HM Government

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## Context

In 2019, the UK became the first major economy to legislate for a net zero target for greenhouse gas emissions by 2050. While the legal commitment to net zero by 2050 represents a significant step change in the UK's level of ambition, the scale of this challenge must not be underestimated. Achieving net zero and broader environmental objectives will require fundamental changes in our society and economy, and innovative technology will be critical to making these changes. Given the long timescales and practicalities required to get innovation into individual homes and businesses, and the scale of change needed, we must act quickly.

The UK's regulatory system was largely designed before the government's commitment to net zero. A policy and regulatory framework that continues a 'business as usual' approach will not deliver the change needed to meet our objectives. The government will need to shape policies and regulations to create a market environment that increases consumer and business demand for low-carbon solutions, encourages sustainable private sector investment, and makes it easy for citizens to adopt new technologies. Without a stable regulatory environment which provides long-term investment opportunities, the UK risks missing out on the significant economic opportunity provided by the global transition to a decarbonised economy.[1] Action over the next 12-18 months will be needed.

The UK has made progress in developing and deploying R&D and technologies that are critical for enabling the net zero pathway to 2050, including offshore wind, nuclear energy and carbon capture technologies.[2] The challenge now is to create a regulatory environment that ensures environmental and health protection, supports the development and scale up of technologies, and incentivises private investment.

1 McKinsey (2021), 'Opportunities for UK businesses in the net-zero transition', https://www.mckinsey.com/capabilities/sustainability/our-insights/opportunities-for-uk-businesses-in-the-net-zero-transition

2 Resolution Foundation, London School of Economics and Political Science (LSE), 'The Economic 2030 Inquiry (2022): Growing Clean' https://economy2030.resolutionfoundation.org/reports/growing-clean/

## Scope of the Review

A whole systems approach will be required to deliver clean growth and we recognise that in this work we have focused on only one component of the wider system – regulation. Following extensive engagement across government, with regulators, industry and academic experts, this review focuses on the opportunities that we have identified for pro-innovation regulation within the next 12-18 months. The review specifically covers:

- Regulatory barriers to the scaling and implementation of specific technologies;
- Opportunities where early innovation can be progressed to a stage of rapid testing;
- Risks and opportunities that the future regulatory system can help to address.

In this review we offer specific recommendations on:

- Regulator capacity and capability;
- Energy systems (grid connections and infrastructure planning);
- Technology scale-up and deployment (hydrogen, carbon capture use and storage, heat pumps, electric vehicles and waste).

We note that there are other areas where policy decisions will be required to enable a comprehensive plan for net zero technologies, including onshore wind and solar farms. Planning requirements currently pose a barrier to the scale up of these technologies, and if the policy position is to support these technologies, then planning reform would be necessary to speed up implementation. In addition, there are other technologies such as nuclear energy that will play a significant role in supporting the transition to net zero but are not in scope of this review. We note that the advent of modular reactors would simplify the process of regulatory approval provided the design was kept constant for each reactor. Recommendations are made on these and other areas in the Independent Review of Net Zero by the Rt Hon. Chris Skidmore MP. This advice should be considered in line with the Independent Review of Net Zero, the government's 2021 Net Zero Strategy, the independent 2019 advice from the Prime Minister's Council for Science and Technology on achieving net zero through a whole systems approach, and the forthcoming GO-Science Net Zero Society report.

## Role of regulation in green industries

Regulation and standards are crucial for delivering the government's environmental and investment objectives. Well-designed environmental regulations and standards can manage public risk, prevent market failure, and protect the environment and natural resources on which this economy is founded. Regulation also serves to stimulate growth and innovation through providing industry with clarity and incentivising private sector investment.

Strong regulatory signals have recently been given by the government to drive both economic growth and decarbonisation – such as the Zero Emissions Vehicles (ZEV)

mandate, which will result in a 2030 ban on the sale of new petrol and diesel cars and vans, and the Sustainable Aviation Fuels (SAF) mandate which has set targets to secure demand and use of SAF in the UK jet fuel mix from 2025 onwards, with at least 10% from sustainable sources by 2030. However, businesses and other stakeholders are clear that more tangible steps still need to be taken to achieve our net zero ambitions and support growth in the UK, and achieving this will require accelerating the roll out of green technologies at scale. A facilitative regulatory framework is required to enable businesses to make the best long-term investments. We risk failing to deliver the investments needed on time unless our regulatory system keeps pace with technological change. There is a need to create a regulatory environment that allows more rapid introduction of new technologies and facilitates scaling of these to create the impact that is required across the economy.

We note that regulators across green industries do not have a specific duty to consider net zero objectives alongside existing statutory objectives and duties. Regulators report that they can struggle to trade off the variety of duties and objectives to which they are subject to for example, safety, competition, consumer and environmental protection. We will return to this issue – and associated matters such as regulatory horizon scanning and regulator skills and capacity – in a forthcoming report examining how regulators can better promote growth and innovation.

**Case Study A: The UK's regulatory approach for nuclear fusion**

By taking a proportionate and principle-based approach focused on upholding safety standards, public transparency and innovation, the UK was the first country to create a regulatory framework for nuclear fusion. Key to this was the decision from government to not align fusion regulation with fission regulation through the Office for Nuclear Regulation (ONR), which was welcomed by industry.

The decision to approach fusion regulation in this way has boosted confidence and given investors and developers the certainty they require to accelerate the development of the technology in the UK. Four fusion companies from overseas (the US, Canada and Japan) have already moved operations to the UK with one planning to build a £300m site.

As the first country to have a regulatory framework for fusion, the UK is leading international regulatory harmonisation, with the US and Japan mirroring the UK model. This paves the way for an export market from the UK and further investment.

# Recommendations

## Regulator capacity and capability

Due to the physical infrastructure requirements of many green technologies, such as offshore wind, solar and hydrogen projects, the role of the planning system in delivering the government's net zero vision has been identified as a key issue by stakeholders, in addition to wider consenting and licensing regimes.

Technologies such as onshore wind and solar can be built quickly: onshore wind farms can be built within months and solar panels can be installed on roofs in days. However, from our engagement with industry we note that approximately 6.7GW worth of onshore wind and over 8GW worth of solar projects are currently awaiting planning approval, and that a lack of resource and expertise in green technologies across regulators, particularly in planning and permitting authorities, is a key barrier to the scale-up and rollout of such projects.

We have heard evidence that it can take up to a year for applicants to receive an initial response from the Environment Agency (EA) to resource framework (end of waste) and permitting applications, and that a considerable amount of time is taken for projects in key low carbon technology areas such as CCUS to obtain development consent orders under the Nationally Significant Infrastructure Planning (NSIP) regime, which impacts on investor certainty. Specific additional delays of one to three years are likely if a Crown Estates license is required. A survey by Burges Salmon points to both the perception of risks around hydrogen projects and the lack of joined up working as contributing to delays in granting planning permission.[3] The related matter of grid connections is covered elsewhere in this report, where long lead times for offshore wind are acting as a disincentive to expand on the well-established UK market.

The transition to clean energy will demand a significant scaling up of green technologies and the development of many new projects. Increasing regulator capacity and expertise will be required to meet this challenge, and there is a risk that innovators will go elsewhere to test and implement their solutions if this is not addressed.

**Recommendation 1: The government should conduct a rapid review to ensure that relevant regulators, including the Environment Agency, Health and Safety Executive, the North Sea Transition Authority, the Marine Management Organisation, Natural England and OPRED are sufficiently resourced, and have the required technical expertise, to enable quick and effective decision-making on key net zero infrastructure projects. This will also need to link to planning permission processes. Clear objectives and timelines for decision making by regulators should be part of the review. This review should conclude by the autumn.**

3 https://www.burges-salmon.com/consenting-hydrogen-projects

# Energy systems

## Grid Connections

Stakeholders report major constraints in accessing grid connections, with estimated lead times of around 10 years in some cases (offshore wind projects are being given connection dates of up to 12 years) and there is estimated to be up to 320GW of capacity currently in the queue for a connection. While the reasons for long lead times are complex, a primary reason is the existing connections process which has not kept pace with technology. The connections process was designed 20 years ago at a time when connection applications were made by a small number of large fossil fuel generators; it was not designed for the volume of applications we see today across a variety of low-carbon generation technologies. It is also the case that connections are dealt with on a first-come-first-served basis, with no mechanism for prioritising strategically important investments.

We understand that the approach taken by individual Distribution Network Operators can lead to regulatory fragmentation across the UK, and we also note that some projects in the queue are more likely to be viable than others, with companies potentially submitting multiple applications for similar projects. The queue management process is run by network companies in accordance with regulation from Ofgem, and within parameters set by the Electricity System Operator (ESO), taking into consideration overall system impact.

Enabling grid connections to happen smoothly, efficiently and predictably will allow companies to plan effectively, giving confidence to investors and ensuring that a wide range of decarbonisation investments can be delivered at scale from generation through to implementation – for example Electric Vehicle (EV) charging and heat pumps – and that contract for difference (CfD) timelines can be met.

National Grid ESO have made positive steps with their recent five-point plan to speed up grid connections, including an amnesty until April 2023 to allow developers to terminate their connection contracts without incurring liabilities to free up capacity in the queue.[4] However, there remains an urgent need for a more refined and streamlined system. This could incorporate elements such as the ability to fast-track priority applications or the implementation of a process that requires milestones to be reached in order to remain in the queue. To demonstrate a strong commitment to new low carbon generation and innovation in energy storage, the government should build on recent progress and work with Ofgem and network companies to bring about concrete improvements to the network connection process – including dynamic management of the ‘queue’ of connection projects.

**Recommendation 2: The government should continue to work with Ofgem and network companies to reduce connection timescales by both improving the connection process and by releasing network capacity. This should be pursued alongside a series of related reforms to the speed and efficacy of the planning system, as set out in this report and elsewhere. We consider that clear timelines and objectives for decisions should be put in place.**

4 https://www.smart-energy.com/industry-sectors/energy-grid-management/national-grid-releases-5-point-plan-to-expedite-grid-connections/

### A data-driven integrated energy system

Industry stakeholders have noted the inherent complexity of putting in place the network of infrastructure required to deliver low carbon energy and ensure opportunities for scale-up of clean technology. Currently, the location of this infrastructure is driven largely by decisions of developers and landowners, with the availability of grid connections being a major consideration. We make specific recommendations in this report on the opportunities to improve the process for securing grid connections, on increased deployment of hydrogen to help balance the intermittency of wind power, and on targeted improvements to the planning system.

There is an opportunity to take a more strategic and technology-driven approach to planning low carbon networks, by using data science to build a 'national map' to identify relevant geospatial factors and predict patterns in demand for power and power generation capabilities. The UK could, for example, leverage the predictive capability of artificial intelligence (AI) modelling on the basis of factors such as land use modelling, projected regional economic growth, industrial location and energy needs, distance to logistical networks, weather patterns and geological factors, workforce skills, and local preferences. This would enable the government to determine the preferred location for new generation sites, to support climate adaptation and build resilience into the grid while ensuring that low carbon technology is deployed as efficiently as possible. This would help innovators plan their investments and operational delivery. There is also an opportunity to make better use of data to monitor performance and outcomes, and to capture lessons to inform future projects and enable continuous improvement to the energy system. The Independent Review of Net Zero makes related recommendations on the use of data and strategic network planning.

**Recommendation 3: Building on the creation of a Future Systems Operator, the government should establish a regulatory and institutional framework enabling strategic planning of the key energy infrastructure. The approach should be data driven and include an early plan to facilitate the cost-effective scale-up of net zero technologies.**

## Technology scale-up and deployment

### Hydrogen

The UK benefits from world leading hydrogen technology development underpinned by strong science, including within production technologies, CCS and electrolytic hydrogen, aerospace and transport. Hydrogen production will be key to supporting the government's objectives of economic growth, energy security and net zero. Clean hydrogen is expected to add £900 million in gross value added and 12,000 jobs in the UK by 2030. More than 50% of hydrogen demand is likely to come from transport, shipping, aviation, power and other hard to decarbonise industrial uses which account for almost 40% of the UK economy.[5] Building on the UK's globally leading position in offshore wind, hydrogen could have a critical role in balancing intermittent renewables in the power system, enabling resilience and delivering domestic energy security.

5 Boston Consulting Group, The Role of Green Hydrogen Technology 2022.

The UK benefits from a strong policy position, with a clear ambition for up to 10GW low carbon hydrogen production capacity by 2030. However, the regulatory system is fragmented, with a separate set of rules for the Low Carbon Hydrogen Standard and renewable transport fuel schemes (e.g. the Renewable Transport Fuels Obligation), administered by different government departments. The development of an integrated net zero energy system to balance intermittent renewable power generation, and which includes hydrogen from the outset, will be a key enabler and has the potential to deliver £38bn cost savings.[6] We recognise the government's intention to roll out an economy-wide Certification Scheme based on the Low Carbon Hydrogen Standard, and consider that the consistent application of this standard would be highly beneficial.

**Recommendation 4: To deliver the benefits associated with clean hydrogen, the government should continue to work quickly to establish an effective regulatory system. This should include ensuring that future cross-border trading in low carbon hydrogen is facilitated without compromising on standards.**

### Carbon Capture, Utilisation and Storage (CCUS)

Approximately a third of Europe's $CO_2$ storage capacity is in the UK. The scale of the opportunity around CCUS is set out in the government's 2019 Energy Innovation Needs Assessment for CCUS, which estimates a global market for industry CCUS and $CO_2$ transport and storage components of £181 billion and £54 billion per annum in turnover by 2050 respectively.[7] There is currently a large bottleneck in EU storage projects, and according to figures provided by the Carbon Capture and Storage Association, £39bn of private investment is primed to be invested into projects in the UK by 2030. This presents the UK with an opportunity to provide the leading carbon storage service for Europe. Among other issues identified by industry, such as funding, stakeholders have highlighted regulatory barriers that prevent cross-border $CO_2$ transport and storage projects materialising, including stipulations that cross-border transport and storage must be reported as emitted $CO_2$. This hinders innovation in storage approaches. The UK should be an attractive destination for $CO_2$ storage given its capacity and technical expertise, and there is an opportunity to pursue international regulatory alignment to realise this potential, with a view to facilitating the export of $CO_2$ from other countries to the UK. Ensuring regulatory clarity would help provide certainty for investors and businesses.

**Recommendation 5: The government should work with international partners to remove regulatory barriers to the cross-border movement of $CO_2$ to help ensure that the UK can maximise the economic potential of providing $CO_2$ transport and storage services.**

### Heat Pumps

Heat pumps, powered by low carbon electricity, are a central technology in the global transition to sustainable heating. The Climate Change Committee (CCC) estimates that 19

6 Gas and Electricity Transmission Infrastructure Outlook 2050, Guidehouse, October 2022.
7https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/845655/energy-innovation-needs-assessment-ccus.pdf

million heat pumps need to be installed by 2050 in the UK to meet net zero. In 2021, 537,000 heat pumps were installed in France, 380,000 in Italy and 178,000 in Germany compared to 55,000 in the UK.[8]

Current planning regulations, under the Town and Country Planning (General Permitted Development) (England) Order 2015, prohibit heat pumps from being installed within one metre of another property. This has an impact on uptake in, for example, terraced houses where owners may be unable to install them given the rule. While there are a number of factors which impact the scaling up of heat pumps, such as cost, feedback from industry involved in the Boiler Update Scheme indicates that this planning regulation is a significant barrier. This provides a clear illustration of where regulation has not kept pace with technological developments: the regulation was put in place when the technology was less developed and heat pumps were noisy, but they have since become much quieter. Updating this regulation would support the scaling up and commercialisation of heat pumps, particularly in urban areas.

**Recommendation 6: The government should amend current planning regulations to enable the installation of heat pumps within one metre of another property.**

## Electric vehicles and batteries

Transport is the UK's largest emitting sector, and 91% of those emissions come from road transport.[9,10] Estimates show that by 2030, up to 10 million vehicles or a quarter of all cars and vans, will need to be zero emission at the tailpipe.[11]

The Zero Emission Vehicle mandate will set targets to accelerate the uptake of zero emission cars and vans in advance of the 2030 phase out date for the sale of new petrol and diesel cars and vans. To support these ambitious phase-out dates and the transition to zero emission vehicles, it is essential that the EV charging infrastructure across the UK is adequately developed and rolled out, and that the right incentives are put in place.

Delivery of EV charging infrastructure is carried out by local authorities. The government should set a clear expectation that local authorities will plan for and deliver the rollout of charging infrastructure. This could be achieved either by amending the National Policy Planning Framework, or via the Future of Transport bill. The Digital Technologies report published as part of this Review included a recommendation that the government should bring forward the Future of Transport bill, to unlock innovation across automated transport applications. Bringing forward the bill would also enable the government to put in place a mechanism by which it could require local authorities to plan for and deliver EV charging infrastructure.

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8https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1128689/mission-zero-independent-review.pdf

9 BEIS (2021). 2020 UK Greenhouse Gas Emissions (online). Available at: https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2020

10 BEIS (2022). Final UK greenhouse gas emissions national statistics: 1990 to 2020. Available at: https://www. gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2020

11 Estimates from internal DfT modelling (2021). RoCaFF. Consistent with electric vehicle adoption rates published in the 2035 Delivery Plan.

**Recommendation 7: The government should drive the delivery of EV charging infrastructure by creating a clear expectation that local authorities will plan for and deliver charging infrastructure. The government should ensure that the Rapid Charging Fund is implemented in a way that incentivises competition and delivers charge points to motorway infrastructure across England, and consider whether any changes to the planning system are necessary to facilitate the rollout of EV chargers.**

Increased demand for EVs will inevitably increase the number of batteries reaching end of life. This demand will come from the expansion of the EV market, as well as e-bikes, trains, forklift trucks, handhelds and battery storage systems. Landfill is an unacceptable option for value recovery, chemical safety, fire prevention, carbon impact and resource security reasons, and some battery components are toxic. Current recycling techniques are inefficient, labour intensive, and can be dangerous. Supporting innovation and research in this space is therefore an urgent challenge. For example, recycling should be factored into battery design from the outset, while further research is needed to enable the automation of dismantling. The development of an optimal regulatory framework can encourage innovation by setting targets for recyclate yield, without being prescriptive of method. Such a framework should focus on outcomes – with incentives for recyclers to build infrastructure in the UK for “black mass refining” – but avoid setting out prescribed technical solutions as this can hamper innovation. Consideration should also be given to the reuse and remanufacture of batteries in contributing to a circular economy approach to the battery supply chain to fully exploit economic opportunities across the battery value chain.

Given the opportunity to sell into international markets, the UK should ensure it keeps pace with, or improves on, approaches being taken in other countries. There is an opportunity for the UK to develop a significant industry.

**Recommendation 8: The government should work with industry and regulators to create an appropriate regulatory framework for EV battery recycling to support innovation in this area. This framework should be technology agnostic and factor in recycling by design, and should encourage scaling of the technology.**

### Regulatory Sandbox: Innovative use of waste products

There is a significant opportunity to use technological innovations to reduce waste, increase resource efficiency and enable circularity across many industries such as manufacturing, construction and consumer packaging. A more ‘circular’ UK economy could increase resource productivity by 3% annually, generate £10bn gross value add and support 200,000 jobs by 2030.[12]

There are extensive and complex rules and regulations around the treatment of waste in the UK. Innovators could test the potential of this untapped resource through targeted, time-limited and supported interaction with waste streams as part of a ‘sandbox’. A regulatory sandbox is a live testing environment, with a well-defined relaxation of rules,

12 https://www.cisl.cam.ac.uk/system/files/documents/resource-productivity-and-the-circular.pdf

that allows innovators and entrepreneurs to experiment with new products or services under enhanced regulatory supervision without the risk of fines or liability. They are typically operated by a regulator for a limited time period and seek to inform rule making.

Across England, the Environment Agency and other regulators involved in reuse and recycling – drawing on expertise within UKRI – could work with a chosen local authority to run a regulatory sandbox to trial the innovative use of waste products. This could serve as an important demonstrator project to illustrate how appropriate regulatory easing can promote innovation and help to reform the UK waste sector to help achieve net zero. The government's Investment Zone policy aims to stimulate economic growth, including where relevant through regulatory innovation and flexibility.

Stakeholders across multiple sectors have noted that 'end of waste' rules can make the development of waste derived products difficult and can stifle innovation, and that demonstrations of the potential of waste products are vital to providing assurance to potential investors as to the viability of an emerging technology, and to help change perceptions of what can be achieved with waste products.

Regulators have a key role to play by allowing flexibility for testing and demonstration, which Ofgem has proven can be successful with Emergent Energy smart grid connections enabled through its regulatory sandbox (See Case Study B).

**Recommendation 9: The government should support the Environment Agency, other regulators and standards bodies, research institutions and a chosen local authority to establish a regulatory sandbox for the innovative use of waste products, with a focus on providing derogations to support innovation on priority waste streams which currently cannot be recycled or re-used due to regulatory barriers. The sandbox could be located in a specific Investment Zone.**

**CASE Study B: Ofgem Sandbox**

Through the provision of an Ofgem 'Sandbox' award, Emergent Energy have been able to trial a "smart local energy system" business model operating microgrids that connect individual houses and flats to on-site net zero technologies to supply green electricity and heat generate on-site to residents. The aim is to integrate the equipment to cut running costs and reduce residents' bills.

The Sandbox enables Emergent to trial this process whilst also scaling up its offer for housing companies. These Sandbox awards enable innovators to trial new business models and products without some of the usual regulatory rules applying. After the trial has ended Ofgem will consider the results during future policy development.

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