an integrated energy apprenticeship scheme and develop a roadmap for aligning training and standards. The Hy4Heat programme has also developed a framework for skills accreditation for heating engineers working with hydrogen.

Our expectation of industry

We are aware of – and welcome – several initiatives being taken forward by developers and industry to support skills development. Many of these are tied to emerging hydrogen and CCUS clusters, providing opportunities for the UK skills base to thrive in industrial regions across the UK and maximising opportunities for jobs in the sector.

It is our expectation that the hydrogen sector, as it grows, will invest in growing its skills base and in supporting good-quality jobs, with equality of opportunity as a core focus from the outset.

To support this in the near term, we will seek to introduce measures through the Net Zero Hydrogen Fund, and in due course we would expect to do the same for the proposed Hydrogen Business Model. Our aim is to incentivise project developers to demonstrate how they intend to grow relevant skills and support good quality jobs and equality of opportunity throughout the supply chain.

We will continue to monitor this as the hydrogen sector matures and consult if necessary to identify barriers to sufficient private sector investment in growing the UK skills base and supporting good quality jobs and EDI.

3.3 Maximising our research and innovation strengths

Supporting research and innovation (R&I) will be key to cost-effective acceleration of the UK hydrogen economy and ensuring it can create and stimulate economic opportunities where the UK has expertise. We will take a whole-system approach to R&I throughout the 2020s to be able to deploy and integrate hydrogen technology and systems holistically in the context of wider social, environmental and economic developments.

The UK's existing hydrogen research base is strong. As the second most active country in hydrogen and fuel cell research in Europe, we are well placed to capture part of the global innovation potential in the hydrogen value chain and position the UK as a leading hydrogen technology developer.

Enhancing the ability of the UK R&I ecosystem to support commercialisation

We recognise that the technology journey – from idea to commercialisation – seldom moves from discovery research through to development (learning by research) and demonstration (learning by doing) in a linear way. It is an iterative process which must be further enabled to support the de-risking of current technology while next generation technology is developed.

UK government investment in internationally recognised hydrogen R&I projects has already enabled the development of many key hydrogen technologies, including those promoted by a handful of UK firms, such as Bramble Energy, Ceres Power and ITM Power, who have positioned themselves at the forefront of the global shift to hydrogen.[88]

We want to see others follow in the footsteps of these companies, for example by making the most of opportunities such as our **£1 billion Net Zero Innovation Portfolio (NZIP)**, which has made hydrogen one of ten key priority areas. NZIP itself represents a doubling of the UK's £505 million Energy Innovation Programme over the past five years. We aim for this new funding to be complemented by up to £3.5 billion of matched and follow-on funding from the private sector. **One of the first schemes to be launched under the NZIP is the £60 million Hydrogen Supply 2 Competition**, which will support the development of a wide range of innovative low carbon hydrogen supply solutions in the UK, and identify and scale up more efficient solutions for making clean hydrogen from water using electricity.

To provide crucial long-term certainty for researchers and innovators, we have also already committed to increasing our investment in research and development (R&D) to 2.4 per cent of GDP by 2027 and to increasing public funding for R&D to £22 billion per year by 2024. This will further boost the UK R&I ecosystem, including hydrogen-related activity.


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Public sector funding is often key to leveraging private sector investment in innovation, and even more so in the context of unlocking commercialisation and creating a market for hydrogen. **We will work with the Hydrogen Advisory Council and other partners to better understand the scale, scope and type of private sector investment into hydrogen R&I in the UK, and how it can be further promoted.** Our new Innovation Strategy, which will be published later this year, will further outline how we intend to promote private sector investment in R&I more broadly in the UK.

With such a critical role to play in enabling the UK hydrogen economy, it is important that a joined up and strategic approach is taken to hydrogen R&I investment and prioritisation. Government has already established governance mechanisms through a Net Zero Innovation Board to ensure a coordinated, strategic approach to R&D and demonstration funding across public funding bodies, and to enhance the alignment of public and private sector innovation in support of net zero. Building on this, **we will work with experts, including through the newly established R&I working group under the Hydrogen Advisory Council, to develop a strategic and cross-cutting Hydrogen R&I Roadmap to inform public and private sector R&I investment and prioritisation.**

UK R&I in the global landscape

We recognise that the UK's world-leading R&I sits at the heart of a global network of excellence: UK expertise both benefits from and drives forward advances beyond our own borders. We believe that by engaging actively and openly to share research, progress in R&I can be accelerated and its benefits maximised.

We will use our role as one of the co-leads of Mission Innovation's new Clean Hydrogen Mission – and coordinator of its R&D pillar of activities – to champion this approach from the top down. Our commitment to the Mission affords us a unique opportunity to showcase UK R&I expertise and to leverage its outputs to spur further technological progress, and ensure innovation is commercialised in a way that can push forward hydrogen technology development. In Chapter 4 of this strategy, we set out how we will work to ensure this 'push' boost of R&I progress is joined-up with policy, regulatory and demand-focused actions that 'pull' its contributions through the value chain.

We will also continue to foster collaborative international research and information exchange on the production and deployment of hydrogen as a global energy carrier, through our active membership of the International Energy Agency (IEA) Hydrogen Technology Collaboration Programme (Hydrogen TCP).[89]

3.4 Attracting investment

The development of a UK hydrogen economy fit for net zero presents unique opportunities for investment in UK projects, associated infrastructure, supply chain companies, technologies and innovation. We will work to create an attractive environment to secure the right investment in UK projects, with benefits to UK business and communities.

We are confident that UK strengths and assets, including potential for rapid scale up across the domestic value chain, coupled with our strategic and policy approach, will create the right conditions to unlock the significant scale of private investment that will be needed to develop and grow the UK hydrogen economy. The development of other clean growth energy industries can give a sense of the scale of investment needed to develop and grow new low carbon sectors such as hydrogen: for example, according to Wind Europe[90] over the ten years to 2020 the UK leveraged €56 billion (around £47 billion) in our world-leading offshore wind industry, almost half of all European investment in the sector.

As a start, the *Ten Point Plan* outlined that over £4 billion of private investment could be unlocked over the 2020s, positioning the UK hydrogen sector to deploy at scale in the 2030s and supporting our ambitions in the context of the growing global market. Alongside this strategy, we are consulting on the primary means to stimulate deployment of – and investment in – hydrogen projects through the Net Zero Hydrogen Fund and the proposed Hydrogen Business Model.

The new UK Infrastructure Bank[91] launched in June this year will provide leadership to the market in the development of new technologies including hydrogen, particularly in scaling early-stage technologies that have moved through the R&D phase. The Bank will have an initial £12 billion of capital, and will invest in local authority and private sector infrastructure projects, as well as providing an advisory function to help with the development and delivery of projects. Through these investments the Bank will 'crowd-in' private investment to accelerate our progress to net zero whilst helping to level up across the UK.

The government has also established a new Office for Investment (OfI), which will support high value investment opportunities into the UK which align with key government priorities

– including the hydrogen sector and associated infrastructure – to drive economic recovery and growth across the UK, as well as advancing R&D. We will work closely with the OfI to support the aims and direction set out in this strategy.

We will also continue to champion the UK hydrogen sector, technologies and projects through our world-class UK trade networks, promoting opportunities for foreign investment.

Through these and our ongoing engagement and policy activity, we will continue to work with the investment community to support investment across the hydrogen value chain and its supply chains, with a view to ensuring that the UK hydrogen sector remains a world-class investment case.

3.5 Realising export opportunities

The green industrial revolution has created a once-in-a-generation opportunity for the UK, as well as globally. We will capitalise on our strengths, skills, capabilities, technologies, innovation and investment to position UK companies to springboard into the expanding global hydrogen economy.

Our vision is clear: maximise the investment, growth and export potential of the green industrial revolution. We want to see a lasting and sustainable clean energy sector that can exploit global clean growth opportunities such as those associated with low carbon hydrogen. This will, in turn, support the broader sustainability of the sector and drive down costs.

Analysis suggests that around a quarter of UK jobs in the hydrogen sector, and around 30 per cent of economic opportunity, could be driven by exports by 2030, with these growing in relative importance by 2050. The UK is already an exporter of fuel cell and electrolyser technologies, and our world class engineering, procurement and construction management (EPCm) services sector is well geared to support international opportunities

as the global hydrogen economy grows. Our regulatory framework and decades of experience in gas management and safety are strengths from which the rest of the world can learn and which we are well geared to support internationally.

While our focus in the near term will be on securing domestic deployment of both electrolytic and CCUS-enabled hydrogen projects, we expect that through this UK companies will be increasingly well-positioned to seize opportunities in other markets. We are already working through UK Export Finance, the UK's export credit agency, to support UK hydrogen companies to seize such opportunities – with £2 billion earmarked to finance clean growth projects overseas to create export opportunities for British businesses. UKEF is able to provide favourable financing terms for clean energy projects, as well as working capital and contract bond support for exporting SMEs in the clean growth sector.

New trading relationships will offer further avenues for our businesses to experience the benefits of exporting. We will seize the opportunities for the UK hydrogen sector presented by Global Britain as we advance new Free Trade Agreements.

To help make the most of these opportunities, we will look to work with countries that, like the UK, have an established oil and gas sector that can transition to a low carbon future through hydrogen, sharing learning and establishing common investment and export opportunities.

We will also look to position the UK so that it is able to seize opportunities to export hydrogen itself. A further export opportunity will lie in ammonia produced from low carbon hydrogen, building on trade links that exist for high carbon ammonia today. To put the UK in a position of strength to unlock and benefit from these opportunities for the longer term, we will work to identify any necessary requirements, such as certification, and any constraints, for instance around ports and infrastructure.

The Department for International Trade (DIT) is uniquely placed to promote UK businesses and associated supply chains to access global opportunities, working in 117 separate overseas markets.

DIT works to connect businesses to encourage exporting globally. Its staff use their local expertise, networks and government-to-government relationships to reduce market access barriers for UK businesses and connect businesses with overseas buyers. DIT can link UK-based engineering expertise to emerging global CCUS opportunities, providing intelligence on projects and advice on the supply chain value to the UK. It can also connect the UK industrial clusters to overseas projects.

We are clear that by working closely with industry, academia, and other stakeholders to foster a strong UK low carbon hydrogen sector; create jobs and develop relevant skills and capabilities; and exploit our world-leading innovation, investment and export opportunities, we will position the UK to take a clear global leadership role in hydrogen. The next chapter sets out how we will work with our international partners to help unlock the economic and decarbonisation benefits of hydrogen for the UK, while supporting the scale up of a global hydrogen economy.

Chapter 4:
Demonstrating international leadership

Climate change is a global challenge, and requires a global response. The UK leads the world by example – we were the first major economy to legislate for net zero, and are achieving larger and faster emissions reductions than any comparable economy. The ambitions and commitments set out in this strategy demonstrate our similar determination to develop a low carbon hydrogen economy that will be a key part of our transition to net zero. We are equally determined to play a key role in international collaboration – learning from others and sharing our experience and expertise to help scale up further and faster – so that low carbon hydrogen can help with the wider global transition to net zero.

Coordinated international action on the deployment of low carbon hydrogen technologies will make the transition to net zero faster, easier and cheaper for all. Governments have a crucial role in supporting the coordination of the 'push' and 'pull' needed to develop and then move these technologies into the marketplace, ensure safe deployment and support early demand. By collaborating, we can accelerate progress towards these goals.

Today, low carbon hydrogen technologies remain at a relatively early stage of deployment. This makes international collaboration especially important, to help mitigate first-mover risks and create larger shared markets for the deployment of low carbon hydrogen. The UK is keen to work with other leading hydrogen proponents, both to share our own expertise, and to learn from the experience and knowledge of others. We will take an open and active approach to hydrogen collaboration and cooperation. We believe that:

- By sharing the outcomes of cutting-edge research, we can accelerate the supply 'push' of technological developments and cost reductions needed to allow production and deployment across sectors at scale.

- Through developing common technical and emissions codes and standards, we can support economies of scale – and facilitate a truly global market, with trade, energy security and climate benefits.

- By joining up policy and regulatory activity, we can expedite the creation of markets for low carbon hydrogen, 'pull' forward innovation and investment, and lay the groundwork for an integrated, competitive global hydrogen market.

While we recognise that the global market for low carbon hydrogen will take time to mature, the recent proliferation of national strategies and private sector commitments reflects substantial international ambition. The IEA estimates that in a scenario in line with the Paris Agreement, global low carbon hydrogen demand could reach 2,000TWh in 2030, and 10,500TWh in 2050.[92] In this scenario, hydrogen could meet seven per cent of final energy consumption and deliver 1.6 $GtCO_2$ per year of greenhouse gas abatement in 2050.[93] Other analysis suggests demand could be even higher: BNEF estimate that in a scenario with a strong policy framework supporting hydrogen, demand could reach 27,400TWh by 2050, meeting 24 per cent of final energy usage.[94] These projections underline hydrogen's potential to make a key contribution to global net zero. We must act together now to fully realise that potential.

The UK in international partnerships

The UK plays an active role in many of the key institutions driving multilateral collaboration on hydrogen innovation, policy and standards. These include Mission Innovation (MI), the Clean Energy Ministerial (CEM), the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE), the Hydrogen Energy Ministerial, the International Energy Agency (IEA) and the International Renewable Energy Agency (IRENA).

The UK co-leads the MI Clean Hydrogen Mission, launched in June this year with a goal to foster innovation gains that enable clean hydrogen end-to-end costs of 2 USD/kg in the most competitive regions by 2030. This end cost is achievable, with production costs of USD 1.6-2.3/kg projected by 2030 for CCUS-enabled and electrolytic hydrogen in average regions respectively.[95] The Mission's focus on aligning and targeting innovation funding and research and demonstration programmes towards cost reduction across the supply chain

will help accelerate the development of a comprehensive, international value chain. We will continue to drive global collaboration through MI that facilitates these cost reductions, recognising that this will help accelerate global low carbon hydrogen deployment and the decarbonisation and economic benefits it brings. We are also a core member of the MI Zero Emission Shipping Mission, which aims to have at least 5 per cent of the global deep-sea fleet running on zero-emission fuels such as low carbon hydrogen, green ammonia, green methanol and advanced biofuels by 2030.

We will complement the work of the MI Clean Hydrogen Mission through participation in other forums. We are committed to driving implementation of the 'Tokyo Statement' and Global Action Agenda developed under the Hydrogen Energy Ministerial, whose activities are aimed at promoting hydrogen deployment and encouraging better coordination amongst member countries. We are a member of the CEM Hydrogen Initiative, and will champion its efforts to raise international policy ambition and advance low carbon hydrogen deployment at scale. We will continue to participate actively in IPHE discussions that bring together policymakers and stakeholders in pursuit of regulatory, standards, safety and education objectives, and where we are already contributing to exploring the requirements for future rules governing trade in hydrogen.

These partnerships are making strong progress, but we believe that together, we can go further. The UK will work with partners to strengthen the alignment of individual strands of international collaboration, seeking to develop a globally coordinated 'push-pull' strategy to drive development and deployment of low carbon hydrogen as swiftly and efficiently as possible. Governments are uniquely placed to support both innovation and deployment of technologies to increase supply ('push') and demonstrate and incentivise demand ('pull'), stimulating further private sector investment in research and innovation, production and end use. With strengths across the hydrogen value chain from research to commercial actors and a strong global network, the UK is well placed to work with other leading hydrogen proponents to galvanise this enhanced activity.

We will use our 2021 Presidency of the G7 and co-Presidency of COP26 to advance these international efforts. **Through the G7, we will reaffirm the importance of low carbon hydrogen in the clean energy transition, and seek commitments to increase its production and deployment.** This will support the establishment of a future international hydrogen market, based on recognition of the job-creation and sustainable growth potential of low carbon hydrogen.

Through our global climate leadership, including through our co-Presidency of COP26, we will seek to bring together public and private actors who recognise the crucial role that hydrogen can play in tackling emissions and unleashing clean growth, to facilitate greater coordination and progress across international hydrogen innovation, deployment and policy activity. This approach will include developing countries, and both public and private sector initiatives – sending a clear signal about hydrogen's place in the future global energy mix to give investors and innovators across the value chain confidence, certainty and clarity.

Opportunities for bilateral and regional collaboration

Alongside multilateral collaboration, we are keen to work with key partner countries to develop shared research and innovation activities, complementary policy frameworks and future trade opportunities. We recognise that, in cases of particularly well-matched hydrogen interests or shared challenges, more specific and in-depth collaboration can build on and complement the work of multilateral forums. We will embrace these opportunities.

Working with our North Sea and European neighbours will be key to developing common approaches that will support UK hydrogen investment and facilitate regional trade through interconnectors, pipelines and shared infrastructure. Opportunities include:

- Activities which build on, and complement, multilateral activities. For example, as co-leads of MI's Clean Hydrogen Mission, the UK and European Commission – and individual European partners – could expand on its work on regional value chains.

- Collaboration with North Sea partners to realise the region's potential significance for hydrogen production, storage and transportation, including facilitation of future North Sea trade.

- Activity under Horizon Europe. The UK played a strong role in the Fuel Cells and Hydrogen Joint Undertaking (FCH JU), and will continue to make an active contribution to the Clean Hydrogen Partnership for Europe.

We will also continue to work with key global partners to develop our respective hydrogen economies and establish a global hydrogen market. Opportunities include:

- Joint research and innovation, especially where we share common interests – such as in decarbonising industrial sectors – or hold complementary expertise.

- Developing common regulatory approaches and other policies where appropriate – including by pooling insights on policy development and the feasibility of new use cases.

- Facilitating long-distance trade in hydrogen. As a leading maritime nation, the UK is well-positioned to build on existing trade in ammonia and to develop new trade routes in hydrogen derivatives to realise global trading opportunities.

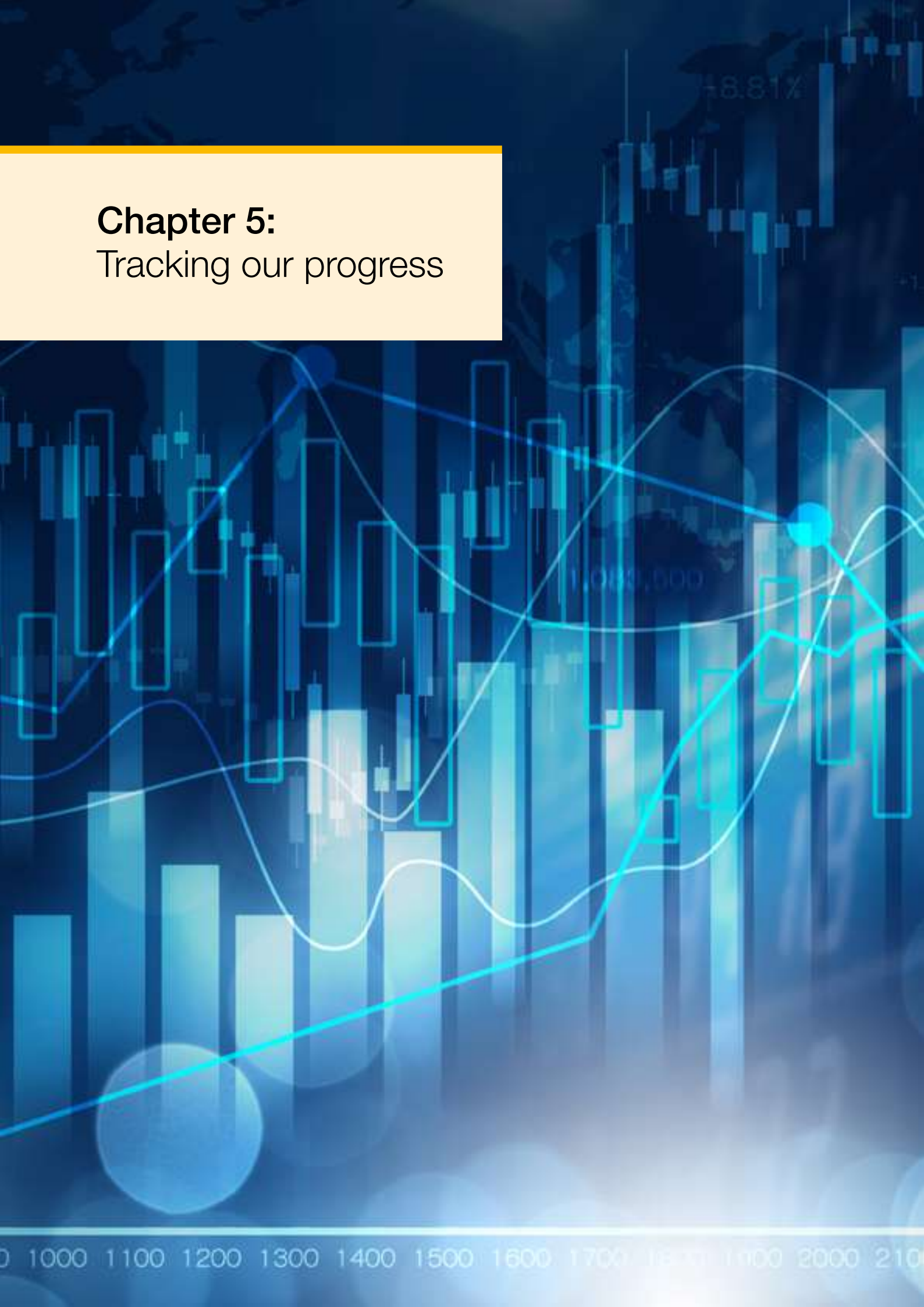
Ensuring fair distribution of shared gains and supporting hydrogen through trade agreements

We will continue to support hydrogen-enabled low carbon transitions and share relevant UK expertise through Official Development Assistance, building on our work to date. This includes support to develop hydrogen roadmaps in Mexico and South Africa through the UK Partnering for Accelerated Climate Transitions programme, and UK Clean Energy Innovation Facility support for scoping green hydrogen production, priority uses and export opportunities in Morocco. Under our international CCUS programme, a global decarbonising natural gas study is analysing the use of CCUS across the natural gas value chain, including for hydrogen generation.

The UK will also use its position as a leading advocate for free trade to galvanise action on hydrogen. We will seize opportunities, including through Free Trade Agreements and our place in the World Trade Organization, to support the development of a global low carbon hydrogen market. This means ensuring an attractive trade regulation environment, reducing technical barriers to trade, and facilitating investment in hydrogen technologies and trading infrastructure. This approach is a natural extension of the support we will provide to the UK's own hydrogen sector, as set out in Chapter 3, and will allow our world-leading commercial sector to fulfil its potential to contribute to the global deployment of clean energy technologies.

Climate champion, proven partner: primed for hydrogen

The UK has a proven record of leadership in developing and deploying innovative clean energy solutions, supporting research, development and deployment activities that bring down costs, and creating the policy frameworks to enable scale-up. This has resulted in rapid decarbonisation while supporting clean growth. We have consistently shared our experience and lessons with the world, and sought to learn from and build on the achievement of others in turn. Our net zero ambition and collaborative approach will ensure that by 2030, the UK can stand with our partners at the heart of a new global low carbon hydrogen success story.



Chapter 5:
Tracking our progress

This strategy sets out the key steps needed in the 2020s to deliver our 5GW ambition by 2030 and create a thriving low carbon hydrogen economy in the UK to support our CB6 and net zero targets. We have detailed a number of commitments and actions that we will take to make this happen. The strategy is an ambitious, first of its kind document for hydrogen in the UK. It signals our long-term commitment to developing low carbon hydrogen as a credible, safe and affordable energy option in our journey to net zero.

The UK Hydrogen Strategy outlines a range of policies and initiatives already underway, and other commitments which we will take forward over the coming years (summarised at the end of the strategy), that will support the delivery of our 2030 ambition and the role of hydrogen in CB6 and net zero. We will design and implement these as well as any future policies following best practice guidance outlined in the HM Treasury Green Book.[96]

We will use the principles set out in Chapter 1.5 – long term value for money for taxpayers and consumers, growing the economy whilst cutting emissions, securing strategic advantages for the UK, minimising disruption and cost for consumers and households, keeping options open, adapting as the market develops and taking a holistic approach – to guide the actions we take over the coming decade. This includes the development of hydrogen-specific policies, for example the design of the Net Zero Hydrogen Fund and Hydrogen Business Model, as well as ensuring that the role of and opportunity for hydrogen is appropriately reflected in broader energy system developments, such as in delivering our goal of deploying CCUS in four industrial clusters and our aim for 40GW of offshore wind by 2030.

Our approach

Tracking our progress is essential to ensure that we are developing a UK hydrogen economy in line with the outcomes set out in Chapter 1.5 and our roadmap. As such, we will monitor progress against the outcomes while also supporting data collection on low carbon hydrogen more broadly, for example through incorporating data on its deployment into existing BEIS energy systems publications.[97] Our approach to monitoring aims to be flexible and transparent but also efficient – with a view to minimising reporting burdens on government and industry by, for example, making use of established data collection processes. This supports BEIS' vision, outlined in its monitoring and evaluation framework, to create the conditions for proportionate, good quality monitoring and evaluation across the department's policies.[98]

Flexible

As the market for low carbon hydrogen is still nascent, we will need to be flexible and adaptable in our approach to monitoring and evaluation. The success of UK offshore wind[99] shows how new low carbon technologies can defy expectations and analytical projections. The lesson is that we cannot know with certainty if the outcome measures and success indicators in this strategy will reflect the UK context in 2030. The exact mix of technologies, end use and locations which will make up the hydrogen economy is still unclear, as is how low carbon hydrogen will compare to and compete with other new low carbon technologies. We will remain alert to changes and market developments and be willing to amend our indicators and metrics if necessary.

Transparent

We want to make sure that our progress in developing a hydrogen economy is well understood, and we welcome public accountability. We are already following best practice guidance on sharing information for publicly funded hydrogen innovation projects. Sharing information and data in a transparent and open way can yield significant benefits. For example, sharing commercially appropriate insights from 'first-of-a-kind' projects will enable new project developers to better understand the conditions for success (which can make it easier to attract investment). Additionally, research conducted to date (primarily in the context of use of hydrogen for heat) has highlighted considerable public unfamiliarity with hydrogen as a technology and fuel source. The more we collect and share information, the more readily we can socialise this new decarbonisation option with the public. This strategy has signalled where there are gaps in our understanding and how we are initiating work to fill those gaps. As our understanding and delivery evolves, we will continue to keep the public informed on the progress of decarbonisation and the development of the hydrogen economy in the UK. The government will aim to publish a review of this strategy every five years, with regular updates to the market on policy development in the interim.

Efficient

This strategy details how developing a hydrogen economy cuts across a number of existing areas of economic, energy and climate policy. This means that data collected in relation to low carbon hydrogen will have multiple uses which can inform policy design and strategic prioritisation of government activity. To reflect the increasingly important role of hydrogen as a key energy vector we will incorporate data on its deployment into existing BEIS energy systems publications.[100] Similarly, we will mainstream hydrogen indicators into future monitoring frameworks, including implementation plans for the NZHF and the Hydrogen Business Model work.

Forward looking

The UK Hydrogen Strategy signals a step change in government's policy activity on hydrogen. Data collection and metrics will allow us to develop strong monitoring and evaluation processes for future policies. Evidence gathered through monitoring will develop our understanding of the hydrogen economy and will feed into the policy development cycle to ensure that future policies are evidence-based and effective.[101]

Outcomes

We will track progress against our outcomes through a set of key indicators and broader metrics where available (see Table 5 below). Given the early state of low carbon hydrogen deployment we will need to develop metrics and collect new information against many of the outcomes. Tracking a range of data will help us provide a comprehensive picture of the strategy's impact across the economy.

Table 5: Hydrogen strategy outcomes and indicative metrics

Strategy outcome	Potential indicators and metrics
Progress towards 2030 ambition	• Low carbon hydrogen capacity installed (GW) • Volume of hydrogen produced (TWh) • Breakdown by technology (such as electrolysis and methane reformation)
Decarbonisation of existing UK hydrogen economy	• Remaining volume of fossil fuel hydrogen produced (TWh)
Lower cost of hydrogen production	• Levelised cost (£/MWh)
End to end hydrogen system with diverse range of users	• Estimated volume of hydrogen used in the UK (TWh by sector)
Increased public awareness	• Percentage of people aware of/familiar with hydrogen

Promote UK economic growth and opportunities (including jobs)	• We are exploring using metrics such as:
	  • Number of low carbon hydrogen jobs available in different regions of UK and/or percentage of people trained or retrained into 'green' jobs within the sector
	  • R&D spend and patents
	  • Gross Value Added (GVA)

Emissions reduction under Carbon Budgets 4 and 5	• CO_2 emissions reduction from hydrogen
Evidence-based policy making	• Quantitative and qualitative data collected • Engagement with stakeholders and expert advice

We will develop clear metrics in line with Table 5 above to enable us to monitor progress against our outcomes and commitments in this strategy, including incorporating data on hydrogen production into the Digest of UK Energy Statistics (DUKES).

We recognise that industry, investors and other stakeholders will value and need further clarity on what government is doing to support the hydrogen economy as it develops and scales up over the course of the decade and beyond. As indicated in Chapter 1.5, we intend to provide regular updates to the market as our policy develops. The first of these is expected in early 2022, where we intend to provide a response to our Hydrogen Business Model consultation and indicative heads of terms, our hydrogen production strategy and finalised design elements of the low carbon hydrogen standard. This approach will support learning by doing and maintain ongoing dialogue and engagement, providing early certainty and clarity where possible while developing the sustainable, long term underpinnings of a dynamic, world-leading hydrogen economy and securing strategic advantages for the UK.

Delivering a thriving UK hydrogen economy

Low carbon hydrogen has a key role to play in the UK's net zero energy future. The 2020s will be critical for laying the groundwork to develop a thriving hydrogen economy by 2030, positioned for further ramp up to help meet CB6 and set us on a pathway to net zero by 2050. This strategy sets out our whole-system approach to meeting this ambition. This includes working closely with industry and the research and innovation community to scale up along the value chain and put in place the wider policy frameworks to support this, and to secure the economic opportunities that the hydrogen economy holds for the whole of the UK. In doing so, we will work with our international partners to ensure that low carbon hydrogen can contribute to the global transition to net zero, and we will track our progress to make sure that we deliver on our objectives. Building a thriving UK hydrogen economy is a once-in-a-lifetime opportunity to help create a new, clean energy industry of the future which can play a key role in the UK's transition to net zero and deliver real economic opportunities across the UK.

Full list of commitments

Chapter	Commitment
2.2 Production	We will work with industry to deliver our ambition for 5GW of low carbon hydrogen production capacity by 2030. In doing so, we would hope to see 1GW of production capacity by 2025.
	We will provide £240m for the Net Zero Hydrogen Fund out to 2024/25 for co-investment in early hydrogen production projects. We intend to launch this Fund in early 2022.
	We will provide up to £60 million under the Low Carbon Hydrogen Supply 2 competition, which will develop novel hydrogen supply solutions for a growing hydrogen economy.
	We intend to finalise the design elements of a UK standard for low carbon hydrogen by early 2022.
	We intend to provide a response to our consultation on a Hydrogen Business Model alongside indicative Heads of Terms in Q1 2022. We aim to finalise the business model in 2022, enabling the first contracts to be allocated from Q1 2023.
	We will develop further detail on our production strategy and twin track approach, including less developed production methods, by early 2022.
2.3 Networks & storage	We will continue to support research, development and testing projects to explore development of hydrogen network infrastructure.
	We will review the overarching market framework set out in the Gas Act 1986 to ensure appropriate powers and responsibilities are in place to facilitate a decarbonised gas future.
	We are reviewing gas quality standards with a view to enabling the existing gas network to have access to a wider range of gases in future, potentially including hydrogen.
	We will launch a Call for Evidence on the future of the gas system this year.
	We will undertake a review of systemic hydrogen network requirements in the 2020s and beyond, including need for economic regulation and funding. We will provide information on the status and outputs of this hydrogen network review in early 2022.
	We will provide up to £68 million for the Longer Duration Energy Storage Demonstration competition, with storing hydrogen produced from excess electricity in scope (subject to eligibility criteria).
	We will undertake a review of systemic hydrogen storage requirements in the 2020s and beyond, including need for economic regulation and funding. We will provide information on the status and outputs of this review in early 2022.
	We will use the Hydrogen Business Model consultation to seek views on a number of questions which will feed into our hydrogen network and storage reviews.
	We will provide up to £60 million under the Low Carbon Hydrogen Supply 2 competition, which will develop novel hydrogen supply solutions, including storage technologies.

Chapter	Commitment
2.4.1 End use: industry	Within a year, we will publish a Call for Evidence to explore with industry the further interventions needed to phase out carbon intensive hydrogen and transition to low carbon production methods and sources, at the required pace to meet net zero.
	We will provide grant funding to support fuel switching technologies, including low carbon hydrogen, through Phase 2 of the £315m Industrial Energy Transformation Fund.
	We will launch a new £55 million Industrial Fuel Switching 2 Competition later this year to develop and demonstrate innovative solutions for industry to switch to low carbon fuels such as hydrogen.
	We will launch a new £40 million Red Diesel Replacement Competition to fund the development and demonstration of innovative technologies that enable Non-Road Mobile Machinery (NRMM) used for quarrying, mining, and construction to switch from red diesel to hydrogen or other low carbon fuels.
	We will provide support for research and innovation to support use of hydrogen in industry through the Net Zero Innovation Portfolio and initiatives led by the Industrial Decarbonisation Research & Innovation Centre.
	We will work with cluster projects to better understand the opportunities that pathfinder sites present, so to maximise the benefit to the sites themselves and the associated clusters.
	By the end of this year we will launch a new Call for Evidence on 'hydrogen-ready' industrial equipment.
	We will work with industrial end users to ensure their needs and the potential impacts of a full or partial transition to hydrogen via the gas grid are well understood.
2.4.1&2 End use: industry & power	We will engage with industry later this year on possible requirements for a research and innovation facility to support hydrogen use in industry and power.
2.4.2 End use: power	We will engage with industry to understand the economics and system impacts of introducing hydrogen into the power sector, including the impacts of sector coupling and utilising hydrogen energy storage.
	We will review the progress of recent actions in the power sector, and engage with relevant stakeholders and hydrogen projects early to ensure there is suitable support for hydrogen in the power sector.
2.4.3 End use: heat in buildings	We will deliver hydrogen for heat trials (neighbourhood by 2023, village by 2025 and potential pilot town by 2030), with a view to inform our 2026 strategic decision point on the future of hydrogen for heat.
	We aim to consult later this year on the case for enabling, or requiring, new natural gas boilers to be easily convertible to use hydrogen ('hydrogen-ready') by 2026.

Chapter	Commitment
2.4.4 End use: transport	We will provide up to £120 million this year through the Zero Emission Bus Regional Areas (ZEBRA) scheme towards 4,000 new zero emission buses, either hydrogen or battery electric, and infrastructure needed to support them.
	We will provide up to £20 million this year to design trials for both electric road system and hydrogen long haul heavy road vehicles (HGVs) and to run a battery electric trial to establish the feasibility, deliverability, costs and benefits of each technology.
	We will provide up to £20 million this year for the Clean Maritime Demonstration Competition, to accelerate the design and development of zero emission marine vessels in the UK.
	We will provide up to £15 million this year for the 'Green Fuels, Green Skies' competition to support the production of first-of-a-kind sustainable aviation fuel plants in the UK.
	We will provide £3 million this year to support the development of a Hydrogen Transport Hub in Tees Valley, and £4.8 million (subject to business case) to support the development of a hydrogen hub in Holyhead, Wales.
2.5.1 Creating a market: market framework	We intend to provide a response to our consultation on a Hydrogen Business Model alongside indicative Heads of Terms in Q1 2022. We aim to finalise the business model in 2022, enabling the first contracts to be allocated from Q1 2023. We will provide further detail on the revenue mechanism which will provide funding for the Business Model later this year.
	We will undertake further work to understand and develop appropriate market frameworks to drive investment and deployment and transition to longer term competitive market frameworks. We will aim to publish initial conclusions and proposals in early 2022.
	We will work across government to highlight the potential role of hydrogen in the future energy system and consider how this should be reflected in the design of wider energy markets and policies (e.g. capacity market, green gas support scheme).
	We will continue to work with industry and regulators in the early 2020s to identify, prioritise and address regulatory barriers faced by hydrogen projects, and consider changes needed to unlock hydrogen investment and deployment across the value chain. We will aim to publish initial conclusions and proposals in early 2022.
Case study: gas blending	We will engage with industry and regulators to develop the safety case, technical and cost effectiveness assessments of blending up to 20 per cent hydrogen (by volume) into the existing gas network. Subject to completion of safety trials, we aim to provide an indicative assessment of the value for money case for blending by Q3 2022, with a final policy decision likely to take place in late 2023.

Chapter	Commitment
2.5.2 Creating a market: regulatory framework	We will continue to work with industry and regulators to consider what regulatory changes may be appropriate across the hydrogen value chain.
	We will work across government to highlight the potential role of hydrogen in the future energy system and consider whether and how this should be reflected in wider regulatory and policy changes.
	We will establish a Hydrogen Regulators Forum, with representation across the relevant regulatory areas (environmental, safety, markets, competition and planning).
	We will work across government and with regulators to ensure that interlinkages between hydrogen and broader governance and regulatory changes are appropriately considered. We will consult this year on the institutional arrangements governing the energy system over the long term, including system operation and energy code governance.
3.1 Economic benefits: supply chains	We will actively monitor the extent to which competitive UK businesses are benefitting as the hydrogen sector matures. If necessary, we will consider what options are open to ensure a fair playing field that includes UK businesses. We will set out more detail on this in our Hydrogen Sector Development Action Plan by early 2022.
	We will work with industry to improve visibility of the low-carbon hydrogen project pipeline across the supply chain, learning from the successes of initiatives in other low-carbon sectors.
3.2 Economic benefits: jobs and skills	As part of our work to develop the low carbon hydrogen sector, we will assess the opportunities for hydrogen employment across the UK.
	We will work with industry, trades unions, the devolved administrations, local authorities, and enterprise agencies to support sustained and quality jobs and ensure that there is effective and targeted investment in relevant skills.
	We will work with industry, education providers and local and regional authorities to explore opportunities for relevant skills programmes, including apprenticeships and re-skilling programmes.
	We will set up an Early Career Professionals Forum under the Hydrogen Advisory Council.
	We will continue to monitor skills as the hydrogen sector matures and consult if necessary to identify barriers to sufficient private sector investment into growing the UK skills base and supporting good quality jobs and equality of opportunity.

Chapter	Commitment
3.3 Economic benefits: maximising UK R&I strengths	We will support hydrogen innovation as one of the ten key priority areas in the £1bn Net Zero Innovation Portfolio.
	We will work with the Hydrogen Advisory Council and other partners to better understand the scale, scope and type of private sector investment into hydrogen R&I in the UK, and how it can be further incentivised.
	We will work with experts including the newly established R&I Working Group under the Hydrogen Advisory Council to develop a hydrogen technology R&I Roadmap to inform public and private sector R&I investment and prioritisation.
	We will use our role as one of the co-leads of Mission Innovation's new Clean Hydrogen Mission to champion open and active international engagement and research sharing to accelerate hydrogen R&I progress and maximise its benefits.
	We will continue to foster collaborative international research and information exchange through our active membership of the International Energy Agency (IEA) Hydrogen Technology Collaboration Programme (Hydrogen TCP).
4 International: demonstrating global leadership	Through the G7, including our Presidency this year, we will reaffirm the importance of low carbon hydrogen in the clean energy transition, and seek commitments to increase its production and deployment.
	Through our global climate leadership, including through our co-Presidency of COP26, we will seek to bring together public and private actors who recognise the crucial role that hydrogen can play in tackling emissions and unleashing clean growth to facilitate greater coordination and progress across international hydrogen innovation, deployment and policy activity.
5 Tracking our progress	We will develop metrics to enable us to monitor progress against our outcomes and the commitments in this strategy, including incorporating data on hydrogen production into the Digest of UK Energy Statistics.

Endnotes

1 Internal BEIS analysis based on the Energy Innovation Needs Assessment (EINA) methodology with updated domestic and global scenarios; figures consider the direct GVA and jobs linked to hydrogen production, stationary CHP fuel cells and domestic distribution only; EINA methodology provided by Vivid Economics (2019), 'Hydrogen and fuel cells (EINA sub-theme)' (viewed 1 June 2021)
2 Data from the Fuel Cells and Hydrogen Observatory suggests less than one per cent of hydrogen production capacity in the UK is from electrolysis, the carbon intensity of which depends on the electricity source; see Fuel Cells and Hydrogen Observatory (2021), 'Hydrogen Supply Capacity' (viewed 9 June 2021)
3 Fuel Cells and Hydrogen Observatory (2021), 'Hydrogen Demand' (viewed 9 June 2021)
4 Department for Business, Energy and Industrial Strategy (2021), 'Carbon Budget 6 Impact Assessment' (viewed 9 June 2021)
5 Hydrogen as a proportion of final energy consumption in 2050 in agriculture, industry, residential, services and transport sectors; excludes energy demand for resources, processing and electricity generation
6 Department for Business, Energy and Industrial Strategy (2021), 'Final UK greenhouse gas emissions national statistics' (viewed 9 June 2021)
7 HM Government (2020), 'The Ten Point Plan for a Green Industrial Revolution' (viewed 22 June 2021)
8 Based on estimates of carbon captured by trees over 10 year period; see Forestry Commission (2020), 'Responding to the Climate Emergency with New Trees and Woodlands' (viewed 16 June 2021); Forestry Commission (2019), 'Government Supported New Planting of Trees in England' (viewed 16 June 2021)
9 Internal BEIS analysis based on EINA methodology with updated domestic and global scenarios (see Figure 1)
10 HM Government (2020), 'The Ten Point Plan for a green industrial revolution' (viewed 1 June 2021)
11 Internal BEIS analysis based on EINA methodology with updated domestic and global scenarios (see Figure 1)
12 Scottish Government (2020), 'Scottish Hydrogen Assessment' (viewed on 21 June 2021)
13 Scottish Government (2020), 'Scottish Government Hydrogen Policy Statement' (viewed 21 June 2021)
14 UK Government (2021), 'Heads of Terms for the Islands Growth Deal' (viewed 21 June 2021)
15 Welsh Government & Element Energy (2020), 'Hydrogen in Wales: a pathway and next steps for developing the hydrogen energy sector in Wales' (viewed 22 June 2021)
16 DNV GL (2019), 'Hy4Heat, Hydrogen Purity – Final Report' (viewed 18 June 2021) and Energy Research Partnership (2016), 'Potential Role of Hydrogen in the UK Energy System' (viewed 18 June 2021)
17 For further detail, see: 'Current role of Hydrogen' in Department for Business, Energy and Industrial Strategy (2021), 'Hydrogen Analytical Annex' (viewed 21 June 2021)
18 2020s, central case scenario; for more detail on carbon intensity estimates, see: Department for Business, Energy and Industrial Strategy (2021), 'Consultation on UK Low Carbon Hydrogen'; E4tech (UK) Ltd and Ludwig-Bölkow-Systemtechnik GmbH (2021), 'Low Carbon Hydrogen Standard' (viewed 21 June 2021)
19 Department for Business, Energy and Industrial Strategy (2021), 'Hydrogen Production Costs 2021' (viewed 21 June 2021); estimates based on retail electricity and fuel prices; SMR without CCUS estimate based on capex specific for grey hydrogen production and 0% carbon capture; all other costs and technical specifications are in line with those for SMR + CCUS plants
20 For further detail, see: '2030 Ambition' in Department for Business, Energy and Industrial Strategy (2021), 'Hydrogen Analytical Annex' (viewed 21 June 2021)
21 BEIS analysis, as well as external analysis by the CCC and others, shows that a mix of production methods, including electrolytic and CCUS-enabled hydrogen production, will be compatible with reaching net zero in 2050
22 For further detail, see: 'Hydrogen Supply' in Department for Business, Energy and Industrial Strategy (2021), 'Hydrogen Analytical Annex' (viewed 21 June 2021); and Department for Business, Energy and Industrial Strategy (2021), 'Hydrogen Production Costs 2021' (viewed 21 June 2021)
23 For further detail, see: 'Supply beyond 2030' in Department for Business, Energy and Industrial Strategy (2021), 'Hydrogen Analytical Annex' (viewed 21 June 2021)
24 Department for Business, Energy & Industrial Strategy (2021), 'Carbon Budget 6 Impact Assessment' (viewed 9 June 2021)

25 For further detail, see: 'Supply beyond 2030' in Department for Business, Energy and Industrial Strategy (2021), 'Hydrogen Analytical Annex' (viewed 21 June 2021)
26 Gas for Climate (2021), 'The 'Extending The European Backbone: A European Hydrogen Infrastructure Vision Covering 21 Countries' (viewed 17 June 2021); page 4 sets out that by 2040, "a pan-European dedicated hydrogen transport infrastructure can be envisaged with a total length of around 39,700 kilometres, consisting of 69% repurposed existing infrastructure and 31% of new hydrogen pipelines"
27 The business model for CCUS transport and storage is currently under development with the latest commercial update, with implications for producers of CCUS-enabled hydrogen; see Department for Business, Energy & Industrial Strategy (2021), 'Carbon Capture, Usage and Storage An update on the business model for Industrial Carbon Capture' (viewed 17 June 2021)
28 Hydrogen has only one-third of the energy density by volume of natural gas and can cause embrittlement in certain materials, increasing risk of leakage; Arup (2016), 'Five minute guide to Hydrogen' (viewed 3 March 2021)
29 Inovyn and Storenergy (2019),'Project HySecure – Phase 1 Summary Sept 2019', page 4-5, Produced under the Department for Business, Energy and Industrial Strategy Low Carbon Hydrogen Supply Competition (viewed 21 June 2021)
30 Williams J and others, British Geological Survey (2020), 'Theoretical capacity for underground hydrogen storage in UK salt caverns' (viewed 21 June 2021)
31 Energy Networks Association (2021), 'Britain's Hydrogen Network Plan - Report' (viewed 21 June 2021)
32 National Grid ESO (2021), 'Future Energy Scenarios' (viewed 21 June 2021)
33 Gazias E and others, Aurora Energy Research (2020), 'Hydrogen for a Net Zero GB: an integrated energy market perspective' (viewed 25 June 2021)
34 Conversions undertaken by BEIS; see OfGEM (2021), 'GB Gas Storage Facilities' (viewed 21 June 2021)
35 HyNet North West (2020), 'HyNet North West – Unlocking Net Zero for the UK' (viewed 21 June 2021)
36 Equinor (2020), 'H2H Saltend - The First Step to a Zero Carbon Humber' (viewed 21 June 2021)
37 For further detail on the use of ammonia in shipping, see: 'Use of Hydrogen in Transport' in Department for Business, Energy and Industrial Strategy (2021), 'Hydrogen Analytical Annex' (viewed 21 June 2021)
38 Department for Business Energy and Industrial Strategy (2018), 'Low Carbon Hydrogen Supply Competition (closed)' (viewed 21 June 2021)
39 ITM Power, Inovyn, Storenergy, Cadent, Element Energy (2020), 'Project Centurion Feasibility Study', UK Research and Innovation (viewed 21 June 2021)
40 Department for Business, Energy & Industrial Strategy (2021), 'Low Carbon Hydrogen Supply 2 Competition' (viewed 21 June 2021)
41 Department for Business, Energy & Industrial Strategy (2021), 'Longer Duration Energy Storage Demonstration competition' (viewed 21 June 2021)
42 Department for Business, Energy & Industrial Strategy (2021) 'Facilitating the deployment of large-scale and long-duration electricity storage: call for evidence' (viewed 21 July 2021)
43 Or 72 $MtCO_2e$; see Department for Business, Energy and Industrial Strategy (2020), 'Final UK greenhouse gas emissions from national statistics: 1990 to 2018: Supplementary tables' (viewed 21 June 2021)
44 For further detail, see: 'Box 1' in Department for Business, Energy and Industrial Strategy (2021), 'Hydrogen Analytical Annex' (viewed 21 June 2021)
45 Less energy-intensive manufacturing includes the manufacturing of vehicles, wood products, pharmaceuticals and electronics, among other industries
46 Department for Business, Energy and Industrial Strategy (2021), 'IETF Phase 1: Summer competition winners' (viewed 22 June 2021)
47 For further detail, see: 'Box 2' in Department for Business, Energy and Industrial Strategy (2021), 'Hydrogen Analytical Annex' (viewed 21 June 2021)
48 Department for Business, Energy and Industrial Strategy (2020), 'Energy White Paper: Powering our Net Zero Future December 2020' (viewed June 2021)
49 Department for Business, Energy and Industrial Strategy (2020), 'Enabling a high renewable net zero electricity system Call for Evidence' (viewed June 2021)
50 Department for Business, Energy & Industrial Strategy and Welsh Government (2021), 'Decarbonisation Readiness: joint call for evidence on the expansion of the 2009 Carbon Capture Readiness requirements' (viewed 22 July 2021)

51 Department for Business, Energy & Industrial Strategy (2021), 'Facilitating the deployment of large-scale and long-duration electricity storage: call for evidence' (viewed 21 July)
52 Department for Business, Energy & Industrial Strategy (2021), 'Capacity Market 2021: A Call for Evidence on early action to align with net zero' (viewed 26 July 2021)
53 National Statistics (2020), 'Households projections for England', Table 401 and Department for Business, Energy and Industrial Strategy (2020), 'Non-domestic National Energy Efficiency Data-Framework' based on 2018 data (viewed April 2021)
54 National Statistics (2020), 'Households projections for England', Table 401 and Department for Business, Energy and Industrial Strategy (2020), 'Non-domestic National Energy Efficiency Data-Framework' based on 2018 data (viewed April 2021)
55 For further detail, see: 'Box 3' in Department for Business, Energy and Industrial Strategy (2021), 'Hydrogen Analytical Annex' (viewed 21 June 2021)
56 Department for Business Energy and Industrial Strategy (2021), 'UK Greenhouse Gas Emissions' (viewed June 2021)
57 Since 2017, the programme has been delivering new publicly accessible hydrogen refuelling stations, upgrading existing stations and increasing the uptake of fuel cell electric vehicles
58 For further detail, see: 'Box 4' in Department for Business, Energy and Industrial Strategy (2021), 'Hydrogen Analytical Annex' (viewed 21 June 2021)
59 By 2050, there could be 75-9TWh of demand for hydrogen-based fuels (including ammonia and methanol) in domestic and international shipping; for further detail, see: 'Box 4' in Department for Business, Energy and Industrial Strategy (2021), 'Hydrogen Analytical Annex' (viewed 21 June 2021)
60 For further detail, see: 'Box 4' in Department for Business, Energy and Industrial Strategy (2021), 'Hydrogen Analytical Annex' (viewed 21 June 2021)
61 Department for Transport (2020), 'Annual bus statistics: year ending March 2020' (viewed June 2021)
62 Lee and others (2013), 'Shipping and aviation emissions in the context of a 2°C emission pathway' (viewed June 2021)
63 UMAS, E4Tech, Frontier Economics, CE Delft (2019) 'Reducing the Maritime Sector's Contribution to Climate Change and Air Pollution. Scenario Analysis: Take-up of Emissions Reduction Options and their Impacts on Emissions and Costs. A Report for the Department for Transport' (viewed June 2021); based on the definition of UK international shipping that was adopted in the research commissioned by Department for Transport, the estimates for UK international shipping represent the potential hydrogen demand associated with the international shipping activity that transports UK imports; other definitions of UK international shipping would result in different estimates
64 UMAS, E4Tech, Frontier Economics, CE Delft (2019) 'Reducing the Maritime Sector's Contribution to Climate Change and Air Pollution. Maritime Emission Reduction Options. A Summary Report for the Department for Transport' (viewed June 2021)
65 Department for Transport (2019), 'Clean Maritime Plan' (viewed June 2020)
66 H M Government (2021), '£20 million fund to propel green shipbuilding launched' (viewed June 2021)
67 Airbus (2021), 'ZEROe: towards the world's first zero-emission commercial aircraft' (viewed June 2021)
68 'SAF' describes low carbon alternatives to conventional, fossil-derived, aviation fuel which present chemical and physical characteristics similar to those of conventional jet fuel and can therefore be blended into current jet fuel without requiring any aircraft or engine modifications
69 Ricardo (2020), 'Targeted Aviation Advanced Biofuels Demonstration Competition – Feasibility Study' (viewed June 2021)
70 Department for Transport (2021) 'Mandating the use of sustainable aviation fuels in the UK' (viewed 23 July 2021)
71 The Climate Change Act 2008 set a legally binding target for reducing UK carbon dioxide emission by at least 80 per cent by 2050, compared to 1990 levels, which has since been superseded by our net zero target
72 H M Government (2020), 'The Ten Point Plan for a green industrial revolution' (viewed 14 June 2021)
73 Department for Business, Energy and Industrial Strategy (2020), 'Energy White Paper: Powering our net zero future' (viewed 14 June 2021)
74 National Grid (2021), 'Hydrogen: the future fuel to achieve net zero?' (viewed 14 June 2021)
75 Legislation.gov.uk (1996), 'Gas Safety (Management) Regulations 1996' (viewed 4 June 2021)
76 HyDeploy (2021), 'What is HyDeploy?' (viewed 14 June 2021)
77 National Grid (2021), 'FutureGrid' (viewed 14 June 2021)
78 HyLaw sought to identify legal barriers to the commercialisation of fuel cell and hydrogen technologies across 18 countries in Europe; see HyLaw (2021), 'About HyLAW' (viewed 14 June 2021)

79 Internal BEIS analysis based on the EINA methodology with updated domestic and global scenarios; figures consider the direct GVA and jobs linked to hydrogen production, stationary CHP fuel cells and domestic distribution only; EINA methodology provided by Vivid Economics (2019), 'Hydrogen and fuel cells (EINA sub-theme)' (viewed 1 June 2021)
80 Energy Industries Council (2021), 'press release', announcing joint BEIS-DIT-EIC Energy Supply Chain Taskforce (viewed 27 May 2021)
81 Defined as new jobs generated by increased local spending on goods and services
82 As defined in the Department for Business, Energy and Industrial Strategy (2018), 'Good Work Plan' (viewed June 2021)
83 Department for Education (2021), 'Skills for Jobs White Paper' (viewed June 2021)
84 Green Jobs Taskforce (2021), 'Green Jobs Taskforce report' (viewed on 14 July 2021)
85 For 40% women employed in those sectors by 2030; see Department for Business, Energy and Industrial Strategy (2019), 'Offshore Wind Sector Deal' and Department for Business, Energy and Industrial Strategy, (2018) 'Nuclear Sector Deal' (viewed June 2021)
86 Oil and Gas UK (2019), 'Workforce Report' (figure from 2018), (viewed 18 May 2021)
87 Department for Business, Energy and Industrial Strategy (2021), 'North Sea Transition Deal' (viewed June 2021)
88 Silverman D, Imperial College London (2020), 'Imperial pioneers innovation in clean energy sector' (viewed 18 June 2021); Durlacher Ltd (2004), 'Placing and Admission to the Alternative Investment Market' (viewed 18 June 2021)
89 Hydrogen TCP (2020), 'International Energy Agency' (viewed 21 June 2021)
90 Wind Europe (2021) 'Offshore Wind in Europe, Key Trends and Statistics 2020' (exchange rate based on monthly average between Jan 2011 and Dec 2020)
91 HM Treasury (2021), 'UK Infrastructure Bank Press Release' (viewed 17 June 2021)
92 Sustainable Development scenario from 'IEA Energy Technology Perspectives 2020' (viewed 17 May 2021)
93 GHG abatement estimated relative to IEA Stated Policy scenario, accounting for existing policy commitments
94 Strong policy scenario from 'Bloomberg New Energy Finance (BNEF) Hydrogen Economy Outlook 2020', (viewed 17 May 2021)
95 Hydrogen Council (2020), 'Path to hydrogen competitiveness – A cost perspective' (viewed 17 May 2021)
96 HM Treasury (2020), 'The Green Book' (viewed June 2021)
97 To include Digest of UK Energy Statistics (DUKES) and BEIS' Energy and emissions projections (EEP)
98 Department for Business, Energy and Industrial Strategy (2020), 'Monitoring and evaluation framework' (viewed June 2021)
99 Offshore wind prices in renewable Contracts for Difference auctions have fallen from £120/MWh in 2015 to around £40/MWh in 2019, and operational offshore wind capacity has increased from just over 1GW in 2010 to 10GW by 2019; see Department for Business, Energy and Industrial Strategy (2020), 'Energy White Paper: Powering our net zero future' (viewed June 2021)
100 To include Digest of UK Energy Statistics (DUKES) and BEIS' Energy and emissions projections (EEP)
101 For further detail on the policy development cycle, see: HM Treasury (2020), 'The Green Book' (viewed June 2021)

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