for net zero and more broadly (Oliveira-Cunha et al., 2021). The UK has long suffered various skills shortages (particularly with respect to mid-level technical skills), many of which have intensified since COVID-19 and Brexit, and the UK lags in management quality overall, which fosters innovation. Skills support can be in the form of human capital tax credits which would incentivise investment in workforce training by offering tax relief to financially constrained firms (in a similar way as existing R&D tax credits) (Li et al., 2021; Costa et al., 2018).

Question 30: Is there a policy idea that will help us reach net zero you think we should consider as part of the review?

Net zero requires economy-wide change that can only be delivered with an all-government effort, with every department equally committed to this overarching objective. Sridhar et al. (2022) identify coordination, mainstreaming and oversight among the core governance functions that need to be considered by any state preparing to meet the challenge of climate change. There is a strong case for the UK to develop institutional capacity within government that focuses explicitly on performing these functions. Here, coordination refers to facilitating collaboration of vastly disparate entities both horizontally – across ministerial portfolios including energy, transport, infrastructure, agriculture and waste management systems – and vertically – along national, regional and local levels. Mainstreaming, on the other hand, refers to the gradual process of bringing climate considerations into the workings of traditionally non-environmental sectors, while oversight ensures any gap between design and implementation is closed through effective monitoring. In line with these functions, the Government should be active in identifying where existing law and regulation can actually be understood as a barrier to climate action and propose reforms accordingly. The proposals under the Better Business Act are a good start for this, but there is more that could be done.

Central coordination and oversight of the transition to net zero can not only ensure that every government department is doing its fair share towards the transition to net zero but can also prevent any policies that would unintentionally undermine the transition from being put forward. Such central coordination and oversight could be performed by the Cabinet Office or by a Cabinet-level committee. This would also be in line with the recommendation from the Climate Change Committee (2022) addressed to the Cabinet Office and Number 10 that all policies, funding and delivery mechanisms are properly aligned to the pace of transition required and work together constructively towards net zero, for example through introduction of a Net Zero Test.

More generally, strengthening the institutions around (green) industrial or growth policy would be a way to ensure that economic opportunities are being captured in the UK, with the required coordination and longevity. It would be possible to do this by building on the type of approach taken with the Industrial Strategy Council, and as recommended in the LSE Growth Commission (2017).

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