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Reimagining the UK's Net-Zero Strategy

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Our Future of Britain initiative sets out a policy agenda for governing in the age of AI. This series focuses on how to deliver radical-yet-practical solutions for this new era of invention and innovation – concrete plans to reimagine the state for the 21st century, with technology as the driving force.

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Executive Summary

The United Kingdom was the first major economy to set into law the commitment to reach net zero by 2050. This was a significant moment of statecraft and global leadership that helped galvanise more than 140 other countries to commit to their own net-zero targets. But the case for rapid action and ambitious targets has been effectively made. It is time for the UK to demonstrate leadership by action. The ambition – both in the UK and globally – must now be towards accelerating delivery.

This is a moment for a clear-eyed assessment of what is really required to tackle climate change. There are two major challenges that a UK net-zero strategy must consider.

First, climate change is a global problem that requires global solutions. The UK is currently responsible for less than 1 per cent of global emissions. Even if the UK is reducing its domestic emissions, there is a significant global emissions challenge that needs to be grappled with.

Indeed, since the Climate Change Act was introduced in 2008, the picture of where emissions come from and where they are growing has changed dramatically. While emissions are decreasing in Europe and the United States,

those in many developing economies are increasing at a rapid pace. To tackle climate change, the real challenge is therefore to accelerate the energy transition in developing countries.

Second, while the UK has been very effective in achieving rapid emissions reductions to date, delivering the next noteworthy reductions will be far more difficult. It will involve decarbonising buildings, transport and industry; fully decarbonising the electricity grid using intermittent renewables as demand increases; and spurring the transition in agriculture and land use. The current strategy is not up to these challenges, and we are not on track to achieve our goals.

The UK should continue to meet its climate commitments, of which existing targets are a crucial part. But our focus needs to shift from targets for domestic emissions to developing the technology that can help to deliver the transition globally. Right now, the focus primarily on UK targets is distorting policy without either creating the infrastructure capable of meeting those targets or acknowledging the fact that the challenge in climate policy today is the energy transition in developing countries.

The UK's current delivery gap exists because the focus to date has centred on setting increasingly more stringent technology-specific targets without sufficient consideration of the supporting policies that would need to be implemented to achieve them. This has left the UK with a number of sectoral targets that look increasingly unachievable – for example, we must add 3.5 times more electricity-generation capacity than has been added since 2010, double the capacity of the electricity grid and increase the number of heat pumps installed per year by 23 times – and all by 2035.

This delivery gap sits against a backdrop of declining public support in the UK and European Union for imposing significant financial costs to citizens associated with decarbonisation and increasing mistrust that government will achieve the existing targets with current policy.

It is important for the UK's net-zero strategy to wrestle with the challenge of delivering decarbonisation without sacrificing broader social and economic goals. This would be undesirable for the country's future, would hurt public support for climate action and could set a damaging precedent internationally. The economy, and ultimately the climate, are not served by setting unrealistic targets that we don't meet.

To actually deliver net zero, in the UK and abroad, we therefore need to recalibrate our strategy towards what really matters. While it is right to have ambitious targets to reflect the ambitious action needed, we need to shift focus away from setting additional sectoral and technology-specific targets, instead orienting towards accelerating delivery.

This will involve restructuring government strategy and policy to alter the incentives in society and create the conditions for clean technologies to thrive over fossil fuels in a way that aligns with desired social and economic outcomes.

Innovation in technology and business models is ultimately the route through which we can contend with the domestic and international dimensions of the challenge to deliver net zero.

Technological development and innovation have led to some of the greatest success stories in recent history. The cost of producing electricity using solar has fallen by 89 per cent in ten years, meaning it is now the cheapest source of energy almost everywhere. Battery costs have fallen by more than 97 per cent in the past three decades.[1] The result is that solar and batteries are now cost-competitive with coal plants in countries like India and are set to become cheaper than natural-gas plants in the US and new coal in China. At the same time, breakthroughs are now happening at an even more rapid pace, aided by artificial intelligence.

However, there is still much to be done – from developing cost-effective low-carbon solutions for long-duration storage to scaling sustainable aviation fuels. The UK should set its sights on developing the next generation of climate solutions and encouraging their adoption across the world.

Our strength as a country in the fight against climate change does not solely lie in our own emissions reductions; it also lies in the spillover effects our actions could produce. A radical approach to unleashing technological innovation and driving its adoption across the globe involves more ambition from both the UK and the world, not less.

Not only is this a more practical and realistic approach to net zero, it also comes with a considerable potential economic opportunity for the UK. With more than $1.8 trillion[2] being spent on the energy transition globally last year – a number that is growing rapidly year on year – the UK could reap crucial

economic advantages from leading innovation and fostering future clean-technology companies.

This requires an update of the underpinning strategy and policy landscape for the delivery phase:

1. **Enhancing the UK's net-zero legislation for the delivery phase** to align with clean-technology innovation, consider whole-system impacts and drive international delivery.
2. **Improving coordination and responsiveness of government delivery** to make government a platform for clean-technology innovation and delivery. This should include a dedicated net-zero team at the centre of government and widening the role of the Climate Change Committee (CCC) to include a longer-term mandate that includes the identification of clean-technology opportunities.
3. **Creating the conditions for transformative climate R&D** by aligning innovation funding with how innovation happens and supporting commercialisation, treating data as a competitive asset and setting up a new AI and materials-science national laboratory.
4. **Reforming regulatory regimes** to enable innovation in clean technology and make the regulatory system more agile and responsive to technological change.
5. **Using government funding and regulatory powers strategically to create and shape the markets for clean technologies** by updating the retail and wholesale energy markets to align with the physics of the system and technologies, and introducing new tailored market-shaping and funding schemes.
6. **Increasing UK climate leadership globally** by leading international cooperation on research and innovation and instigating deployment and innovation of clean technology everywhere for maximum impact.

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The Current Approach and the Challenge Ahead

The 2008 Climate Change Act still stands as a defining moment in the UK's net-zero strategy. It set out emission-reduction targets for the entire economy, starting with an ambition of an 80 per cent reduction by 2050. Then, in 2019, the government upped the ambition: net zero by 2050.

The Climate Change Act requires the government to set legally binding "carbon budgets" to act as stepping stones towards the 2050 target. The carbon budgets are broken down into five-yearly reduction caps that the UK is legally required to implement policies to meet. Government decisions that are likely to result in missing a budget could be subject to judicial review. Carbon budgets are set at least 12 years in advance to allow policymakers, businesses and individuals enough time to prepare. The country is currently on its fourth carbon budget, covering the period from 2023 up to 2027. Preparing and presenting plans for how to meet the carbon budgets is the responsibility of the Secretary of State for Energy Security and Net Zero.

The Climate Change Act also established a new advisory committee – the Climate Change Committee (CCC) – tasked with providing advice on setting and meeting the carbon budgets.

The framework for delivering emission reductions set out in the Climate Change Act has been critical in creating long-term certainty around the direction of travel towards an emission-free economy. The legislation has had a valuable signalling effect for industry, propelling investment and focus on net zero, and has been an instrumental lever in shifting the incentives for the state itself. This has meant that to date, the UK has been highly effective in meeting the established carbon budgets. It is the first G7 country to reduce emissions by 50 per cent on 1990 levels and has developed an international reputation as a climate leader.

However, even if the approach so far has worked well, it does not mean that the framework is sufficient to deliver the transformative changes that are needed over the next few decades.

There are, broadly speaking, two core challenges that require a refreshed net-zero strategy: the domestic political and economic challenge associated with meeting the tough targets ahead with current policy and technology, and the challenge of tackling increasing global emissions, particularly in developing countries, which the domestic targets don't address.

THE POLITICAL AND ECONOMIC CHALLENGES

The UK's emission reductions to date have been relatively painless. The measures taken to meet the emissions budgets thus far haven't greatly impacted consumers or come into conflict with wider government aims. But the next set of carbon budgets will involve far greater challenges.

The fifth carbon budget, set before the 2050 net-zero target was introduced, requires an emissions reduction of 57 per cent by 2032. The sixth carbon budget, the first set after the 2050 ambition was increased to net zero, covers the period from 2033 to 2037. This budget requires a 78 per cent reduction in UK territorial emissions between 1990 and 2035, which represents a 63 per cent reduction compared with 2019 levels. The sixth carbon budget also includes international aviation and shipping emissions for the first time. In addition, the UK has committed to an international target, its nationally determined contribution (NDC), of 68 per cent by 2030.

The targets set in the sixth carbon budget will be far more challenging to meet than those in previous budgets. An outline of the CCC's assumptions within the main "balanced" pathway for achieving the sixth carbon budget can be seen in the box below. The lower-hanging fruit of decarbonisation have already largely been picked, and the next phase will involve decarbonising challenging sectors such as the UK's old and poorly insulated housing stock, the manufacturing sector, and food and agriculture – all sectors that have largely been left to operate as usual until now – and full decarbonisation and integration of the power sector. The Tony Blair Institute (TBI) highlighted the scale of the delivery gap in the paper *Powering the Future of Britain*.

This next more challenging phase throws up several political and economic challenges for the UK. First, asking individuals and businesses to change their way of life against their will or invest significant amounts of their own money in new technologies that they do not want may cause public backlash. It's important to be honest: the transition will involve change and cost to individuals. But individuals are more likely to understand and agree to bearing

these costs if they comprehend their benefits and they trust that government will support them and be able to deliver those benefits. We've already seen this play out in Germany with public opposition to and an eventual government U-turn on the gas-boiler ban,[3] and across Europe with the farmers' protests.[4] People will have the final say on the net-zero transition, so without a plan to address these concerns progress is likely to halt.

Second, the government is currently operating within a constrained fiscal environment, and unless undertaken in a considered way, rapid decarbonisation could jeopardise economic competitiveness and reduce, rather than bolster, energy security. For instance:

- Using subsidies to reduce the risk of public backlash against net-zero policies without changing the underlying structure of the markets could come at a significant expense to the Exchequer and lock in the wrong solutions.
- Deploying intermittent renewables rapidly and without sufficient focus on storage solutions, frequency services, baseload power and whole-system integration could increase energy costs or reduce energy security, with major economic and social consequences for the country. This is made more challenging by increasingly affordable gas prices making non-renewable sources more economically attractive.
- Aiming to quickly reduce emissions from the power sector may result in attempts to curb power demand, when load growth can actually drive prosperity through investment in key infrastructure like data centres for AI. TBI's work with Carbon-Free Europe has already shown that most models likely underestimate future energy demand.[5]
- Decarbonising heavy industries like steel, cement or agriculture using expensive technologies could lower long-term competitiveness or increase costs of products if other countries don't follow suit.
- Replacing foreign sources of oil and gas with over-reliance on foreign sources of clean technologies displaces one security risk with another, but building supply chains elsewhere may reduce the speed of the transition.

To overcome these challenges, the government must find a way to combine the delivery of emission-reduction measures with a strategy that aligns with consumer choice and growth and prosperity for the country.

Meeting the Sixth Carbon Budget

- The CCC pathway assumes the phase-out of unabated fossil fuels in the electricity grid by 2035. This will involve adding 3.5 times more generation capacity than has been added since 2010 and doubling the transmission capacity of the electricity grid.
- For buildings, the CCC pathway requires upgrading all buildings to energy-performance-certificate standards (EPC) standard "C" over the next 10 to 15 years and for no new gas boilers to be sold after 2033. This means that by 2030, heat-pump sales must reach just over 1 million per year in new and existing homes. This involves selling almost 17 times more heat pumps than were sold in 2023, according to the Heat Pump Association. At present, the total market for boiler installations is 1.8 million annually.
- Surface-transport emissions need to reduce by around 70 per cent by 2035. This assumes a ban on new internal-combustion-engine vehicle sales by 2032 as well as a 9 per cent reduction in car miles travelled by 2035. Commercial-transport zero-emission vehicles are to make up 96 per cent of new sales of heavy-goods vehicles, buses and coaches by 2035 and almost 100 per cent by 2040.
- For aviation, the CCC pathway assumes a gradual reduction in emissions through demand management, improvements in efficiency and a modest but increasing share of sustainable aviation fuels, including through no net expansion of UK airport capacity. Non-CO2 global-warming impacts from aviation such as contrails are not included in carbon-budget accounting.
- Manufacturing and construction emissions need to reduce by 70 per cent by 2035 compared with 2018 levels. This will involve mass migration to electrification, carbon capture and storage (CCS) and hydrogen in the late 2020s and early 2030s, as well as energy-and-resource efficiency. The CCC estimates that the cost to the Exchequer of enabling these deep decarbonisation measures in a way that protects trade-exposed subsectors would be around £2 billion per year in 2030. This cost could reduce over time as policies come into force for imports, and industries are

subsequently able to pass costs to consumers rather than taxpayers at large.

- In the CCC's pathway, agriculture emissions need to decrease by 28 per cent by 2035 and net emissions from land use need to reduce by 93 per cent by 2035, compared with 2018. The CCC pathway suggests one-third of agricultural land will be freed up through changes in output and more efficient farming practices, and 21 per cent of this land is designated to sequester and reduce CO2.
- The CCC estimates that engineered emissions removals of 58 million tonnes of carbon dioxide (MtCO2) per year are required in 2050, in addition to nature-based sinks of 39 MtCO2 per year from UK land. Removal technologies like biochar, carbon-negative cement and enhanced weathering are considered as speculative so have not been included in the CCC's scenarios.
- The carbon budgets are set on the basis of territorial emissions, and they do not allow for international carbon credits to count towards UK emission reductions. But they do recognise that, if future developments allow credits to be applied to sustainable, verified, permanent CO2 removal in a clearly additional way, there would be a stronger case to allow them to contribute to UK targets.

THE INTERNATIONAL CHALLENGE

The climate does not have borders, and many countries contribute a small fraction of total emissions. The UK is currently responsible for less than 1 per cent of global emissions each year. This means that even when domestic emissions are going down, there is a significant global emissions challenge that needs to be addressed.

Until 2000, the US and Europe produced nearly 70 per cent of cumulative global carbon-dioxide emissions. However, in the past few decades, the

picture of where emissions currently come from has transformed. While the US and Europe are still responsible for the largest share of historic emissions, current emissions mostly come from other countries.

Just as the technologies of the Industrial Revolution delivered improved living standards and economic growth in developed countries, the same technologies are now fuelling growth and prosperity in developing countries.

The source of emissions has now shifted:

- Between 1990 and 2020, the EU's CO2 emissions dropped by 31 per cent. Over the same period, East Asia & Pacific's emissions have increased by 240 per cent. [6]
- In the EU and North America, CO2 emissions per capita have fallen by 35 per cent and 31 per cent respectively since 1990. By contrast, they have increased per capita in East Asia & Pacific, and South Asia by 162 per cent and 138 per cent respectively.[7]
- From 2003 to 2023, North America decreased its coal-generated electricity by 65.84 per cent. In this same period, Asia has increased its coal-generated electricity by 218.15 per cent.[8]

Emissions in Europe, and increasingly also North America, are now on a downward slope. But in emerging economies and developing countries more widely, population growth and energy demand are rising exponentially as development accelerates, with potential major implications for emissions:

- The total worldwide energy consumption of 18 billion kilowatt hours is likely to more than double and could soon reach 40 billion.
- Energy use per capita is 46 times higher in high-income countries than in low-income countries.
- Two dozen emerging economies will fuel future emissions growth. Several of these countries together could create a wave of emissions similar to the one caused by China between 2000 and 2020.

To illustrate, China consumes as much cement every two years as the US did over the whole 20th century and builds more than eight new airports every year. Other countries are likely to follow a similar path to China as they develop.

Developing countries have a right to, and will inevitably, continue to develop in their own self-interest. Curtailing development and energy consumption is not

a viable response to climate change – morally, politically or practically. The challenge for the world now is therefore to find a way to ensure this development can be clean.

A net-zero strategy that exclusively focuses on the UK's own targets therefore misses the bigger picture. Just as the UK has led the way in driving ambitious targets across the globe, now it must drive global delivery to actually solve the climate crisis. The country must find a way to combine emissions reductions at home with accelerating delivery abroad.

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The Solution Lies in Clean Technology

The solution to the dual challenges of curbing domestic and international emissions lies in the same place: driving rapid technological development and diffusion – at home and abroad.

Through leading on the technical and business elements of clean-technology innovation, the UK can create more attractive, cost-competitive solutions and mobilise the transition through market forces, making emissions reductions complementary to – and even an amplifier of – growth, prosperity and consumer choice.

In the UK this means developing more attractive consumer offers and technology solutions that deliver emission reductions that people accept or even want.

In developing countries, this means making clean technologies the more advantageous choice for development, aligning economic growth and prosperity with green choices and helping to make the finance available.

There is good reason to be optimistic that research and technological development will lead to innovative technologies that can achieve this.

The development of AI is already making accelerated innovation and decarbonisation possible. The technology is helping to optimise renewable-generation performance for weather patterns. For instance, applying machine-learning algorithms allowed Google and DeepMind[9] to boost the value of their wind energy by roughly 20 per cent. It also has the potential to improve smart controls in homes, which is predicted to be able to reduce energy consumption by 15 to 25 per cent,[10] and can make homes into virtual power plants to avoid switching on fossil-fuel generation as demonstrated by Octopus Kraken.[11] AI is also helping predict and avoid specific problems with plasma stability in nuclear-fusion reactions,[12] overcoming one of the biggest hurdles to make fusion a reality.

AI is also being applied to materials science, which is helping to accelerate

scientific discovery and progress towards new, lower-cost and abundant materials that can help decarbonise all sectors of the economy. Google DeepMind researchers recently discovered 2.2 million crystal structures – equivalent to nearly 800 years' worth of knowledge. Of these, 380,000 are stable and therefore promising candidates for experimental synthesis.[13] These materials could be used for batteries, computer chips and solar panels. The Lawrence Berkeley National Laboratory used this insight to create new recipes for crystal structures and successfully synthesised more than 41 new materials in only 17 days in their autonomous lab. Similar progress is being made within sectors ranging from carbon capture to plastics and textiles. AI is also being combined with new gene editing technologies to significantly speed up the time it takes to add new traits to crops.[14] Making crops more resilient and productive makes it possible to use fewer emission-intensive fertilisers and dedicate land to carbon-sequestration emissions.

The contributions of AI add to the suite of other technologies being developed to help decarbonise the economy. There has been rapid progress in nuclear development, with a new generation of advanced modular reactors (AMRs) being proven to effectively provide baseline energy and high-grade heat to decarbonise industrial processes. Methane inhibitors could significantly reduce methane from livestock, the largest source of agricultural emissions.

The UK needs a net-zero strategy that helps accelerate and harness this progress through policies that support the rapid implementation and deployment of the solutions being developed. By galvanising its scientific, engineering and technological expertise, the country can help move towards better solutions, reduced costs and the phase-out of fossil fuels globally. Looking towards the next phase of decarbonisation challenges, it is the power of clean technology that will have the most significant catalytic effect on addressing climate change.

The impacts of massive US investment in clean technologies through the Inflation Reduction Act tells the story: analysis from the Boston Consulting Group estimates that the investment will bring down the cost of certain clean technologies by as much as 25 per cent, while estimates from the Rhodium Group suggest that for every ton of carbon pollution reduced in the US, 2.9 tons are reduced elsewhere.[15]

The UK already has a track record of action that spurs technology development and cost reduction. The Contracts for Difference (CfD) scheme

was instrumental in driving down the cost of offshore wind globally. Action is now underway to do the same for floating offshore wind, opening opportunities globally beyond areas with shallow waters.

Other sectors have huge potential. With one of the most advanced markets for grid storage in the world and a well-advanced power system that is decarbonising using intermittent renewables, the UK also has a unique opportunity to find technological and policy solutions for grid technology and storage. The storage potential in the North Sea basin and domestic oil-and-gas expertise provide the potential for developing cost-effective solutions to CCS. We have one of the leading centres for nuclear fusion, with promising companies such as First Light Fusion, Tokamak Energy and General Fusion. We also have a thriving sector for carbon-dioxide-removal technology and platforms that could help accelerate the significant increase in removals that are needed to stay within 1.5C.

In addition, the UK's strengths in AI, biotech, fintech and advanced manufacturing could be better deployed to boost cross-sector innovation to speed up climate action. Making the leap towards greater clean-tech innovation comes with considerable potential economic opportunities for the UK and would help embed the benefits of net zero domestically.

Clean technology is widely recognised as a sector where the UK has the potential[16] to reap sizable economic benefits. As the home to a mature clean-tech ecosystem,[17] a robust innovation scene and a strong overall investment landscape, the UK could build on this strength. Last year more than $1.8 trillion was spent on the energy transition globally,[18] and that figure continues to climb rapidly year on year. The UK could reap significant economic advantages from driving innovation and fostering future clean-tech companies. According to The Data City,[19] UK clean tech currently has a turnover of £352.7 billion, the second-largest sector in its data set, estimated to potentially be worth £709.3 billion by 2027.

More than £2.9 billion of venture capital (VC) investment went into the UK's energy and power sector between 2018 and 2022,[20] and approximately $50 billion of VC funding went towards climate-tech startups globally in 2023.[21] Climate-tech projects have dominated the global VC market – accounting for 70 per cent of total VC investment in 2023.[22]

Data from The Data City and the Energy and Climate Intelligence Unit[23] show

thriving activity in the clean-tech sector, with huge potential to stimulate growth and jobs across the whole of the UK.

A more realistic and ambitious approach is possible, but it will require a reimagined net-zero strategy.

THE BARRIERS TO A NET-ZERO STRATEGY FOCUSED ON CLEAN TECHNOLOGY

Making clean-technology innovation and diffusion the core pillar of the UK's net-zero strategy will require a strategic reorientation.

Targets do not equal delivery. Nor do they necessarily encourage and drive the right action. While legal commitments and targets are critical, providing investor certainty and ensuring that the whole of society is working towards the same goals, they cannot and should not replace a longer-term focus on how to unleash more transformational change.

Currently, the politicisation of the net-zero target in the UK has resulted in an approach that is more focused on political gesturing and setting an increasing number of ambitious sectoral and technology-specific targets than delivery on the ground. The ambition to reach net zero has not resulted in policies that facilitate building the infrastructure or investing in the technology required to meet the goal.

There are three main reasons for why this has become the UK's approach – one inherent to the net-zero challenge, one defined by the political debate and one that flows from the UK legal framework.

First, the challenge inherent in striving for net zero. The changes required to deliver net zero are significant and inherently uncertain. Governments are tasked with delivering a full-scale industrial revolution, with no clear blueprint for delivery or the ability to count on technological tailwinds.

To ensure progress is made, it is tempting for governments to focus on the actions they can control – establishing sectoral targets – and hope that industry will deliver. Rather than doing the difficult job of realigning incentives and creating the conditions for transformational change, governments have set prescriptive and often technology-specific targets without putting in place the conditions that will allow the market to meet them. The legislation and institutional setup around net zero need to be amended to avoid this. Targets

must be ambitious but realistic in terms of what can be achieved; they must be directed where they will have the most impact and focus on overall outcomes rather than specific technologies. They must spur action aimed at delivery.

Second, the political. Net-zero targets have become a key political instrument, used to capture votes and attention from climate-conscious members of the public or to stoke anti-system sentiments from sceptics. On the one hand, some politicians have begun to engage in climate-target one-upmanship by introducing increasingly specific goals aimed at securing good headlines and winning political favour. On the other, those who are trying to increase doubt in government and traditional politics use unachievable targets as strawmen to stoke mistrust.

The result is shifting targets rather than focusing on how to implement them. The UK government recently delayed the deadlines for eliminating internal-combustion engines and gas boilers. Scotland has rowed back its 2030 pledges due to a combination of committing to over-ambitious targets and failing to create a conducive environment in the lead-up to the targets maturing. The result is confusion and instability, rather than boosting industry and public confidence and spurring action.

Real political leadership is required to shift the focus away from constant debate around the targets and towards the practical plans to deliver them, and also to provide a vision for how society will change in a net-zero world.

Finally, the legislation. In order to comply with the Climate Change Act, the government needs to "prepare such proposals and policies as the Secretary of State considers will enable the carbon budgets that have been set under this Act to be met".[24] However, the definition of what makes a proposal robust enough to meet the carbon budget is less clearly defined. This leaves government vulnerable to the risk of judicial review. In 2023 the government was taken to court – and ultimately defeated in 2024 – over its net-zero strategy on the grounds that it relies heavily on "unproven and high-risk technological fixes".[25] This incentivises the government to produce plans and focus its energy policy only on the levers and technologies available today, for which there is robust carbon accounting, rather than considering the opportunities of the future and structural assessment of market-creation tools. While this approach is part of the story, it does not create the conditions for innovation and future delivery.

This is compounded by the current remit of the CCC. Its role is to focus mainly on finding specific and proven pathways for delivery, not to identify potential areas for innovation or to consider systems challenges – for example in energy or food – and how they link wider social and economic priorities. The problems are structurally embedded as the carbon budgets and the CCC's accompanying advice are set several years in advance. This means, for example, the CCC's advice for decarbonisation in the late 2020s and early 2030s does not reflect the opportunities this generation of AI could have on optimising systems and driving flexibility – in fact, AI is not mentioned at all in the CCC's advice.

The Climate Change Act as currently set out also embeds a limited domestic focus. Emission reductions are counted on a strict territorial basis and international carbon credits cannot count towards UK progress towards net zero.

Together, these factors mean that the UK's current strategy and approach to net zero is risk-averse, prescriptive and devoid of innovation-centric, future-oriented consideration of delivery.

Rather than accelerating delivery at home and abroad, the UK is on track to fail to meet even its own domestic targets, contributing less than it could to keeping global increase in temperature within 1.5 degrees Celsius.

New TBI polling with YouGov paints this picture starkly: people lack faith in the government's ability to deliver on its priorities, and this impacts support for net zero. Only 21 per cent of the UK public believes the government will reach net zero by 2050. But TBI's polling shows that focusing on the impact clean technology has had to date increases faith in delivery. A treatment showing the success of technology so far and its future potential increased belief that governments and businesses will achieve their goals, especially among those who are most sceptical about climate action. It was also highly effective in decreasing opposition to net zero. For example, among those identified as the most hardened climate sceptics, the tech message reduced opposition to the net-zero target from 85 per cent to 74 per cent.

A new approach is needed that can align short-term delivery of emission reductions with long-term structural focus on unleashing innovation and transforming the economy for the better. This will help maximise impact on global climate change, anchor economic benefits and manage the political

challenges of the transition.

04

The Way Forward: A Net-Zero Strategy for the Delivery Phase

For the UK to deliver the next phase of emission reductions and unleash the potential of clean-technology solutions, it will need to reimagine the structural setup of its net-zero strategy placing science and technology at the centre.

The government should focus on creating the conditions for truly transformational change rather than being prescriptive about technology solutions. This will ultimately involve a strategy that, alongside practical plans for short-term delivery, is more accommodating of uncertainty about what the longer-term transition to net zero will look like and is more responsive to technological advances.

The desired outcomes should be anchored in the carbon budgets and the CCC's advice on steps that the UK should take to decarbonise the domestic economy but remain broader in their outlook. They should consider the kind of future economy, energy system and food system the UK wants, while taking into account wider objectives such as economic growth, energy security and food security.

The government should also focus on areas where the UK can have the most meaningful impact on international climate action while simultaneously deriving domestic benefit. Leading on investment and innovation in technologies that can be used to reduce emissions can also become an economic strength for the UK.

It is important that government strategy has several time horizons. The reality is that decarbonising the economy requires consideration of both short-term implementation of the solutions and technologies available now, and longer-term structural change to unleash the transformative technologies of tomorrow.

However, within the current structure of the Climate Change Act, successive governments are incentivised to maintain only a short-term focus. For instance, nuclear fusion – which could be game-changing in terms of supplying clean and abundant power to the world – is not mentioned in any

CCC documents, as it is not an existing technology that could help the UK meet immediate short-term carbon budgets. A narrow focus on the next five years, or even 15 years, limits the opportunities of tomorrow.

The systemic shift needed is illustrated by the changes required to the UK's approach to power-sector decarbonisation. The process of decarbonising the power sector will involve not only reducing emissions from fossil fuels, but also transforming a relatively simple system of static supply and demand into one with intermittent and distributed supply and flexible demand. This involves new challenges associated with costs and energy security in the short term, but also new opportunities for the expansion of international trade, the emergence of innovative companies with potential to export intellectual property, and ultimately a low-cost, highly secure energy system. As a leader in decarbonising the power system using intermittent renewables, the UK could aim to create the world's most efficient, secure and modern decarbonised energy system by focusing on encouraging innovation in technology and in business models.

This ambition would extend beyond decarbonisation, instead homing in on what we want the future system to look like and how we want the power system to amplify wider ambitions, such as powering the UK's AI future. It could then incorporate ambitions for the power sector beyond the remit of short-term targets, based more on scientific and technological innovation, for instance, to become the first country in the world to commercialise fusion or become a world leader in developing the next generation of battery technology. It could involve integrating power with industrial decarbonisation by, for example, creating strategic sites with low-carbon power from AMRs, which can provide power and high-grade industrial heat to potential industrial clients or power to data centres.

Another example is how we approach the decarbonisation of private homes. Here, the most significant challenge to progress in this area is bringing the public along on the journey. By shifting focus away from specific technology targets, and towards creating world-class personalised home-decarbonisation journeys and consumer offers, the UK could make decarbonisation seem like a more attractive option. Using data and AI, we could improve the way the government and energy companies personalise individuals' net-zero progress, better targeting support and models to align with individual choice and preferences. The government could aim to provide

a platform for innovation in consumer offers and home-decarbonisation technologies, one that works with consumer preferences rather than pushing against them, and one that looks to create modern homes of the future that empower consumers to be in charge of their own decarbonisation journeys and even become energy producers themselves.

This shift in strategy does not mean abandoning the overall ambition to reach net zero or the commitment to meet the country's nationally determined contribution (NDC). Nor does it entail abandoning existing sectoral or technology-specific targets. The UK should still aim to decarbonise the power sector by 2035 and phase out the sale of new internal-combustion-engine vehicles by 2030, but these targets should be secondary to the broader aim of achieving the types of services and systems we want to see and must be placed within a wider social and economic context.

Reduced focus on prescriptive targets does not need to conflict with certainty and stability for investors. Targets that are subject to political volatility give far less certainty than clear, long-term enabling conditions and delivery mechanisms.

Such a shift will not just require a different mindset, it will also necessitate some structural changes to the underlying setup. While the Climate Change Act was a momentous piece of legislation, it is important that it does not become immutable.

The circumstances around how we understand climate policy, its politics and the far-reaching changes required have changed hugely since 2008. We should not be afraid of updating the Climate Change Act and its implementation strategy to reflect changing circumstances and to accelerate delivery.

The government should consider a few key changes to the Climate Change Act and its underlying structure:

- **Review whether the Climate Change Act needs to be updated** to provide more clarity on what constitutes a "credible" plan to ensure that longer-term delivery plans that entail more uncertainty won't result in continuous legal challenge. Given the pace of technological change, some uncertainty and reliance on innovation must be considered "credible", particularly for delivery beyond the next few years. A change may be necessary to enable

government to focus on more holistic societal change and driving clean-tech innovation.

- **Consider allowing international carbon credits to count towards UK carbon budgets.** Climate change is a global problem, and tackling it requires global action. The primary goal should be to achieve the maximum carbon-emission reductions. Counting international credits towards our carbon budgets would be a more practical way of driving progress in some instances.
- **Move the responsibility for plans to meet the carbon budgets from the Department for Energy Security and Net Zero (DESNZ) to the Treasury** to better align carbon-emission-reduction considerations with economic ones. This will provide a more rounded consideration of climate targets and ambitions within the economic strategy. The move should be combined with a comprehensive review of how the Treasury considers climate change in economic and fiscal decisions, including ensuring the fiscal framework is able to drive the long-term investment needed to facilitate the role of technology in meeting the net-zero goal.

These changes to the structure underlying the Climate Change Act must be accompanied by an ambitious renewed policy and delivery plan. A plan that can achieve transformational change by creating the enablers for innovation, and that can help clean technologies thrive over fossil fuels in the UK and beyond. To do so, the government should apply its net-zero policy and delivery levers at each stage of the technological-innovation process, from conception to mainstream deployment: supporting research and exploration, facilitating rapid implementation of new solutions and fostering demand to scale the technologies.

Such a plan will require public investment to be viewed as an investment in our future. But spending should also strategically leverage private capital accompanied by structural reform and needs to focus on the areas that can have the most transformative impact.

In addition to updating the underlying framework, the five practical steps the government should take are:

1. Establishing effective government-delivery mechanisms
2. Creating the conditions for transformative climate R&D
3. Forming an enabling and agile regulatory environment to test and scale solutions

4. Creating and shaping the markets for clean technologies of the future
5. Creating the conditions for international collaboration on research and global deployment of climate solutions

ESTABLISHING EFFECTIVE GOVERNMENT-DELIVERY MECHANISMS

Delivering net zero involves several complex whole-system changes across the economy. The transition is already happening at pace, and technology is developing even faster. But the transition needs to accelerate, and technology needs to be adopted faster.

If government is to work effectively as an enabler of progress and clean-technology innovation, it will need to take a more agile and better-coordinated delivery approach. Political leaders will also need to set improved and clearer systemic priorities and break out of conservative, risk-averse approaches.

For the government to enable effective delivery of net zero, it will need an approach that achieves several separate but connected objectives:

- Long-term certainty around the direction of travel and investible pipelines that attract private capital
- Policy, funding, regulation and market incentives that are aligned to enable effective delivery
- Effective identification of new technology opportunities and the government support they require to develop
- Contextually situated net-zero strategy that accounts for the social and economic outcomes the government wants to achieve
- A responsive system that can quickly recalibrate to optimise delivery

The current delivery framework is not enabling the UK to achieve these objectives. First, it is widely recognised that the UK does not have the policy coherence or certainty needed for industry to feel confident investing in the country. This is attributable to the difficulty of implementing politically challenging policies and the day-to-day political pressures that stop long-term decisions being made, as well as a lack of longtermism in funding arrangements.

Second, regulation and policy are often conflicting and incoherent, and often do not enable rapid proliferation of new infrastructure, creating barriers and delays to implementation. For instance, the planning system is not geared

towards quick development, and electricity-network regulation does not encourage sufficient investment. This is made worse by a set of government bodies and regulators with conflicting objectives.

Third, the government is consistently behind the curve in identifying new technology solutions, and attractive support structures take years to implement.

Fourth, insufficient consideration of wider outcomes can lead to shifting policy direction. For instance, concerns from industry and the public have led the government's flagship heat-pump policy to be dubbed "the boiler tax", resulting in an emissions-reducing technology succumbing to political whims. In addition to delaying the delivery date for this goal, this has further eroded confidence in the government's ability to deliver the net-zero transition.

Finally, the system is slow to act and align with net-zero delivery, as evidenced by the amount of time it has taken for the government to address the significant grid and planning issues holding back power-sector decarbonisation.

To overcome these challenges and successfully deliver net zero, we must therefore improve the way government machinery is organised and create an environment that favours rapid progress, innovation and investment.

Government will need to treat net zero as a whole-system and cross-economy challenge, rather than as a number of discrete targets. This will require a stronger coordination function. Responsibility for delivering net zero currently sits primarily with the DESNZ. Locating accountability for a key cross-cutting policy area within a delivery department limits the ability to coordinate and set direction. DESNZ does not have the mandate to effectively create coherence across net-zero strategy and wider government aims, the oversight to assess trade-offs and prioritise delivery, or the forcing mechanisms to effect policy change in other departments.

The shortcomings of this approach to net-zero accountability are evident in the slow progress on key priorities like planning reform, which is essential to achieving net zero but involves alignment across several government departments and trade-offs with other priorities. To unlock faster progress, stronger political delivery from the centre is crucial.

To enable more effective coordination, responsibility for net-zero delivery

should be placed at the centre of government, in a new team within the Cabinet Office, the Treasury and Number 10 focused on net-zero delivery and driving clean-technology innovation.

To ensure the central net-zero team can effectively make decisions, the team should consist of highly skilled and specialised civil servants, including those from science, engineering and finance backgrounds. It should also include experts in AI. As identified by the Artificial Intelligence for Climate Change Mitigation Roadmap,[26] it is essential to place staff with AI expertise in units and agencies responsible for the delivery of the net-zero strategy.

Alongside increased leadership and oversight from the centre, the DESNZ needs improved delivery focus and functions. The department needs a central strategy and coordination unit that has an overview of the whole system, rather than for delivery to be considered in technology-specific silos. The breakdown of silos also needs to extend beyond the strategy function. For instance, rather than individual teams developing bespoke business models for clean technologies, the department needs stronger collaboration to enable more rapid delivery.

Just like within the centre of government, DESNZ also needs to be bolstered to include better scientific expertise and, crucially, ensure there are enough staff members with deep experience in the energy system. A core team of AI experts should also be embedded at the centre of the department to drive progress in harnessing the power of AI across the energy system and wider net-zero delivery plans.

Historically, the UK government has taken many of the right steps on climate, but progress is often slow. This limits the ability of new solutions to come to market quickly. Enhanced access to real-time data and analysis will enable better decision-making and rapid response to changing circumstances to drive effective delivery across government.

The government should use the power of data on emissions and the energy system to enable better and faster delivery. By tasking the central data and analysis team to create a digital policy twin of net-zero delivery by collecting, combining and improving disparate data sources, the government could begin to understand and analyse delivery in real time. For energy data, much of this information should be provided through the National Energy System Operator (NESO).

To provide more effective technical advice, the CCC should be given an expanded remit to identify the most promising technological innovations solutions the government should focus on, both for the short and longer term. The CCC can work closely with the research community to identify opportunities, including the riskier bets that are worth investing in due to their transformational potential. Advice should be updated more regularly to recognise developments in technology.

Finally, beyond the centre of government, another key barrier to effective net-zero delivery is the wide range of bodies involved that have overlapping and conflicting objectives, overseeing a wide range of sometimes contradictory interventions. The result is a system where responsibility for key issues can fall through the cracks or where different organisations will incentivise different actions.

It is important that all the actors in the sector work towards the same overarching aims and objectives to enable industry and individuals to deliver effectively and pursue the right goals. This will require clear steers on priorities from the centre, combined with defined remits for each actor in the ecosystem. The government needs to clarify, streamline and rationalise the roles and responsibilities of these bodies, to ensure they serve discrete but complementary functions in the delivery ecosystem.

To ensure the centre of government is structured to drive whole-system delivery of net zero and accelerate clean-technology development, the government should:

- **Create an office for net zero in Number 10/Cabinet Office** with responsibility for cross-government delivery. This office should be staffed by civil servants including those with expertise in engineering and finance.
- **Reorganise DESNZ to become a delivery department for energy-system change** by introducing a strong central strategy function and hiring more technical experts.
- **Create a net-zero-policy digital twin with data from across the sector** to better analyse different policy options and complex system changes. This will also require improved collection and centralisation of data.
- **Recruit AI experts within central government and governmental bodies focused on energy and climate.** AI experts can help in understanding the opportunities presented by AI for more effective net-zero delivery.
- **Expand the remit of the CCC to include technological horizon-scanning**

and providing advice on the most promising clean-technology solutions the government should advance.

- **Conduct a rapid review of the statutory bodies with responsibility for net-zero delivery** to ensure their incentives are aligned and decisions integrated. As outlined by the Energy Systems Catapult,[27] this includes bodies responsible for air, land, water, agriculture, transport, digital and telecommunications.
- **Clarify the roles and responsibilities of existing and new bodies in the energy sector** to create an enabling framework for delivery and innovation for a 21st-century energy system. A whole-system approach requires clear functions and objectives for each organisation that fit wider government objectives. Broadly speaking, there should be three main roles in the system: the government creates policy, the Office of Gas and Electricity Markets (Ofgem) regulates, and the newly established NESO is responsible for strategic forward planning and running the energy system.

SUPPORTING MORE IMPACTFUL CLIMATE RESEARCH AND DEVELOPMENT

Effective R&D will be instrumental in developing new solutions that the UK and the world need in order to decarbonise. A stable global climate system is a public good, and it's essential that government further invests in climate and energy R&D to accelerate progress. Public and private R&D is the foundational element of the transformational change the climate transition requires.

Impactful R&D public spending comes with economic rewards. It helps attract matching private investment, driving growth and boosting tax returns. Estimates suggest[28] that public R&D investment in key technologies could deliver between £54 billion and £115 billion of cumulative UK energy-system savings between 2019 and 2050.

To date, the UK has been providing robust and increasing levels of funding for climate and energy R&D. This has yielded success – the UK is the second-largest hub[29] for climate startups and scale-ups globally and has granted the third-highest number of green-technology patents[30] in Europe.

However, the spending itself, and in particular its impact and effectiveness, is less significant than it could be. There have been attempts to improve this. In 2021 a UK Net Zero Research and Innovation Framework[31] was published setting out the short-, medium- and long-term needs for innovation across different sectors. The intention was to lay the foundations for research and

innovation planning in government. However, there are still several structural problems.

First, there is a lack of consistency and clarity in the strategy behind UK R&D funding. The strategic direction is constantly shifting: since 2017 we've had the Clean Growth Strategy, the Industrial Strategy Challenge Fund and the Net Zero Innovation Portfolio. This is compounded by disparate pots of additional funding that aren't sufficiently grounded in a strategy. R&D funding should be used as a key tool to support the priority areas of the country's net-zero and industrial strategies, but to effectively achieve this the underlying strategy, the administration of funding and the ecosystem organisation needs to be steadier and more strategic.

Second, and partly as a result of the lack of a clear strategy, there is a degree of fragmentation within the UK climate and energy R&D ecosystem, with overlapping initiatives and insufficient coordination among government agencies, research institutions and industry partners. This means that the system sometimes fails to effectively identify and foster key synergies and lacks sufficient focus on the areas or types of research that can accelerate the transition most quickly.

Third, while the UK has one of the world's best research bases, much of it never makes it out of the lab to become commercialised. More could be done to support university spinouts and help them become viable businesses with the clean-tech solutions for the future.

Most notably, when compared with countries like Germany, Korea, the US and China, the UK has a very small number of national laboratory institutions working on energy and climate, most of which are small-scale and have seen a lot of instability over time.[32] For instance, the US Department of Energy has 17 national laboratories that aim to address large-scale, complex R&D challenges with an emphasis on translating basic science into innovation.[33] Data from Germany, China and South Korea show that the share of public R&D funding for energy in public research institutions has been stable or increased in recent years, representing around 40 to 50 per cent of public R&D in energy in those countries.[34] There are opportunities for the UK to explore how adding national laboratories, or merging existing ones, could help support the development and commercialisation of cutting-edge research.

Finally, the R&D funding process is too prescriptive and not aligned with how

innovation happens. For instance, certainty of long-term funding is critical to undertaking truly transformational research and innovation. However, currently, funding is often allocated within short-term spending reviews. Funding decisions also tend to be fairly risk-averse and are sometimes made by people who lack the proper expertise to assess the merit of candidates for funding. Even those who do receive funding are often saddled with strict prescriptions for how their research should be carried out, laborious reporting requirements and even what their conclusions should contain.

We need an approach to R&D that is more comfortable with risk, that aligns with how innovation actually happens and that encourages solutions to move from the lab to implementation. As set out in the TBI report *A New National Purpose: Innovation Can Power the Future of Britain*, government needs to empower and nurture the nation's key research assets rather than micromanage them. Every demand for data and metric-based targets reduces the agency, time and freedom of people on the front line, and risks constraining our institutions.

By improving the underlying structure, streamlining the administration of funding and enhancing the focus of the R&D ecosystem, as well as providing researchers with better data, the government can become a more impactful platform for truly transformative energy and climate research and innovation that will find the solutions we need for the net-zero transition.

To improve climate and energy R&D the government should:

- **Aim to increase R&D spending on climate and energy in line with a general increase in R&D funding,** as proposed in *A New National Purpose: Innovation Can Power the Future of Britain*. UK climate and energy R&D spending has been increasing over the past few years, but the government should be more ambitious. As set out in *A New National Purpose*, government should also place core funding for key delivery agencies such as UK Research and Innovation (UKRI) and the Advanced Research and Invention Agency (ARIA) on longer spending cycles of seven to ten years. Certain institutions and other long-term investments should also be allowed light-touch checkpoints based on expert international review rather than laborious periodic reporting.
- **Ensure innovation funding is less prescriptive in terms of outputs** and that it aligns with how innovation actually happens. Currently, a number of government funding streams define set outputs from funded projects. In

order to get the most out of public R&D and innovation funding, it is necessary to ensure this is structured in the most conducive way – one that works with how innovation happens. As set out in *A New National Purpose*, government should assess funding recipients at the outset and trust them to deliver innovative results, rather than prescribing outputs.

- **Set up a new "Lovelace Laboratory" for using AI to accelerate materials science** in areas such as carbon capture, batteries and plastics. This could make the UK a world leader in applying AI to climate-transition-accelerating research. There are already some teams across the country using AI for materials science, such as Imperial College London's Institute for Digital Molecular Design and Fabrication (DigiFAB) and the University of Liverpool's Materials Innovation Factory. To accelerate this progress and harness the opportunities, the UK could form a new lab focused explicitly on AI for materials science. This could form part of the network of "Lovelace Disruptive Innovation Laboratories", as proposed in *A New National Purpose*.
- **Provide targeted R&D support to help support piloting and commercialisation of clean technologies.** This includes additional support for schemes that help get solutions out of the lab and into the market such as Imperial College London's Greenhouse accelerator programme[35] and Climate Solutions Catalyst,[36] University of Oxford's Planet Positive Lab,[37] or friction-reduction programmes such as the Better Futures Retrofit Accelerator.[38] It also includes providing more affordable laboratory and demonstration space to support new startups. In the US, the government hosts several prototypes for AMRs on government-research land. The UK government could explore making old coal sites and similar sites that have existing grid connections available for new projects such as AMRs.
- **Implement pivot-support programmes (PSPs) for nuclear fusion to capture value from fusion investment** as previously proposed by TBI. Nuclear fusion promises not only an abundant new source of energy but also the possibility of technology breakthroughs in sectors outside of power generation worth trillions of pounds. But despite the recent surge in private funding for fusion, the best way to harness these technology spillovers remains unclear. A PSP could help support fusion companies to pivot into other commercial territories and harness the economic potential of fusion investment.
- **Make valuable public-good data sets available** for clean-tech innovation. The government could set up a group to identify what data should be made available and then coordinating the opportunities. There are a large number of data sets on the economy and natural world that could be

valuable to innovators and accelerate progress towards net zero. As set out in *A New National Purpose*, government must use data as a competitive asset as an enabler to advance innovation. The UK should take the lead in creating highly valuable public-good data sets that can be used to develop new solutions and train AI models for R&D into – and eventually implementation of – new solutions, including encouraging the use of synthetic data where appropriate.

- **Ensure all energy-system data that can be shared are shared** in a consistent and timely manner. Energy-sector data are instrumental in enabling the integration of renewables into the grid, improving system efficiency and reducing carbon emissions. There are already solutions in development that are helping to encourage efficiency and increase the pace of decarbonisation. However, data are often not released in timely, consistent and accessible ways. This limits the ability for new solutions to be developed and implemented. Through initiatives such as Icebreaker One, a non-profit operating at the intersection of data and sustainability, industry is already taking steps to make energy data available as standard, but government should take a stronger lead. This can be achieved through better collection and regular release of data for all at-home energy assets, improved requirements for all transmission-system operator (TSO) and distribution-system operator (DSO) data to be made available in standard formats, and accelerated efforts to roll out smart meters in all buildings, as highlighted by the Energy Systems Catapult.[39]

CREATING A SOLUTIONS-ORIENTED, ENABLING AND AGILE REGULATORY ENVIRONMENT

Development of new solutions to improve climate action are happening at a faster pace than ever before, yet our regulatory system is slow in catching up with innovation and enabling the rapid development and deployment of new infrastructure and technology.

Most sectors of the economy that new net-zero technology solutions are entering are heavily regulated. While a strong regulatory regime is essential for consumer protection, the UK has increasingly fostered a system that is too risk-averse and slow to keep up with the pace of change required for the net-zero transition.

For instance, technologies like AI offer a large suite of opportunities for climate action, to optimise systems and bring new and better solutions to market in

sectors as diverse as the electricity grid, power generation, traffic control and agriculture. However, the pace at which AI solutions are being deployed is vastly slower than it could be, as policy and regulation lag behind technology.

The UK could lead the way in developing proactive and enabling regulation that promotes innovation and encourages rapid development – regulating energy and other sectors of the economy for a decarbonised, AI-enabled society.

To make sure that climate solutions can get to market and have an impact as quickly as possible, and to keep climate-tech companies in the UK, the government should aim to have one of the most agile yet robust regulatory environments in the world. The government should seek to quickly identify barriers and use innovative solutions to swiftly address them while keeping consumer protection in mind.

This includes streamlining the creation of the necessary underlying infrastructure and the more mature technologies we know can decarbonise – creating a system that is geared towards build and new solutions. It also includes a higher risk appetite, and more agile solutions for testing and scaling new innovations.

The government should:

- **Reform the planning process for Nationally Significant Infrastructure Projects** to enable rapid construction of new green infrastructure such as the electricity grid and low-carbon generation, by centralising decision-making and using digital tools like digital twins for more strategic planning, as proposed in *Building the Future of Britain*.
- **Ensure that the planning system remains agile and responsive to new technologies** such as heat pumps and electric-vehicle charging by conducting a wholesale review of how the planning system hinders the installation of smaller green projects. Recent changes to planning regulations for heat pumps are a start, but continuous progress is needed to make low-carbon technologies quick and easy to install. Government should also review the planning barriers to changing buildings on farms to controlled-environment agriculture or fermentation.
- **Deploy new approaches to increase the pace of regulatory approval for new technologies.** The government could fast-track regulatory approvals where technology has already been approved in other trusted jurisdictions

to remove the domestic regulatory burden and speed up timeframes for deployment. This should apply for sectors such as new nuclear, as proposed by Sam Dumitriu,[40] and to novel foods, as highlighted by Form Ventures. The government could also introduce a "pay for speed" option to secure speedy decisions for regulatory approval, as recommended by Form Ventures.[41] This means that for regulators not usually funded by industry, and where application fees are usually free, companies could pay to secure a speedy decision with guaranteed fee refunds where an ambitious timeline is not met.

- **Target R&D support to help companies overcome the barriers in providing appropriate evidence** to qualify for regulatory approval. For instance, the feed additive Bovaer/3-NOP could cut methane emissions from dairy cows by at least 40 per cent[42] if approved by the Food Standards Agency. The government should support farmers who raise livestock to trial feed additives and direct research funding to more effective additives.
- **Review the regulatory incentives for DSOs and TSOs** to ensure that legislation incentivises the installation of new low-carbon assets with a focus on flexibility and innovation. The price-control framework currently incentivises DSOs to resist rather than embrace change in the form of adopting low-carbon technologies. The effect is that in many cases DSOs become a block to, rather than enabler of, innovation and rapid rollout of new technologies. Instead, DSOs should be regulated based on performance, as is done in many other countries. For TSOs, the Network Innovation Allowance should be reformed to allow for a broader spectrum of innovations to be implemented.
- **Move to measuring over modelling for regulation** where appropriate. Modern satellite and sensor technology, and AI make it possible and cost-effective to measure the emissions and outcomes of different interventions and technologies rather than relying on hypothetical models. This can enable more outcome-driven and technology-neutral regulation, for instance in building efficiency.

SHAPING AND CREATING MARKETS THAT INCENTIVISE INNOVATION

Deploying clean technologies relies on shaping and creating markets that allow innovative clean-technology solutions to compete with fossil fuel, shifting demand in the system.

Over the past ten years, government policy has successfully helped key technologies like wind, solar and batteries scale and become cost-competitive with fossil fuels. Now the same needs to be applied to next-generation technologies in sectors like food and agriculture, industry and commercial transport. Innovations including long-duration storage and baseload power also need to be brought online to fully decarbonise the power sector. In the UK, this challenge also applies to areas like home and building decarbonisation, where a market needs to grow for low-carbon solutions such as heat pumps.

Active government involvement in this process is required. First, several clean technologies are hardware-heavy and require high upfront capital investment. This is the case for more established renewable technologies like wind and solar, but also for novel technologies like carbon capture and hydrogen facilities. This makes it harder for companies to get private funding without government de-risking investment.

Second, many clean technologies carry risks, including commercial risk and technological risk. In areas like wind and solar the uncertainty of future power prices makes return on investment difficult to predict, which renders them risky for traditional investors. In addition, many novel technologies suffer from heightened technological risk, which also makes investors hesitant.

For instance, to limit the global temperature rise to 1.5 degrees Celsius, the world will need to rapidly remove carbon from the atmosphere, alongside reducing emissions. Estimates suggest that, based on the Intergovernmental Panel on Climate Change's pathways, novel carbon-removal solutions need to be scaled from 0.002 billion tonnes (Gt) of CO2 per year today to 6 Gt in 2050. However, without a price on carbon that extends to removals, there is no way to recognise or assess their value, which means there is no certainty for any offtakes and therefore revenue. This means that even if an innovative carbon-removals company manages to scale and remove significant volumes of carbon from the atmosphere, potential investors have no certainty that there will be dependable cash flows. This is holding back the ability of the industry to grow, and therefore limits the necessary cost reductions.

Government Tools to Help Shape and Create Markets

- **Carbon taxes:** The purest way to shape markets in favour of clean technologies is by implementing carbon taxes. In the UK and EU, the Emissions Trading System (ETS) has been instrumental in creating the incentives for heavy industry to decarbonise and improve efficiency. The proposed Carbon Border Adjustment Mechanism (CBAM) will strengthen the effect of these policies by limiting the ability of imported high-carbon goods to compete in the marketplace.
- **Regulation:** This can include mandating or banning certain technologies or solutions, but it can also concern the ways in which the markets themselves are structured. Mechanisms for the latter include energy-market design, which determines what location and temporal signals are passed to different players in the energy market.
- **Direct government funding:** This can include direct "push" funding or tax breaks, such as those implemented by the US through the Inflation Reduction Act, to help make clean technology competitive with fossil fuels.
- **Government revenue guarantees:** The government can de-risk private-sector investment by providing assurances regarding revenue. In the UK, the main example of this is the CfD system, which has been instrumental in driving investment and huge cost reductions in offshore wind, in particular. The first auction round saw a strike price of approximately £120 per megawatt hour (MWh), and in the fourth auction round the strike price was £44 per MWh.
- **Public procurement and advance market commitments (AMCs):** The government can use its procurement power to create demand for low-carbon goods, either by directly procuring goods or services, or through tools such as AMCs. These mechanisms have been used in vaccine development, where the government commits to paying a price for a good or service if it reaches a certain cost and/or standard.

These tools all come with different deliverability challenges. Taxes and bans

can be powerful signals to the market and effectively shift demand but come with cost and acceptability risks that make them politically challenging to deliver. Using government procurement or spending comes with limits to available financial headroom and involves government absorbing significant risk.

Considering the number of tools at the state's disposal, the UK government should take a more active role in shaping and creating markets for innovative clean-technology solutions in a way that works with the nature of the technology and the market. The aim should be to create long-term conditions that allow clean technologies to thrive and attract the maximum amount of private investment.

The government should:

- **Reform the energy wholesale market** to reflect the properties of renewable energy and the demands of the 21st century, and to reward more efficient solutions and system integration. In the next phase of the energy transition, the UK's attention should focus on how the energy market can best incentivise investment in the next generation of technologies that will support the creation of a low-cost, efficient 21st-century power system. Where the market was previously focused on integrating low-carbon technologies into a fossil-fuel-based system, the energy system of tomorrow will be radically different, consisting of decentralised generation and more flexible demand, backed up by smart technologies and AI. It is essential, too, that market incentives drive towards a highly efficient, low-cost and abundant energy supply. The electricity system is not only an area where innovation is happening rapidly, it is also one of the key enablers of innovation in the wider economy through electrification of the demand side and AI.
- **Develop and implement appropriate market-shaping tools for the**

energy system beyond improved market signals. The energy market requires additional layers to ensure sufficient capacity for security of supply and to secure revenue certainty in a system based on renewables with low or zero marginal costs. The CfD scheme, the capacity market for storage and the ancillary markets for frequency response have made the UK a world leader in deployment of key technologies like offshore wind and grid-scale batteries. The UK should continue to create appropriate business models for novel low-carbon technologies, making sure the schemes are developed and implemented quickly, and that they welcome and advance innovation, just as the CfD did for wind. This should be prioritised, given the potential associated with technologies such as AMRs, without which reaching net zero will cost an estimated £2.4 billion more, according to modelling from the Energy Systems Catapult.[43]

- **Assess the current approach to de-risking low-carbon technologies** and interrogate whether the highly centralised and technology-specific route in place is the best way to create an innovative, low-cost electricity mix, beyond the initial phase. The market also relies heavily on bespoke government arrangements for specific technologies, limiting opportunities to settle on the optimal energy mix for lowest-cost power. For the next review of the electricity market arrangements, the government should consider whether to introduce a system that allows for more effective competition between different technologies based on capacity in a less controlled marketplace. Alternative models have been suggested by the Energy Systems Catapult.[44]
- **Reform the retail energy market** to create the incentives for new user-centred business models.[45]The future energy system will involve more volatile energy prices and need a more flexible demand side. The retail energy market should encourage innovation and the creation of business models that help consumers engage with the energy system in ways to promote its effective working. This could include encouraging uptake of flexibility technologies and on-site generation as well as low-carbon heating solutions. Innovation is already happening within the current regulatory framework, driven by market leaders like Octopus and Ovo, but the pace of change could be accelerated with effective retail-market reform. This should take place alongside expediting the introduction of half-hourly settlement to create the most granular temporal signals in the retail space and enable the creation of time-of-use tariffs tailored to individual users, creating effective price signals to encourage flexibility.
- **Create an effective market for low-carbon heating** by reducing the

barriers to access government support schemes. Simplifying government home-energy efficiency and clean-heat schemes by reducing the number of additional requirements and seeking to move to an outcome-based model for support will allow more people to more quickly reduce their domestic carbon emissions. Financial support should also be tailored to ensure that it is fiscally sustainable with increased uptake, for instance through better targeting of subsidies to where they are needed the most. Data and AI can also be used to personalise home decarbonisation journeys and automate access to funding and skilled workers.

- **Create an advance market commitment (AMC) for carbon removals** with clear standards. To date, carbon removals have been driven mostly by the private sector through AMCs like Frontier.[46] But to scale these solutions at a pace that can meet those targets, governments need to take an active role in kickstarting demand. To support the growth of the markets, the UK needs to consider how it can create the demand-side "pull" funding needed to help spur investment in key projects. As discussed in *A New National Purpose*, there are a number of examples of where governments have acted a "buyer of first resort" to create markets for early-stage innovation and accelerate progress. The US government has already adopted this approach for carbon removals with its Carbon Dioxide Removal Purchase Pilot Prize, which will provide up to $35 million in cash awards in the form of offtake agreements from the federal government in four carbon-dioxide-removal pathways. The UK should seek to implement a similar commitment to drive demand and technology development for carbon removals.
- **Create an AMC for nuclear fusion** to support rapid commercialisation and attract private investment into fusion development. The government could commit to buying the first 10MW of a fusion plant to create offtake and revenue certainty and make the UK the first country to commercialise fusion.
- **Continue the integration of tech-based carbon removals into the Emissions Trading Scheme (ETS)** by allowing companies with existing ETS obligations to use removals in addition to emissions reductions to meet their obligations. The longevity, integrity and long-term policy-certainty offered by the UK ETS provides a credible commitment to future demand for carbon removals. The government has already outlined its intention to do this, and it should be prioritised and implemented with strong measurement, reporting and verification (MRV) standards, based on strong research in the area. Importantly, to get the required scale and spur low-

cost solutions, removal credits should be available from international projects, not just from those based in the UK, even if this does not directly impact UK net-zero targets.

- **Shift subsidies in food and agriculture towards productivity-enhancing grants and establish a new What Works Centre for agricultural technologies,** to both improve the demand and uptake of new technologies and facilitate better knowledge exchange.
- **Incentivise** consolidation in the UK pensions system, as advocated in *Investing in the Future: Boosting Savings and Prosperity for the UK*, to unlock and maximise the amount of private capital that can flow into climate solutions. As previously highlighted by TBI, the UK has the second-largest pensions market in the world, and yet overseas pensions invest 16 times more in UK-based venture capital and private equity than domestic public and private pensions.
- **Develop a more active strategy to help clean-technology companies bridge the "valley of death"** and build their first-of-a-kind to nth-of-a-kind projects by enhancing the status and role of the UK Infrastructure Bank (UKIB). The UKIB and British Business Bank (BBB) currently have some funding available, but it's not sufficiently strategic nor well-known within the system, limiting impact. The UKIB could take a clearer role in filling this space, serving as a "green-innovation bank". UKIB could move down the risk ladder to become one of the prominent actors able to financially de-risk clean tech through catalytic capital tools such as loan guarantees, direct loans and first-loss capital, and create longer-term certainty in the funding schemes by placing clean tech outside short-term spending reviews.

LEADING INTERNATIONAL COOPERATION ON TECHNOLOGY TRANSFER

The climate does not have borders, and nor should the UK's net-zero strategy.

The UK has a strong track record for driving ambition on climate targets; now the focus should shift towards driving increased delivery.

To ensure the international community can limit global warming, the UK should take the lead and work with partners to develop and scale technologies that can help abate the largest sources of emissions globally, encourage effective technology deployment and support investment to enable the deployment of the key technologies needed to tackle climate change across the world.

Enabling this should be central to the UK's strategy on net zero.

This will necessitate a more international and pragmatic outlook on climate than the current approach. For the UK and other high-income countries, this involves recognising that money and efforts will have significantly higher impact[47] if they are invested in opportunities in low- and middle-income countries. It will also involve recognising that investment in R&D on an international scale in a global public good such as climate mitigation is essential to truly accelerate global progress.

The international element of the UK's net-zero strategy should aim to promote the deployment of clean technology globally. This includes expanding the markets for UK clean-technology companies, building out capacity for producing and innovating clean technology across the globe, and working with international partners to turbocharge R&D to find solutions to this global problem.

First, the UK should accelerate cooperation on R&D. Climate is a global public good, so the UK should be working closely with the international community to encourage advances in climate technologies that can help the world to decarbonise. It is well established that international collaboration, and competition on innovation, will reduce costs and result in better products. The government has made some recent progress on international partnerships for climate R&D, notably the Horizon agreement with the EU, which includes research cooperation on tackling climate change and continued engagement in Mission Innovation[48] and the IEA Technology Collaboration Programme.[49] Similarly, a range of new international research agreements include a significant focus on climate, including the new partnership with India[50] and the agreement between Northern Ireland, the rest of the UK and the Republic of Ireland[51]. However, further action could be taken.

The UK could go further in forging international partnerships that seek to leverage AI for making breakthroughs in climate tech. The recent agreement with Canada on AI compute, which includes a section agreeing to examine opportunities for collaborative AI projects in areas like climate research, is a good first step. But further action should be taken to bring together governments, private-sector compute providers and industry. This could include areas such as batteries technology: Microsoft used its compute power to build a battery that uses up to 70 per cent less lithium. Or it could be applied to the production of low-carbon fertiliser: Fujitsu has used quantum

computing to improve the process and make it less carbon-intensive. Improving the process to make it cheaper would also disproportionately benefit developing countries where the cost of fertiliser is prohibitive, helping to increase local food production and thereby contributing to geopolitical stability.

Second, the UK should expand and improve technology transfer and promote investment into emerging markets and developing countries. This involves supporting governments to create markets to accelerate investment in proven tech such as renewables and speeding up the rate at which more advanced technologies are adopted in emerging markets.

Finally, the UK should empower and create the conditions for innovation and green industrialisation across the world. The aim should be to increase access to markets for UK industries, but also to create conditions for innovation and clean-technology production across the globe to accelerate change and help diversify clean-technology supply chains.

The government should:

- **Set up a new G7 Climate Compute Challenge Fund**, bringing together governments, leading manufacturers of renewable technology, the largest private-sector compute providers and scientists. Given that much of the world's AI and quantum computing power is concentrated within G7 countries, the UK should work with its allies in this forum to introduce a new G7 Climate Compute Challenge Fund to leverage scientific knowledge and compute power in areas of strategic importance. Through a Compute Challenge Fund, governments could jointly finance challenges in aspects of climate tech where compute power has the potential to unlock major breakthroughs, for instance reducing the concentration of cobalt in electric-vehicle batteries or improving the Haber-Bosch fertilisation process. Leading AI and quantum companies would be paid to allocate part of their compute capacity towards supporting funded research.
- **Champion reform to the World Bank** to provide more impactful climate financing. The UK should use its central place within the Bretton Woods system to champion reforms to how the World Bank provides climate finance, including supporting the reforms outlined in the Bridgetown Initiative. Reforms should include increasing the overall climate-finance target, deploying funds more quickly, boosting finance aimed at de-risking climate projects, and enhancing the focus on urgent adaptation and

disaster recovery needs. In addition to this, the UK should exploreadvocating the reallocation of World Bank funds towards investment in high-value public-good research. This would involve the bank first identifying a global public good with a high potential payoff – for example, more resilient crop varieties. Then, if it is identified that science and technology can advance progress in this area and develop new solutions, the bank could establish an AMC or a similar vehicle to promote the development and adoption of these public goods. In the example of resilient crops, producers of new seeds could be rewarded for both producing the seeds and reaching farmers.[52]

- **Renew efforts for a plurilateral World Trade Organisation (WTO) agreement on the trade in environmental goods**, reducing tariffs between participating countries. The WTO is one of the best forums for improving developing countries' access to clean technology. In 2014, negotiations began on a new plurilateral agreement on the trade in environmental goods, but these talks collapsed two years later when countries failed to agree on what goods should be defined as "environmental". Aside from China and Costa Rica, no developing countries participated in the talks due to a lack of interest in reducing tariffs on environmental goods. However, several developing countries have significantly increased their investment in renewables since then. This suggests that a new effort for a plurilateral agreement reducing tariffs on environmental goods could benefit from wider support among developing countries and, if successful, unlock greater climate-tech transfer.
- **Catalyse climate action through non-standard finance mechanisms**, such as debt-for-climate swaps. The International Institute for Sustainable Development[53] has argued that debt-for-climate swaps could be a useful way to increase tech transfer to developing countries while reducing their debt, citing the example of Spain forgiving Uruguay's debt in exchange for their purchasing Spanish wind turbines. With climate-related debt-swaps high on the climate agenda following interest[54] in the Bridgetown Initiative, the UK should explore the potential for debt-forgiveness to developing countries in exchange for their using the released funding to invest in UK climate technology.
- **Establish robust and efficient ways for carbon markets to promote investment** into low-carbon solutions across the world. The UK is well-placed to lead on developing the robust technical systems required to enable more use of carbon markets and function as a "clearing house" for future carbon-credit trading.

- **Improve trade and collaboration with Europe** on energy and clean technology. The future of energy markets is not national but regional. The UK should seek closer integration and trade with Europe to improve economic opportunities for UK companies, as well as accelerate decarbonisation both in the UK and Europe. Actions in this area should include: urgently seeking to accelerate the implementation of new, improved electricity-trading arrangements with the EU; seeking observer status for the National Grid at the European Network of Transmission System Operators for Electricity (ENTSO-E); providing a forum for technical dialogue on electricity markets; establishing clear common regulation and agreements on hydrogen and CCS trade with the EU; and committing to seeking a link to the EU ETS and CBAM exemptions between the UK and EU.

05

A More Ambitious, More Practical Approach Is Possible – and Necessary

Delivering net zero will require a transformation of the world's economies and societies. If global leaders get it right, this can be a transformation for the better. More cost-effective, cleaner solutions will ameliorate economic resilience, improve health and be a source of growth and prosperity in the years to come. If they do not, it could become costly, reduce economic security and result in increased public opposition.

Getting the transition right involves a shift in focus – away from setting the ambition, towards accelerating delivery through clean-technology innovation and diffusion. This is the moment the UK must make this move, for the sake of the climate and the future of the UK economy.

Endnotes

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