

ENERGY WHITE PAPER

Powering our Net Zero Future

December 2020 | CP 337



HM Government



TOGETHER
FOR OUR
PLANET





The Energy White Paper

Powering our Net Zero Future

Presented to Parliament
by the Secretary of State for Business, Energy and Industrial Strategy
by Command of Her Majesty

December 2020



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ENERGY WHITE PAPER

Ministerial foreword



The government presents this white paper at a time of unprecedented peacetime challenge to our country.

Coronavirus has taken a heavy toll on our society and on our economy. But we will overcome COVID-19 and rebuild our economy, building back better and levelling up the country.

As we do so, we must address the inter-generational challenge of climate change. Unchecked, the impact of rising global temperatures represents an existential threat to the planet. So, building back better means building back greener.

The UK has set a world-leading net zero target, the first major economy to do so, but simply setting the target is not enough – we need to achieve it. Failing to act will result in natural catastrophes and changing weather patterns, as well as significant economic damage, supply chain disruption and displacement of populations.

Tackling climate change will require decisive global action and significant investment and innovation by the public and private sectors, creating whole new industries, technologies, and professions.

But fighting climate change offers huge opportunity for both growth and job creation. The global markets for low-carbon technologies, electric vehicles and clean energy are fast growing: zero emission vehicles could support 40,000 jobs by 2030, with exports of new technologies such as CCUS having the potential to add £3.6 billion GVA by 2030. The time is now to seize these opportunities.

This white paper puts net zero and our effort to fight climate change at its core, following the Prime Minister's Ten Point Plan for a Green Industrial Revolution. The Ten Point Plan sets out how government investment will leverage billions of pounds more of private investment and support up to 250,000 jobs by 2030.

This includes building on our leadership in offshore wind to target 40GW by 2030 – enough to power every home in the UK – which alone will support up to 60,000 jobs.

The way we produce and use energy is therefore at the heart of this. Our success will rest on a decisive shift away from fossil fuels to using clean energy for heat and industrial processes, as much as for electricity generation.

These are more than academic considerations; the shift to net zero will affect us all. This white paper presents a vision of how we make the transition to clean energy by 2050 and what this will mean for us as consumers of energy in our homes and places of work, or for how businesses use energy to produce goods and services.

It sets out the changes which will be required. We will reduce emissions through shifting from gas to electricity to heat our homes and by better insulating the buildings in which we live and work. We will end the sale of petrol and diesel cars and vans, and accelerate the transition to clean, zero tailpipe emission vehicles. We will start to capture carbon emissions from power generation and from industry. And we will switch to new, clean fuels such as hydrogen for heat, power and industrial processes.

As we leave fossil fuels behind us and increasingly rely on clean electricity, our experiences as energy consumers will be very different. Smart technologies are revolutionising how we can engage the market. Smart meters and a range of smart appliances, backed by new smart tariffs, will give us control about how we use energy and help us manage our bills – running the washing machine or charging the electric vehicle when demand is low and electricity is cheap, even selling surplus power back to the grid at a profit.

And we will do this with affordability at the front of our minds. The costs of renewables have fallen sharply over the last five years. Offshore wind prices in renewable Contracts for Difference auctions have fallen from £120/MWh in 2015 to around £40/MWh in last year's auction.

Greater competition and more innovation will drive down the costs of our energy system even further. We expect energy companies to ensure that the benefits of a more efficient system result in a fair deal for consumers. Where we use taxpayers' money to fund the transition to clean energy, we will leverage private capital as much as we can.

Across the board, as a result of our policies, energy bills will remain affordable over the 2020s. A major push on improving the energy efficiency of our homes will mean households can significantly reduce demand and save money on their bills.

We understand the effect that COVID-19 has had on household incomes, and therefore commit to protecting those who are particularly vulnerable. Lower income households can receive up to £10,000 to improve the energy efficiency of their homes via the Green Homes Grant scheme, saving up to £600 each year on bills on average. Through this white paper, we are expanding the Warm Home Discount to around three million homes to provide £150 a year off electricity bills, representing £1.9 billion of extra support for households in fuel poverty. This builds on the Ten Point Plan's commitment to extend the Energy Company Obligation to 2026.

This is an ambitious domestic agenda on which we will also seek to secure equally ambitious international action, through the UK's presidency of COP26, the UN's climate conference being held in Glasgow in November 2021. The actions we take as a result of this white paper, as part of our wider climate agenda, are intended to show leadership and vision and demonstrate to our partners around the world that now is the time to take the bold steps to tackle climate change. The UK is leading from the front in the transition to clean energy, while ensuring that we leave no one behind as we build back greener.

Rt Hon Alok Sharma MP

Secretary of State for Business,
Energy and Industrial Strategy

INTRODUCTION

We are on the cusp of a global Green Industrial Revolution.

A decorative graphic consisting of several concentric circles in shades of purple and blue. A white dashed line forms a partial circle around the text. A white crosshair-like symbol is positioned in the upper right, and another similar symbol is at the bottom center.

The Prime Minister's Ten Point Plan has set out the measures that will help ensure the UK is at the forefront of this revolution, just as we led the first over two centuries ago.

As nations move out of the shadow of coronavirus and confront the challenge of climate change with renewed vigour, markets for new green products and services will spring up round the world. Taking action now will help ensure not just that we end our contribution to climate change by achieving our target of net zero emissions. It will help position UK companies and our world class research base to seize the business opportunities which flow from it, creating jobs and wealth for our country.

Following on from the Ten Point Plan and the National Infrastructure Strategy, the Energy White Paper provides further clarity on the Prime Minister's measures and puts in place a strategy for the wider energy system that:

- ▶ **Transforms energy**, building a cleaner, greener future for our country, our people and our planet
- ▶ **Supports a green recovery**, growing our economy, supporting thousands of green jobs across the country in new green industries and leveraging new green export opportunities
- ▶ **Creates a fair deal for consumers**, protecting the fuel poor, providing opportunities to save money on bills, giving us warmer, more comfortable homes and balancing investment against bill impacts

THE COMPELLING CASE FOR TACKLING CLIMATE CHANGE

We are reminded on a daily basis why we need this Green Industrial Revolution: climate change is having a real effect on our planet.

The melting of glaciers and ice sheets is accelerating, contributing to rising sea levels across the globe, with melting rates of ice sheets in Greenland and Antarctica matching the Intergovernmental Panel on Climate Change's worst-case climate warming scenarios.¹ All ten of the warmest years in the UK's temperature record have taken place since 2002.² Rainfall over Scotland is up 10 per cent from the start of the 20th century.³ The record-breaking European summer heatwave of 2003 resulted in at least 70,000 deaths across the continent,⁴ and such heatwaves are projected to become the norm in the UK by the 2040s at current rates of warming.⁵

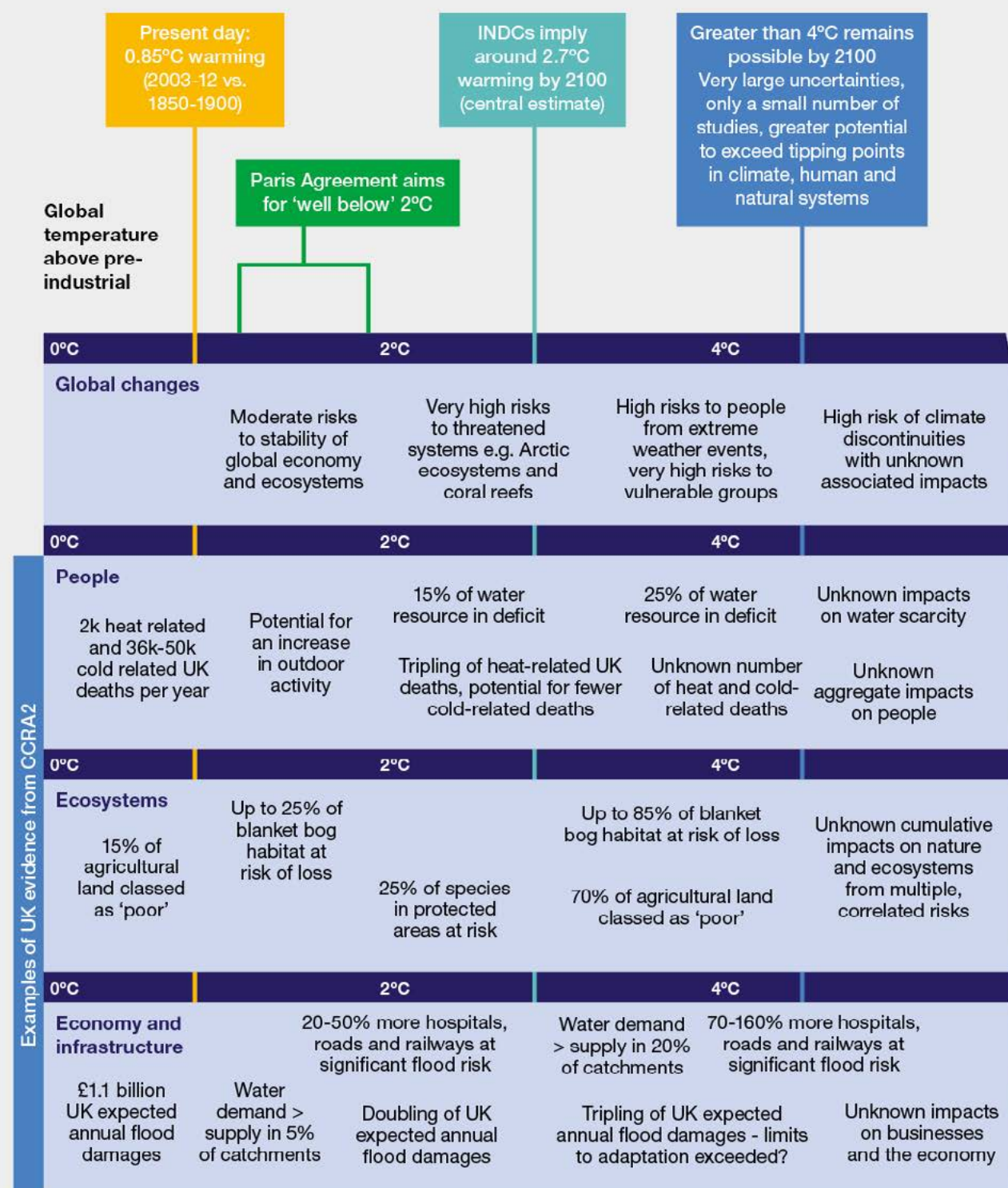
We need to act urgently. The future impacts of climate change depend upon how much we can hold down the rising global temperature. To minimise the risk of dangerous climate change, the landmark Paris Agreement of 2015 aims to halt global warming at well below 2°C, while pursuing efforts to limit it to 1.5°C, increasing measures to adapt to climate change, and aligning financial systems to these goals.⁶

At the global scale, however, we are not presently on track to reach the temperature goal of the Paris Agreement. Based on current national pledges, and assuming the level of ambition does not change, the world is heading for around 3°C of warming by the end of the century.⁷

The cost of inaction is too high.⁸ We can expect to see severe impacts under 3°C of warming. Globally, the chances of there being a major heatwave in any given year would increase to about 79 per cent, compared to a five per cent chance now.⁹ Many regions of the world would see what is now considered a 1-in-100-year drought happening every two to five years.¹⁰

At 3°C of global warming, the UK is expected to be significantly affected, seeing sea level rise of up to 0.83 m.¹¹ River flooding would cause twice as much economic damage and affect twice as many people, compared to today,¹² while by 2050, up to 7,000 people could die every year due to heat, compared to approximately 2,000 today.¹³ And, without action now, we cannot rule out 4°C of warming by the end of the century, with real risks of higher warming than that.¹⁴ A warming of 4°C would increase the risk of passing thresholds that would result in large scale and irreversible changes to the global climate, including large-scale methane release from thawing permafrost and the collapse of the Atlantic Meridional Overturning Circulation.¹⁵ The loss of ice sheets could result in multi-metre rises in sea level on time scales of a century to millennia.¹⁶

To meet the temperature goal of the Paris Agreement, the world must collectively and rapidly reduce global emissions to net zero over the next 30 years. Success will mean we are less exposed to flood and heat risks and preserve our national security, our prosperity, and our natural world which are threatened by the global disruption of climate change.

FIGURE 1.1 – IMPACTS OF INCREASING TEMPERATURES ON UK ¹⁷

Source: CCC CCRA 2017

OUR DOMESTIC AGENDA

As we tackle climate change, we will have the interests of consumers at the front of our mind, now and for future generations.

We are committed to ensuring that the cost of the transition to net zero is fair and affordable. We have consistently balanced spending on measures that decarbonise the energy system with the need to help consumers save money on their bills. Thanks to early investment, many low-carbon technologies are now cheaper than their fossil fuel counterparts.

Our vision is of a system with consumers at its heart, able to make money or save on bills through using the new technologies net zero will require. So our approach means not just deploying measures that save energy and reduce bills, but also ensuring the energy system is fit for a net zero world, making markets efficient, incentivising people to move to clean energy solutions, or making sure system rules are agile and flexible to accommodate new technologies and new ways of doing things.

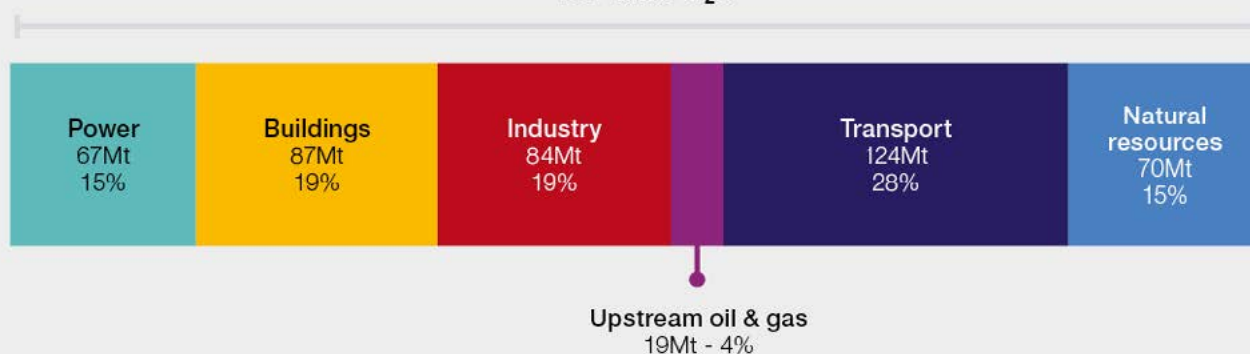
But affordability does not mean compromising our ambition. Achieving our 2050 goal requires action across the economy. The measures in this white paper will reduce emissions from power, buildings, industry, upstream oil and gas, and address the implications for the energy system of electrifying surface transport. We will publish our wider Transport Decarbonisation Plan in the spring.

Action on energy will be consistent with our wider environmental commitments, as we balance new technologies and the need for new infrastructure with protecting the environment, including air quality. Our 25 Year Environment Plan aims to improve the environment within a generation. Through the Environment Bill, we are placing this ambitious set of proposals on a legal footing, including a commitment to bring forward new legally binding environmental targets (on air quality, biodiversity, water, and resource efficiency and waste reduction) by October 2022.

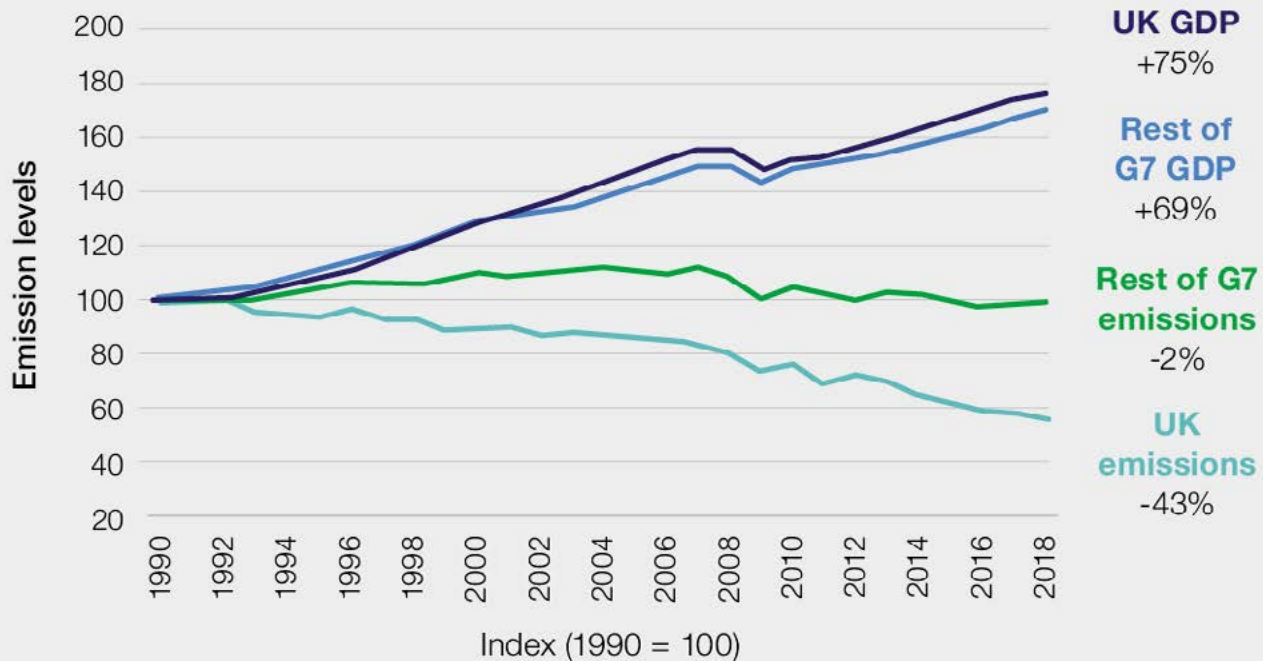
FIGURE 1.2 – UK TERRITORIAL EMISSIONS

2018

451 MtCO₂e



Source: BEIS Analysis of 'Final UK GHG emissions national statistics' and NAEI

FIGURE 1.3 – UK VS REST OF G7 GDP AND EMISSIONS

Source: World Bank, UNFCCC National Inventory Submissions, ONS, BEIS Greenhouse Gas Inventory 1990-2018.

Our National Adaptation Programme, which was updated in 2018, sets out the actions which the government is, and will be taking, to address the risks and opportunities posed by climate change in response to the Climate Change Risk Assessment. This includes a dedicated chapter on infrastructure, including actions to build the energy sector's resilience to climate change.

No one doubts the challenge of achieving net zero emissions, but the UK is able to build on 30 years of successfully reducing emissions while simultaneously growing our economy. Between 1990 and 2018, emissions fell by 43 per cent while GDP rose by 75 per cent, with the UK decarbonising faster than any other G20 country since 2000 (Figure 1.3).¹⁸

Energy has led the way. In 2019, greenhouse gas emissions (MtCO₂e) from electricity generation were down 13 per cent on 2018 levels and 72 per cent lower than 1990 levels,¹⁹ as we have switched from

coal to gas and renewable power together with the continued contribution of nuclear. In April 2017, the UK experienced its first coal free day since the industrial revolution. From April to June 2020, the total coal-free period lasted 67 days.²⁰

Over the past decade, and with government support, the amount of renewable capacity connected to the grid has increased from 8GW in 2009 to 48GW at the end of June this year, an increase of 500 per cent.²¹ The share of low-carbon electricity generation has risen to 54 per cent in 2019, with renewables at a record 37 per cent.²²

Through a mix of early policy action, increased competition, innovation, and growth in deployment, our sustained support for clean electricity has helped secure dramatic falls in the costs of some renewables and provided developers and private investors with long term certainty.

The cost of offshore wind projects contracted in 2019 fell by 30 per cent for example, relative to those contracted in 2018.²³ There are even early signs of some renewable technologies deploying without direct policy support.²⁴

But there is still much more to do. Our energy system is dominated by the use of fossil fuels and will need to change dramatically by 2050 if we are to achieve net zero emissions (see figure 1.4).

Decarbonising the energy system over the next thirty years means replacing - as far as it is possible to do so - fossil fuels with clean energy technologies such as renewables, nuclear and hydrogen.

30

years of successfully reducing UK emissions while simultaneously growing our economy

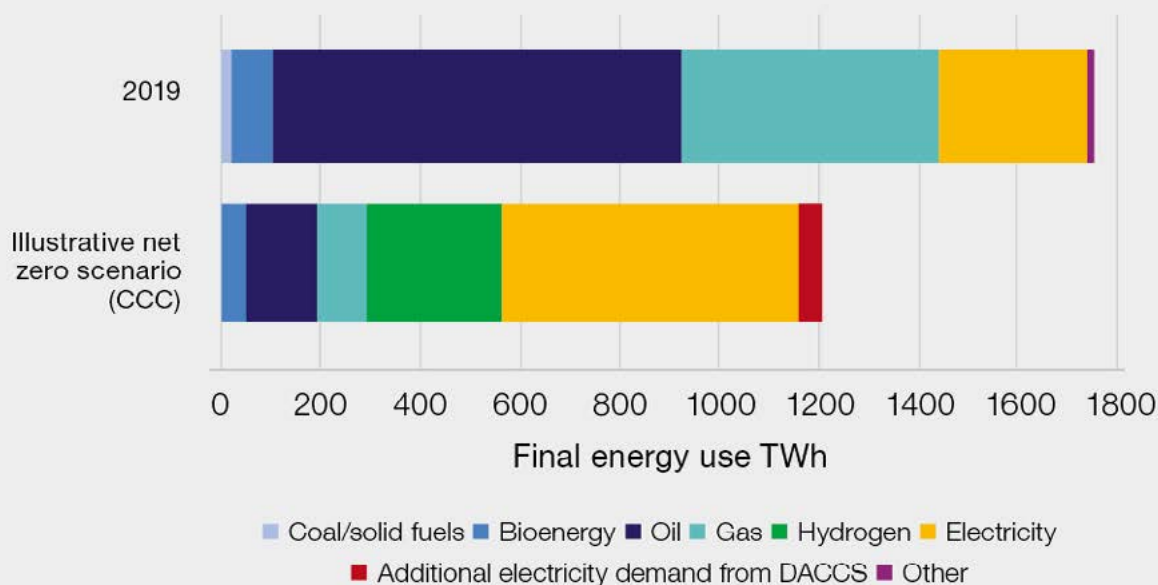
500%

increase in the amount of renewable capacity connected to the grid from 2009 to 2020

72%

reduction in greenhouse gas emissions from electricity generation between 1990-2019

FIGURE 1.4 – ILLUSTRATIVE UK FINAL ENERGY USE IN 2050



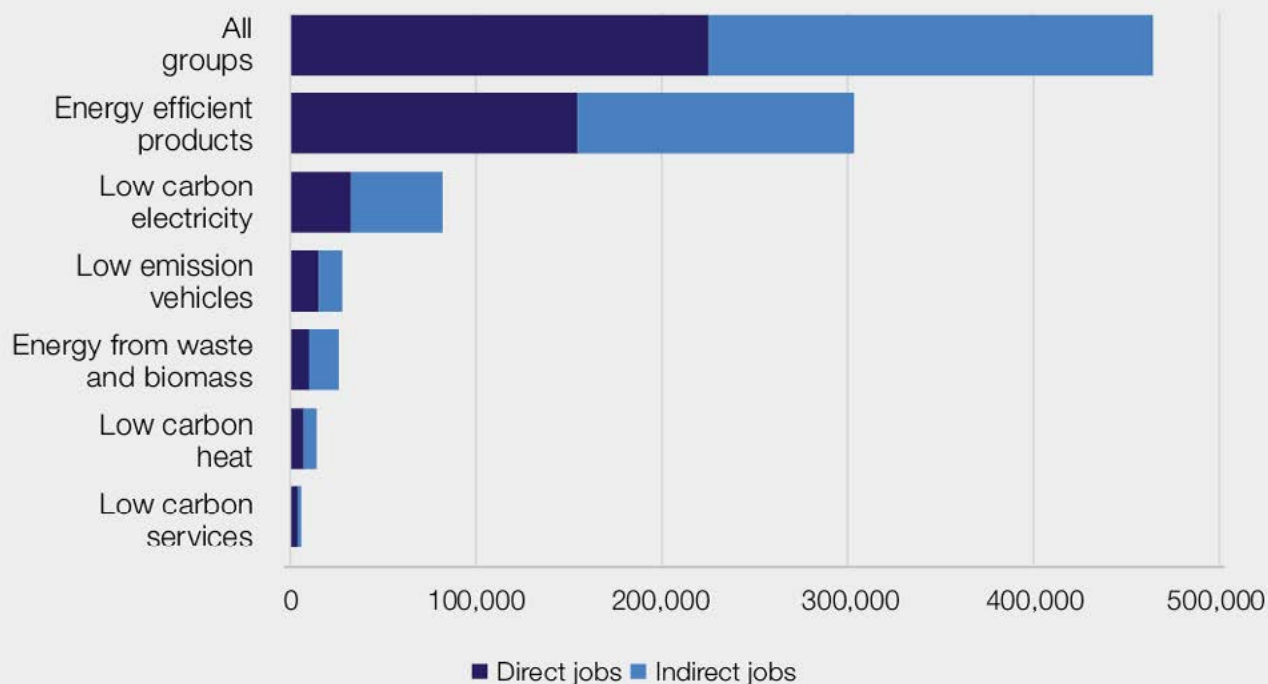
Source: Energy Trends table 1.2; CCC Net Zero Report



This is a significant and historic undertaking. It means ending our dependency on oil to power nearly half of our economy. It means largely eliminating the use of natural gas to heat our homes, and make them considerably more efficient – but as 20 per cent of homes currently overheat even in cool summers we will need to ensure that our homes are not just efficient, but adapted to the future climate.²⁵ This will apply throughout the system.

Clean electricity will become the predominant form of energy, entailing a potential doubling of electricity demand and consequently a fourfold increase in low-carbon electricity generation. We must secure this transition while retaining the essential reliability, resilience and affordability of our energy, as the bedrock of a modern, productive economy driving almost every facet of our home and working lives.

Delivering this transition will require billions of pounds of investment in clean energy infrastructure or new low-carbon technologies, and a major shift away from spending in fossil fuels. As set out in the National Infrastructure Strategy,²⁶ delivering this volume of private investment will require multiple policy levers and the right market frameworks to encourage competition and drive down costs. This challenge is set against the backdrop of an economy which has been hit by the largest recession in 300 years as a result of the COVID-19 pandemic. Our commitments to new and improved buildings, infrastructure and energy sources will support near-term investment and jobs in the UK. It will also establish world-leading capabilities in the new technologies which will be needed globally to tackle climate change, growing our capability to trade UK expertise around the world.

FIGURE 1.5 – LOW CARBON & RENEWABLE ENERGY EMPLOYMENT

Across the UK almost half a million people are already employed in the low-carbon economy and its supply chains (Figure 1.5).²⁷ These jobs are frequently outside the South East of England, including electric vehicle manufacturing in the Midlands and North East, and reconditioning and recycling in the North East and West Midlands. The offshore wind sector supports an estimated 7,200 direct jobs as a whole, with a burgeoning industry on the north east coast of England, centred around the Humber and the Tees.

But this is just the beginning. In November 2020, the Prime Minister announced his Ten Point Plan to lay the foundations for a Green Industrial Revolution. We will start by supporting 90,000 jobs across the UK in this Parliament, and up to 250,000 by 2030. The response to the pandemic has been a reminder of the excellence of British science, a research and development (R&D) capability

which engineers, fitters, construction workers and many others will harness to develop the clean energy technologies of the future and forge new industries to service new markets at home and abroad.

We will generate new clean power with offshore wind farms, nuclear plants and by investing in new hydrogen technologies. We will use this energy to carry on living our lives, running our cars, buses, trucks and trains, ships and planes, and heating our homes while keeping bills low. And to the extent that we still emit carbon, we will pioneer a new British industry dedicated to its capture and return to under the North Sea. Together these measures will reinvigorate our industrial heartlands, creating jobs and growth, and pioneering world-leading SuperPlaces that unite clean industry with transport and power.

THE PRIME MINISTER'S TEN POINT PLAN



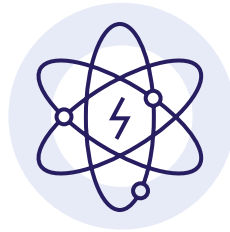
GREEN PUBLIC TRANSPORT, CYCLING AND WALKING

We will accelerate the transition to more active and sustainable transport by investing in rail and bus services, and in measures to help pedestrians and cyclists. We will fund thousands of zero-emission buses and give our towns and cities cycle lanes worthy of Holland.



HYDROGEN

Working with industry the UK is aiming for 5GW of low-carbon hydrogen production capacity by 2030. We are also pioneering hydrogen heating trials, starting with a Hydrogen Neighbourhood and scaling up to a potential Hydrogen Town before the end of this decade.



NUCLEAR POWER

Nuclear power provides a reliable source of low-carbon electricity. We are pursuing large-scale nuclear, whilst also looking to the future of nuclear power in the UK through further investment in Small Modular Reactors and Advanced Modular Reactors.



OFFSHORE WIND

By 2030 we plan to quadruple our offshore wind capacity so as to generate more power than all our homes use today, backing new innovations to make the most of this proven technology and investing to bring new jobs and growth to our ports and coastal regions.



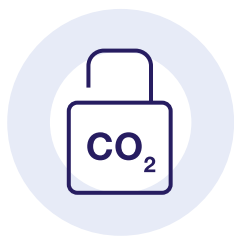
JET ZERO AND GREEN SHIPS

By taking immediate steps to drive the uptake of sustainable aviation fuels, investments in R&D to develop zero-emission aircraft and developing the infrastructure of the future at our airports and seaports, we will make the UK the home of green ships and planes.



GREENER BUILDINGS

Making our buildings more energy efficient and moving away from fossil fuel boilers will help make people's homes warm and comfortable, whilst keeping bills low. We will go with the grain of behaviour, and set a clear path that sees the gradual move away from fossil fuel boilers over the next fifteen years as individuals replace their appliances and are offered a lower carbon, more efficient alternative, supporting 50,000 jobs.



CARBON CAPTURE, USAGE & STORAGE (CCUS)

Our ambition is to capture 10Mt of carbon dioxide a year by 2030 - the equivalent of four million cars' worth of annual emissions. We will invest up to £1 billion to support the establishment of CCUS in four industrial clusters, creating 'SuperPlaces' in areas such as the North East, the Humber, North West, Scotland and Wales. We will bring forward details in 2021 of a revenue mechanism to bring through private sector investment into industrial carbon capture and hydrogen projects via our new business models to support these projects.



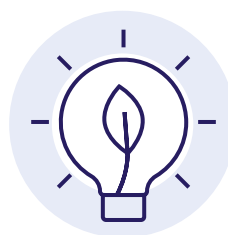
PROTECTING OUR NATURAL ENVIRONMENT

We will safeguard our cherished landscapes, restore habitats for wildlife in order to combat biodiversity loss and adapt to climate change, all whilst creating green jobs.



ZERO EMISSION VEHICLES

From 2030 we will end the sale of new petrol and diesel cars and vans, 10 years earlier than planned, and provide a £2.8 billion package of measures to support industry and consumers to make the switch to cleaner vehicles.



GREEN FINANCE AND INNOVATION

We have committed to raising total R&D investment to 2.4 per cent of GDP by 2027 and in July 2020 published the UK Research and Development Roadmap. The next phase of green innovation will help bring down the cost of the net zero transition, nurture the development of better products and new business models, and influence consumer behaviour.

LEADING GLOBAL ACTION

The UK accounts for less than one per cent of annual global emissions.²⁸ We therefore need to help other nations reduce their emissions in line with the Paris Agreement.

Our leadership is based on taking practical domestic action, which in turn creates business opportunities for the UK to export clean technology, skills and know-how.

We use our international partnerships and work through multilateral fora to influence international agreements on climate change and clean energy issues which help reinforce our domestic and international priorities. The principal vehicle we work through is the United Nations Framework Convention on Climate Change (UNFCCC), which delivered the Paris Agreement.

We will continue to demonstrate international leadership by building on the policies set out in the UK's National Energy and Climate Plan (NECP) and a number of other publications. This white paper goes even further than the ambitions set out in the NECP for renewables and energy efficiency.

Our presidency of the UN Climate Change Conference of the Parties (COP26), which will meet in Glasgow in November 2021, provides the opportunity to drive further ambitious action on climate change and unite the world on a path to a net zero economy, including through our COP26 Energy Transition Campaign and co-leadership of the Powering Past Coal Alliance.

Around 120 countries are committed to, developing plans or advancing consultations on **long-term climate or carbon neutral targets**



We are already seeing encouraging signs. In March, the European Union (EU) Commission proposed the first European Climate Law, which would commit the EU to achieving net zero greenhouse gas (GHG) emissions by 2050. In September, China announced that it would achieve carbon neutrality by 2060 and enhance its 2030 Nationally Determined Contribution (NDC). In October, both Japan and South Korea committed to achieving net zero by 2050. And thanks to the efforts of the UK, the EU, and other nations, there are now around 120 countries that are committed to, are developing plans or advancing consultations on long-term climate or carbon neutral targets.²⁹

The countries delivering on these commitments will need to radically change their energy, transport, buildings and land use sectors. By driving forward UK action now, we can build companies that can win the lion's share of these new global markets in the future.

WHAT THE WHITE PAPER DELIVERS – AND BEYOND

This white paper builds on the Prime Minister's Ten Point Plan to set the energy-related measures the Plan announced in a long-term strategic vision for our energy system, consistent with net zero emissions by 2050.

It establishes our goal of a decisive shift from fossil fuels to clean energy, in power, buildings and industry, while creating jobs and growing the economy and keeping energy bills affordable. It addresses how and why our energy system needs to evolve to deliver this goal. And it provides a foundation for the detailed actions we will take in this Parliament to realise our vision.

We estimate the measures in this paper could reduce emissions across power, industry and buildings by up to 230MtCO₂e in the period to 2032 and enable further savings in other sectors such as transport. In doing so, they will support up to 220,000 jobs per year by 2030. These figures include the energy measures from the Prime Minister's Ten Point Plan as well as additional measures provided in this white paper.³⁰

We recognise that more will need to be done to meet key milestones on the journey to net zero, including our ambition for Carbon Budget 6, which we will set next year, taking into account the latest advice from the Climate Change Committee. In the run-up to COP26 we will bring forward a series of sectoral strategies, and our overarching Net Zero Strategy, which will set out more detail on how we will meet our net zero target and ambitious carbon budgets.

FIGURE 1.6 – ESTIMATED CUMULATIVE EMISSION SAVINGS TO 2032 FROM THE ENERGY WHITE PAPER



Source: BEIS analysis

Overview of key commitments

This white paper sets out the government's policies and commitments that will put us on course to net zero, levelling up the country and strengthening the union as we achieve this goal. We will:

TRANSFORM ENERGY

Building a cleaner, greener future for our country, our people and our planet, by measures including:

- ▶ **Targeting 40GW of offshore wind by 2030**, including 1GW floating wind, alongside the expansion of other low-cost renewables technologies.
- ▶ **Supporting the deployment of CCUS in four industrial clusters** including at least one power CCUS project, to be operational by 2030 and putting in place the commercial frameworks required to help stimulate the market to deliver a future pipeline of CCUS projects.
- ▶ **Establishing a new UK Emissions Trading System**, aligned to our net zero target, giving industry the certainty they need to invest in low-carbon technologies.
- ▶ **Aiming to bring at least one large-scale nuclear project to the point of Final Investment Decision** by the end of this Parliament, subject to clear value for money and all relevant approvals.

- ▶ **Consulting on whether it is appropriate to end gas grid connections to new homes being built from 2025**, in favour of clean energy alternatives.
- ▶ **Growing the installation of electric heat pumps**, from 30,000 per year to 600,000 per year by 2028.
- ▶ **Building world-leading digital infrastructure for our energy system** based on the vision set out by the independent Energy Data Taskforce, publishing the UK's first Energy Data Strategy in spring 2021, in partnership with Ofgem.

SUPPORT A GREEN RECOVERY FROM COVID-19

Growing our economy, supporting thousands of green jobs across the country in new green industries and creating new export opportunities, by measures including::

- ▶ **Increasing the ambition in our Industrial Clusters Mission four-fold**, aiming to deliver four low-carbon clusters by 2030 and at least one fully net zero cluster by 2040.

- ▶ **Investing £1 billion up to 2025 to facilitate the deployment of CCUS in two industrial clusters** by the mid-2020s, and a further two clusters by 2030, supporting our ambition to capture 10MtCO₂ per year by the end of the decade.
- ▶ Working with industry, **aiming to develop 5GW of low-carbon hydrogen production capacity by 2030.**

CREATING A FAIR DEAL FOR CONSUMERS

Protecting the fuel poor, providing opportunities to save money on bills, giving us warmer, more comfortable homes and balancing investment against bill impacts, by measures including:

- ▶ **Creating the framework to introduce opt-in switching**, consulting by March 2021 on how it should be designed, tested and incrementally scaled up.
- ▶ **Considering how the current auto-renewal and roll-over tariff arrangements could be reformed** to facilitate greater competition, consulting by March 2021 on how opt-out switching could be tested as part of any future reforms.
- ▶ **Assessing what market framework changes may be required to facilitate the development and uptake of innovative tariffs and products** that work for consumers and contribute to net zero, engaging with industry and consumer groups throughout 2021 before a formal consultation.
- ▶ **Ensuring the retail market regulatory framework adequately covers the wider market**, consulting by spring 2021 on regulating third parties such as energy brokers and price comparison websites.
- ▶ **Establishing the Future Homes Standard** which will ensure that all new-build homes are zero carbon ready.
- ▶ **Consulting on regulatory measures to improve the energy performance of homes**, and are consulting how on how mortgage lenders could support homeowners in making these improvements.
- ▶ **Requiring that all rented non-domestic buildings will be Energy Performance Certificate (EPC) Band B by 2030**, barring lawful exceptions.
- ▶ **Extending the Energy Company Obligation to 2026** and expanding the Warm Home Discount to £475 million per year from 2022 to 2025/2026.

In addressing these issues we respect the devolution settlements with Scotland, Wales and Northern Ireland. All proposals in this white paper which touch on devolved matters will be progressed in accordance with those settlements.

CHAPTER 01

Consumers

OUR GOAL

We are committed to making the right reforms that will protect the interests of consumers and create opportunities to reduce bills and carbon emissions.

In partnership with the Office of Gas and Electricity Markets (Ofgem), we will:

- ▶ Create a **fair deal for consumers**
- ▶ **Protect the fuel poor**
- ▶ Provide **opportunities to make savings** on energy bills



CONSUMERS

The strategic context



Energy is integral to everything we do, from work, to travel, to leisure, to just relaxing at home. Whether it be for heating and lighting our homes or powering appliances, we all rely on secure, affordable energy every day. But the way we use energy in the home is changing.

Smart technologies, enabled by our increasingly digital world, offer new products and services which help us to take control of our energy use and reduce bills. And, over the next 30 years, electricity will become a significant proportion of the energy we use at home, powering electric cars, replacing petrol and diesel, and enabling the installation of electric heat pumps which reduce the need for oil and gas to heat our homes.

Over the next 30 years, **electricity will become a significant proportion of the energy we use**



This transformation of energy in our homes will only accelerate over the coming decade. The government and Ofgem have an important role to play, making regulatory reforms which place fairness and affordability at the heart of our efforts to protect the interests of consumers and create opportunities to save money.

This means:

► **Creating a fair deal for consumers.**

We will increase competition throughout the energy retail market to benefit consumers and, as we transition to net zero, we will make sure the costs of doing so are distributed fairly;

► **Protecting the fuel poor.** We will offer additional protections to the vulnerable and fuel poor, through our Energy Company Obligation (ECO) and expanded Warm Home Discount (WHD) schemes and the Green Homes Grant, providing financial support of at least £6.7 billion over the next six years (see 'Buildings' chapter);

► **Providing opportunities to make savings on energy bills.** We will create opportunities for consumers to reduce bills and carbon emissions by upgrading the energy performance of homes (see 'Buildings' chapter), switching to clean energy, or using energy when it is cheapest thanks to smart technology.

SMARTER, CLEANER ENERGY FOR ALL CONSUMERS

Traditionally, households have been passive consumers of energy from fossil fuels.

Smart technology is unlocking new opportunities to give consumers more control, choice and flexibility over their energy use. We are seeing retail offers that will help consumers engage in the market and save money in the process.

SMART METERS

Smart meters are replacing traditional gas and electricity meters in homes and small businesses across Great Britain as part of an essential infrastructure upgrade to make the energy system more efficient and flexible, helping to deliver net zero emissions cost-effectively.

Smart meters are also modernising energy services by ending manual meter readings, delivering accurate bills and enabling prepayment customers to conveniently track their usage and top-up credit without leaving home. The In-Home Display (IHD), which households are offered when they have smart meters installed, gives accurate information about energy consumption and costs so consumers can easily understand how to save money on their bills.

The real-time information about energy use, recorded by smart meters, ensures that consumers are accurately charged by their suppliers. Smart meters also enable consumers to access innovative solutions such as smart tariffs, including 'time of use' tariffs. These tariffs reward consumers financially for using less electricity at peak times of demand or using more when overall demand is low and there is surplus generation available, for example on a sunny or windy weekend. This can reduce the cost of using clean electricity to power homes, businesses and electric vehicles, making the system more efficient and saving consumers money.

SMART TARIFFS

Smart tariffs include: tariffs where costs vary by the time of use, based on the cost of electricity; export tariffs, for those with generation technology such as solar panels; load control tariffs that can manage when appliances are used to ensure consumers use the cheapest energy; and tariffs designed for consumers with low-carbon technology, for example, electric vehicles, to ensure they can charge at the cheapest times.

There are now new ways for households to find the best energy products and services to match their specific needs. This ensures consumers are getting the best deal available and can help them choose new ways to engage with the energy system.

Consumers can be rewarded for playing a bigger role in our energy system. There are plenty of ways to save money, from installing energy saving measures to making the most of new technologies, such as batteries, heating controls or smart washing machines and dishwashers. Consumers can also generate their own electricity through roof-top solar panels, store it in batteries, and even sell any excess power back to the grid to generate a profit at times of higher demand.

CASE STUDY: SMART TARIFF COMPARISON TOOL

Smarter Tariff – Smarter Comparison, Vital Energi

Vital Energi is leading a consortium of experts to develop a comparison tool that gives consumers an easy way to find the most suitable smart tariff. Smart tariffs are often not included on price comparison websites and consumers have little visibility of their benefits. For example, many electric vehicle owners are unaware that there are dozens of tariffs designed specifically for them.

Supported with government funding, the project is developing a tool which will help people find the best smart tariff to match their needs. Consumers can use their actual smart meter data as an input to get personalised, accurate comparisons and, after they switch, see if they have achieved the expected savings. It eliminates the need to manually provide estimated electricity bills and integrates time-of-use tariffs and use of low-carbon technologies in the tariff search. Consumer research indicates that many people would be more likely to use a smart comparison tool such as this.

At the end of the project in March 2021, the proof of concept will be free for anyone to reuse. This means that suppliers, comparison websites and others will be able to integrate it into their services or reuse it. The research findings will be made public so they can be used by innovators in the market.



CASE STUDY: SMART TARIFF

Agile Octopus Tariff, Octopus Energy

Agile Octopus is a 'time-of-use' tariff, which gives consumers access to half-hourly electricity prices, tied to wholesale prices, which are updated daily. So when energy prices drop, so could bills. Sometimes prices even go 'negative' - meaning that consumers can be paid to use energy during that period. Octopus also cap prices at 35p/kWh to protect consumers during price spikes.

Octopus calculate that, on this tariff, customers could save £120 a year by shifting electricity use outside of the 4pm to 7pm peak.³¹ This is best suited for households with lots of electricity demand during those periods. For example, households with electric heating or electric vehicles.

CASE STUDY: CONNECTED HOME

Core4Grid, geo

Through the 'Core4Grid' trial, battery storage and smart meters have been installed in 24 houses that already had solar panels, electric heating or electric vehicle chargers. Using Core - its "energy brain" - the technologies have been integrated to run as a whole system within each home.

Core responds to signals from the electricity system to make decisions on when to use energy or charge the batteries, using either excess solar generated by the household's panels or grid electricity imported during cheaper periods.

The trial has been running since March, with participating homes sourcing over half of the energy they used from their solar and batteries. The houses have generated almost 30MWh of local generation (equivalent to ten times a typical dual fuel household's annual electricity use³²) for the period.

Electric vehicles will accelerate this trend (see Transport breakout box). By using a smart charger when powering up their electric vehicle, consumers will play an essential role in helping manage electricity demand, avoiding the expensive peak periods. Increasingly, consumers will also be able to export energy from their electric vehicle back to the grid. In doing so, they could significantly reduce their energy costs and help maximise the amount of solar and wind energy used to charge their vehicle.

CASE STUDY: SMART ELECTRIC CAR CHARGING AND 'VEHICLE-TO-GRID' TRIAL

Project Sciurus, Kaluza, Ovo Energy

Project Sciurus is the largest domestic 'vehicle-to-grid' (V2G) demonstration in the world - with 323 V2G chargers supplying electricity to the grid at times of high energy demand. These operate on the 'Kaluza' platform, which receives live signals from the grid so that consumers can charge their vehicle when prices are low, and sell electricity back to the grid at times of peak demand.

The Sciurus project is part of a £30 million Innovate UK competition, with a diverse consortium of participants taking part. The majority of trial participants have found V2G capability to be valuable. Consumers have changed how and when they were charging their electric vehicles to help reduce costs for themselves and the grid, all while helping balance the energy system and saving money.

And some local communities are coming together to establish their own approach to managing energy demand in their areas. Smart local energy systems are community-based initiatives which bring together a range of energy issues, typically including heat, power and transport, to reduce emissions in an integrated way, while also promoting local jobs and businesses. Local Authorities are key to delivering these systems by combining energy into their wider statutory work on housing, transport, waste and planning, making delivery more cost-effective and preparing for a net zero future. Government provides funding for Local Authorities to deliver programmes that support decarbonisation and will continue to work with communities to enable projects to be tailored and delivered to meet local needs.

CASE STUDY: COMMUNITY ENERGY

Energy Local Clubs, Energy Local

Energy Local has designed a local energy market. Households and small renewable generators form a Local Energy Club, the first of which started in a small town called Bethesda, in North Wales back in 2016. Through this, households use their smart meters to show how much power they are using.

They agree a 'match' tariff with local generators that pays them a price for the power they produce when households are using it. This keeps more money local and offers consumers the chance to reduce household bills by using energy when it's cheaper. They also partner with a supplier (Octopus Energy) to buy more power when there's not enough locally.

It benefits suppliers, generators and communities, giving a fair price to renewable generators and developing a suitable package of improved energy controls in the home, particularly for those at risk of fuel poverty as the benefits of local generation can be shared with anyone who joins the Local Energy Club, without having to pay a high capital cost.

HOUSEHOLD ENERGY BILLS

The average household's dual fuel energy bill in 2019 was similar to 2010 (figure 2.1).

However, the underlying costs have changed. Over the past decade, electricity prices have gone up, because of rises in policy and network costs, while gas prices have fluctuated, reflecting movements in the wholesale gas price. However, consumers have used less energy, which has balanced out the cost increase.³⁴

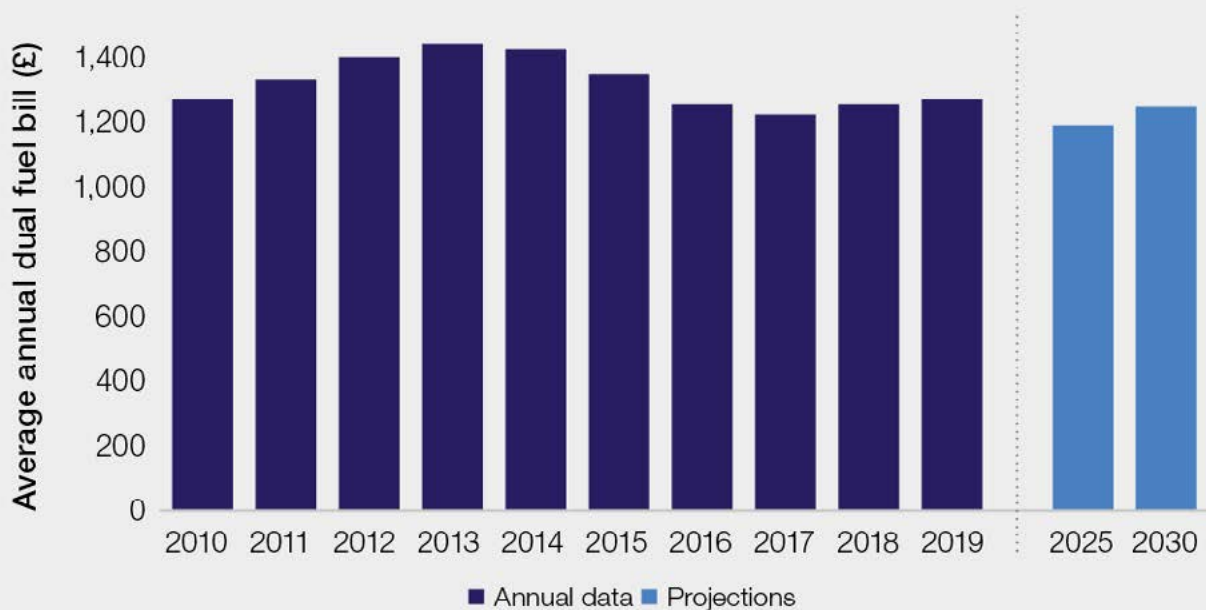
Overall, households who install energy saving measures will see significant savings and can offset the costs. Through targeting our energy saving schemes, such as extended ECO,³⁵ expanded WHD,³⁶ and the Green Homes Grant, many of the people making savings will be low-income or vulnerable

households on benefits, whose homes currently have poor energy efficiency ratings. For such households, energy represents a significant share of their outgoings, so these savings can have a significant impact on their disposable income.

Our ECO and expanded WHD schemes will provide at least £4.7 billion of extra support to low-income and vulnerable households between 2022 and 2026. Under the Green Homes Grant, we expect £500 million to be spent on low-income households through Local Authority Delivery. In addition, £500 million of the £1.5 billion voucher scheme is also intended for low-income households.

FIGURE 2.1 – AVERAGE HOUSEHOLD DUAL FUEL BILL

2010 to 2030 (2020 prices)



Source: BEIS analysis. This graph is based on a limited set of assumptions and shows average net costs. The cost of policies still being developed, such as heat pump deployment, are not included. Individual bills will vary depending on consumer characteristics and behaviour. See references for more detail.³³



For example, a household in receipt of Universal Credit and living in an old, inefficient home could enjoy bill savings worth over £400, making them warmer, healthier and reducing their carbon emissions.

Over the next ten years, increases in network costs, along with funding for clean energy and supporting vulnerable households could push gas and electricity prices up. Based on the policies in this white paper with agreed funding, we estimate that household dual fuel bills will be, on average, broadly similar in both 2025 and 2030 to 2019 (figure 2.1). These policies are estimated to amount to a net increase of around two per cent on average,³⁷ though households who take up measures stand to make material net savings. This depends on a range of uncertain and variable factors, including future fossil fuel prices and how consumers use energy. We have used a central set of assumptions for these drivers.

ENERGY BILL COMPONENTS

Wholesale costs:

The amount energy suppliers pay to buy gas and electricity.

Network costs:

The costs to build, maintain and operate the pipes, wires and cables that transport gas and electricity from producers to consumers.

Supplier costs and margins

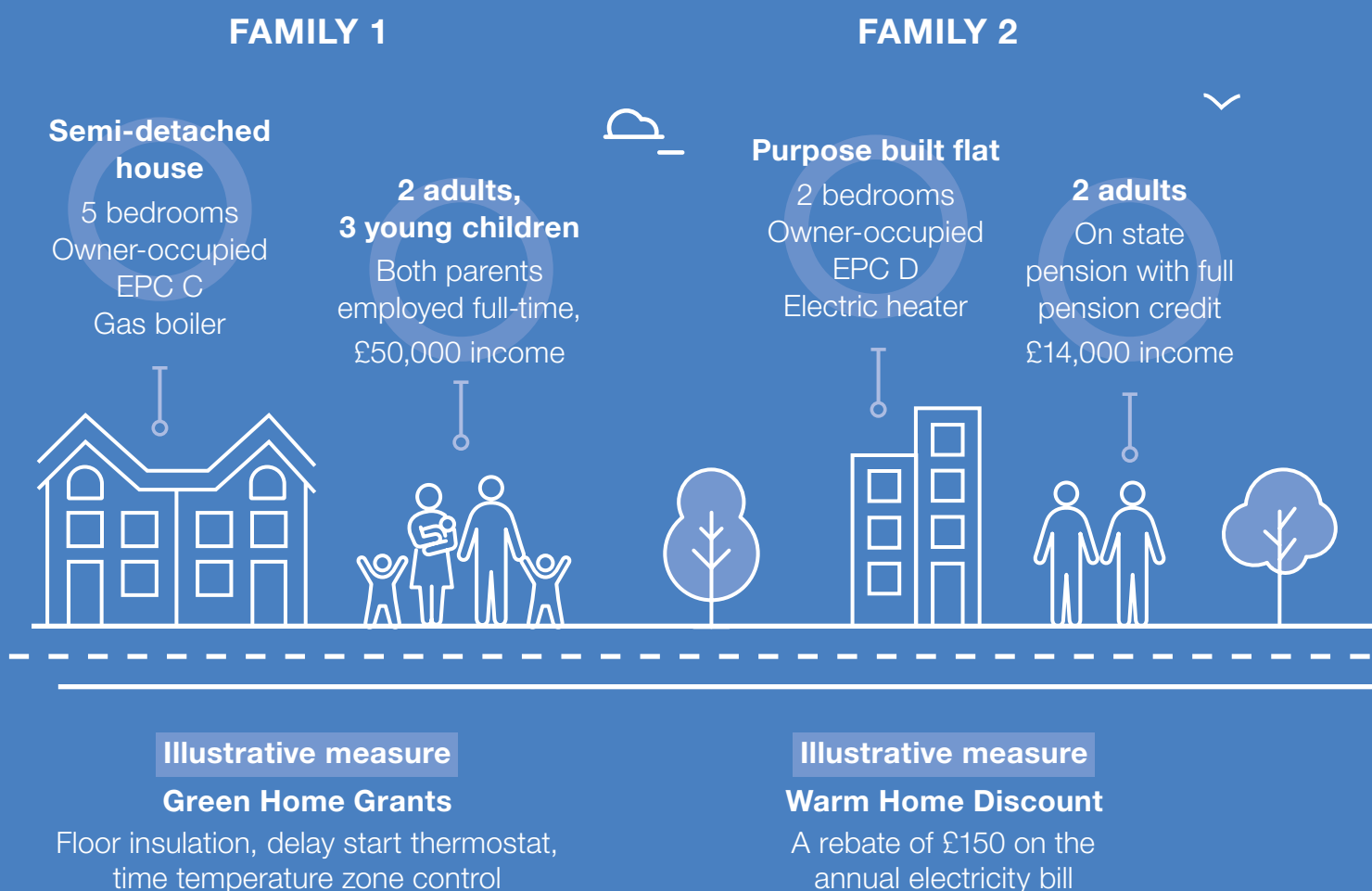
The administrative costs of running the supply business, including customer service, marketing, metering, plus profits.

Policy costs:

Cost of programmes to save energy, reduce emissions, and provide financial support to the fuel poor.

ILLUSTRATIVE ANNUAL BILL SCENARIOS

Our assessment sets out the average picture. Underlying this, households could see net savings or costs depending on whether they take up measures. The graphic below sets out some illustrative case studies of how an individual household's bill may change because of the policies announced in this white paper.



FAMILY 1 ANNUAL BILL

| | |
|---|---------------|
| Prior to white paper | £1,100 |
| With white paper impacts before savings | £1,200 |
| Potential energy bill savings | £110 |
| WITH ENERGY BILL SAVINGS | £1,090 |

FAMILY 2 ANNUAL BILL

| | |
|---|---------------|
| Prior to white paper | £1,300 |
| With white paper impacts before savings | £1,390 |
| Potential energy bill savings | £150 |
| WITH ENERGY BILL SAVINGS | £1,240 |

Details are provided on the household's characteristics and the composition of the household, including income. These are designed to be hypothetical households that can take advantage of certain policies (either Green Home Grants, ECO or WHD). They are not a complete list of qualifying criteria, and both a household's eligibility for certain policies and its potential savings will vary according to its characteristics, composition, and, in some cases, whether the household proactively chooses to apply for a measure.

Example bills are for the year 2025. The exact measures or level of rebate available under the future ECO and WHD schemes are subject to future consultation. For households who access schemes, there are opportunities for saving to significantly outweigh upward pressure on bills. Access to these opportunities depends on the policy. Schemes such as ECO are targeted at fuel poor households whereas the Green Home Grants is open to applications from a wider set of households.

FAMILY 3

Mid-terraced house

3 bedrooms
Private rented
EPC D
Gas boiler

1 adult, 2 young children

Unemployed, on
Universal Credit
£11,000 income

FAMILY 4

Semi-detached house

3 bedrooms
Owner-occupied
EPC E
Gas boiler

1 adult, 2 young children

Employed part-time,
on Universal Credit
£14,000 income

Illustrative measure

Warm Home Discount

A rebate of £150 on the
annual electricity bill

Illustrative measure

Energy Company Obligation

External solid wall insulation, hot water
tank insulation, delay start thermostat,
time temperature zone control

FAMILY 3 ANNUAL BILL

| | |
|--|---------------|
| Prior to white paper | £1,200 |
| With white paper impacts before savings | £1,230 |
| Potential energy bill savings | £150 |
| WITH ENERGY BILL SAVINGS | £1,080 |

FAMILY 4 ANNUAL BILL

| | |
|--|-------------|
| Prior to white paper | £1,200 |
| With white paper impacts before savings | £1,280 |
| Potential energy bill savings | £500 |
| WITH ENERGY BILL SAVINGS | £780 |

Our key commitments

AFFORDABILITY AND FAIRNESS

It matters how much consumers pay for their energy, particularly when household budgets are tight.

The government will work with the regulator, Ofgem, to take the necessary steps to help households manage their bills. We have already introduced a price cap to ensure that the market does not excessively penalise consumers who do not frequently shop around for better deals.

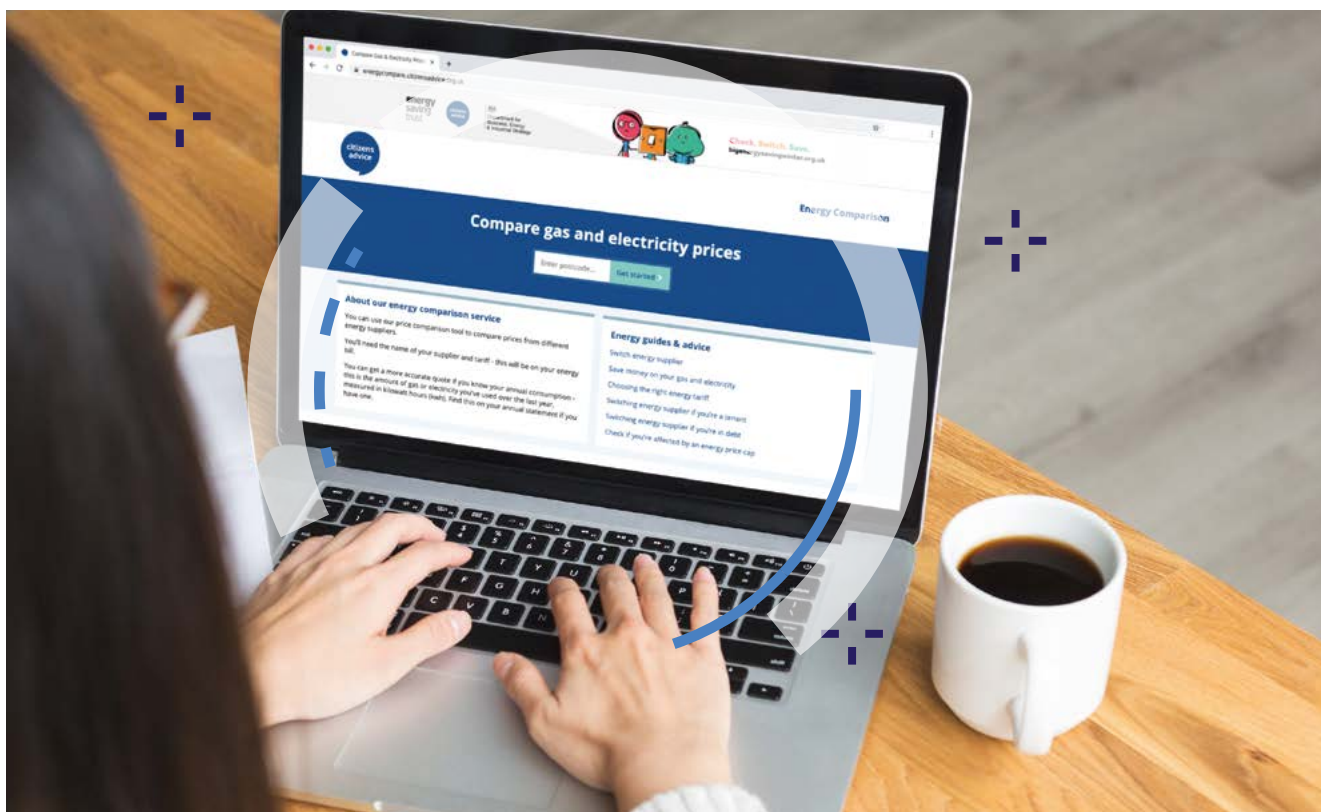
As we move to a clean energy system, fairness will be at the heart of our approach. Every household and business should be confident that everyone is paying their fair share of the costs of the transition. The members of the Climate Assembly UK identified “fairness within the UK, including for the most vulnerable” as one of the top two principles that should guide decisions around net zero.³⁸ We agree.

► **We will publish a call for evidence by April 2021 to begin a strategic dialogue between government, consumers and industry on affordability and fairness.**

We will work across the sector to identify existing distortions in the system and gain insights into the trade-offs involved in the distribution of energy costs. This will allow us to take decisions on how energy costs can be allocated in a way which is fair and incentivises cost-effective decarbonisation.

The nature of costs in a smart, clean energy system will be different. The largest part of our electricity bill is the cost to our energy supplier from buying power. This cost has traditionally been determined by the underlying price of gas or coal but this is changing. Gas will set the electricity price for some years to come but, over time, will do so less frequently, as more and more wind and solar connect to the electricity system. These are technologies which do not have a fuel cost. What we are paying for is the cost of building and operating the wind or solar farms, not the fuel cost. This trend fundamentally reshapes the costs of the system we must pay for. How consumers are charged will need to reflect this.

Ensuring that costs are fairly allocated between all consumers will be a central challenge for government. We need to strike the right balance between different households, between domestic consumers and businesses, including the big energy users in industry. The way that the costs are passed through to bills can incentivise or disincentivise certain types of consumer behaviour, including how the costs of decarbonising energy are apportioned between gas and electricity bills.



This can be a particular barrier to electrifying heat, which will be crucial for the transition to low-carbon buildings (see ‘Buildings’ chapter). It will be essential to ensure that price incentives are fair and help achieve our net zero target.

We are also mindful that, as we rightly encourage households to adopt new technologies such as roof-top solar and home energy storage, this change could affect how consumers pay for their energy in a way which is unfair to others. Households which self-generate electricity and store it, even sell it back to the grid, will be able to reduce how much they pay towards the fixed costs of the electricity system, while still relying on the system when they are not self-supplying. It could leave other consumers to pay a greater share, some of whom may not be able to take advantage of new technologies.

For all these reasons, the time is now right to reflect carefully on the nature of energy costs, who pays for them and how. HM Treasury has already launched a review of how the transition to net zero would be funded and where the costs would fall. An interim report will be published in December 2020, with a view to completing the review in spring 2021. This white paper sets out what we currently do to enshrine fairness in the way consumers are treated in the energy sector and puts forward new policy proposals to go even further. Building on this foundation, we will start a conversation with consumers and the energy industry about the fairness and affordability of the cost of moving to clean energy over the long-term. We are clear that the outcome of this work is a net zero world which continues to ensure a fair distribution of costs and maintains support in society and business for our climate goals.

ROLLING OUT SMART METERS

It remains our ambition to achieve market-wide roll-out of smart meters as soon as practicable, enabling homes and small businesses to access digital energy services that put them in charge of their energy use.

Second generation smart meters – which are compatible with all energy suppliers from the point of install – are now being rolled out as standard across Great Britain, while the enrolment of first generation smart meters into the national communications system will ensure these stay smart when consumers switch energy supplier.

We have introduced a new smart meter obligation on suppliers, which will start in July 2021. This will drive consistent, long-term investment, by setting annual targets and providing regulatory certainty. We are committed to exploring ways to encourage consumer uptake.

We are working with industry and delivery partners to help energy suppliers develop successful strategies for consumer engagement which improve the installation and operational performance rates of new meters, while stimulating consumer demand.

To allow consumers to make the most of the data recorded by smart meters, it needs to be combined with half-hourly settlement for suppliers. This will allow households to access more real-time prices, should they wish. Most households are currently billed at a fixed price, based on an estimate of when they use electricity during the day. Half-hourly settlement provides the option for different prices in each 30-minute period of the day. Ofgem's analysis estimates that half-hourly settlement would bring net benefits for consumers of between £1.6 billion and £4.6 billion by 2045.³⁹ Ofgem intend to publish their final decision in spring 2021 on how and when to implement half-hourly settlement.

FACILITATING COMPETITION AND TACKLING THE LOYALTY PENALTY

We are already seeing the value of innovation in smart controls and tariffs, as well as household batteries and solar panels.

To ensure that the growth in technological innovation goes from strength to strength, we need to ensure markets provide consumers with access to the services they want and offer fair value to all consumers. This is especially pressing as the system becomes more complex. Vulnerable consumers may need additional protections appropriate to their circumstances.

Consumers who have been automatically rolled onto a default tariff when their introductory tariff ends, or who start off on an auto-roll-over tariff, such as when they move into a new house, often pay much more for their energy, even when significantly cheaper alternatives are available. Over 50 per cent of consumers remain on default tariffs, despite almost all consumers knowing they can switch.⁴⁰ Many remain in this position for a long time, paying a 'loyalty penalty',⁴¹ while other suppliers struggle to compete to provide these consumers with a better deal.

The price cap currently limits the extent of the loyalty penalty, but we believe competition is the most effective and sustainable way to keep prices low for all consumers over the long-term. Where the market and policy conditions for effective competition are not yet in place, we are prepared to ensure that proportionate price protection remains.

We have set out options for long term measures to protect consumers from the loyalty penalty in the joint government and Ofgem consultation ‘Flexible and responsive energy retail markets’ of July 2019.⁴⁴ With the measures set out in this white paper, we aim to address barriers to consumer engagement and the current nature of default tariff arrangements, the two leading causes of the loyalty penalty.

OPT-IN SWITCHING

► **We will create the framework to introduce opt-in switching, consulting by March 2021 on how it should be designed, tested and incrementally scaled up.**

We know from today’s energy market that, for some consumers, the existence of cheaper deals is not sufficient in itself to drive consumer behaviour. Ofgem has found in recent trials that opt-in switching and similar tools can facilitate greater consumer engagement with the energy market.⁴⁵

We will learn from these trials and create the framework to enable the introduction of opt-in switching by 2024. This will be implemented once we have reformed the exemption that smaller energy suppliers have from paying for energy efficiency measures (ECO) and from offering a discount for customers in fuel poverty (WHD).

OPT-IN SWITCHING TRIALS

Since 2017, Ofgem has run trials to develop and test new prompts to increase consumer engagement. Ofgem found that customers who have not switched energy tariff for many years can be prompted to do so following simple, well designed letters and emails. The trials included over 1.1 million customers and resulted in over 94,000 of them switching to new energy tariffs, with most of them making an active choice about their energy tariff for the first time in years. In total, these customers have saved around £21.3 million between them.⁴²

The most successful trials were the opt-in collective switching trials.⁴³ These removed as many steps as possible from the switching process and provided additional reassurances, such as independent support. Between 19-30 per cent of consumers switched their tariff – five to ten times higher than the control group, which had rates of 2.6 - 4.5 per cent.

DEFAULT TARIFF ARRANGEMENTS AND OPT-OUT SWITCHING

- **We will consider how the current auto-renewal and roll-over tariff arrangements could be reformed to facilitate greater competition, consulting by March 2021 on how opt-out switching could be tested as part of any future reforms.**

Default or roll-over tariffs are important for ensuring continuous supply and service for consumers, even where they have not agreed a specific deal. However, these tariffs also enable passive engagement with the market, which limits competition and allows suppliers to charge such consumers excessive prices.

We want energy markets to be truly competitive. We do not think that energy suppliers should expect to roll over or continue contracts with customers indefinitely. Where consumers do not opt-out, reforms could move consumers on default tariffs to a new, cheaper contract through a competitive process. We will test how moving consumers to new contracts, with the option to opt-out, could work best for consumers, consulting by March 2021. We will engage closely with stakeholders to consider the design of the testing, including which consumers should be targeted, how the new tariff is determined and what safeguards should be in place to ensure beneficial outcomes.

REMOVING MARKET DISTORTIONS

We will work with industry to reduce the barriers to consumer engagement so that more households make informed choices about the products and services they receive.

So, it is important that they have clear and easily accessible information on the options to do so. We will assess how effectively the market provides consumers with clear information on costs and clean energy choices.

TRANSPARENCY

- **We will ensure consumers are provided with more transparent and accurate information on carbon content when they are choosing their energy services and products, consulting on reforms in early 2021.**

Smart digital technology is not just giving consumers more control, choice and flexibility in their energy use. It allows consumers to make a personal contribution to delivering a clean energy system.

This will be the key to helping consumers make informed decisions. We will consult in 2021 on how to ensure consumers receive transparent information when choosing an energy product, for example quantifying the additional environmental benefits of a tariff marketed as 'green'.

POLICY OBLIGATIONS

We will consult on how:

- ▶ **The energy supplier thresholds of ECO can be removed without incurring disproportionate costs on suppliers, including potentially introducing a buy-out mechanism as part of reforms to the scheme beyond 2022.**
- ▶ **The energy supplier thresholds of WHD can be removed as part of reforms to the scheme beyond 2022 to ensure administrative simplicity and consistency.**

ECO and WHD are obligations on suppliers that tackle fuel poverty by providing targeted energy efficiency measures and discounts on bills (see ‘Buildings’ chapter for more detail).

Supplier thresholds for these schemes were introduced to avoid creating significant administrative barriers to market entry for new suppliers. The thresholds exempt suppliers with fewer customers from some of the costs to which their larger competitors are exposed. However, these thresholds may create market distortions as smaller suppliers are able to undercut other suppliers who still have to pay the costs.

For WHD, the threshold also creates barriers to switching for the fuel poor, as some suppliers are not required to offer the discount. We want to remove policy obligation thresholds but ensure that schemes can be extended, without creating significant administrative burdens for small suppliers. This will mean that fuel poor consumers who receive WHD can have greater confidence that switching to a cheaper tariff with an alternative supplier.

RETAIL REGULATORY FRAMEWORK

- ▶ **We will assess what market framework changes may be required to facilitate the development and uptake of innovative tariffs and products that work for consumers and contribute to net zero, engaging with industry and consumer groups throughout 2021 before a formal consultation.**

Consumers can benefit and contribute more effectively to net zero through an energy retail regulatory framework that accommodates emerging and innovative business models. Consumers are best placed to decide which business models suit their needs through market participation, but they could include peer-to-peer trading; energy as a service, where customers buy an outcome for an agreed price, such as a guaranteed temperature at home or guaranteed level of heat pump performance, rather than paying for units of gas or electricity; or the bundling together of utilities, such as water and energy.

The market framework will need to enable innovation and competition, while protecting consumers. We will continue to review whether the current supply licence framework strikes this balance effectively. We will assess whether incremental changes, alongside wider sectoral initiatives, are sufficient or whether more fundamental changes are required.

PROTECTING CONSUMERS AS TECHNOLOGIES AND SERVICES EVOLVE

Consumers must be able to benefit from robust and consistent protection when engaging the energy market, no matter where they obtain their products and services.

THIRD PARTY ENERGY PRODUCTS AND SERVICES

- ▶ **We will ensure the retail market regulatory framework adequately covers the wider market, consulting by spring 2021 on regulating third parties such as energy brokers and price comparison websites.**

The energy market is evolving rapidly as technology advances and consumer behaviour changes. Consumers can engage in the market in new ways. When the current licensing framework was developed, the majority of consumers would engage directly with their new supplier when arranging a switch but this is less common now, as consumers increasingly use price comparison websites. Ofgem does not currently regulate third parties like energy brokers and price comparison websites and we need to ensure that consumers can be confident that they are protected when engaging with any energy product or service through these channels.

This principle of protection does not just apply to households. In its Microbusiness Strategic Review, Ofgem identified harms to microbusinesses from some brokers such as mis-selling and misrepresentation. Government and Ofgem will work together to ensure microbusinesses have appropriate protection from bad practices.

SMART APPLIANCES

- ▶ **We will take powers to regulate smart appliances based on principles including interoperability, data privacy and cyber security, legislating when Parliamentary time allows.**

The market for smart appliances, such as smart fridges, washing machines and heating systems, is just emerging. Regulation of these devices, in particular relating to interoperability, data privacy, and cyber security, is required to support its development and to ensure that appropriate consumer protection is in place ahead of time. Devices should be able to link with any service provider's systems so that consumers cannot be locked into a single provider. It is also important that devices are cyber secure, to ensure consumers' data remains private and the energy system as a whole is protected. Industry is developing standards for smart appliances in line with these principles, which will be published by summer 2021.

We will ensure that the approach adopted for regulating smart appliances is compatible with the Department for Digital, Culture, Media and Sport's existing commitment to take powers to regulate the cyber security of consumer smart devices.

Our key commitments



We will **publish a call for evidence by April 2021** to begin a strategic dialogue between government, consumers and industry on affordability and fairness.



We will **create the framework to introduce opt-in switching**, consulting by March 2021 on how it should be designed, tested and incrementally scaled up.



We will **consider how the current auto-renewal and roll-over tariff arrangements could be reformed** to facilitate greater competition, consulting by March 2021 on how opt-out switching could be tested as part of any future reforms.



We will **ensure consumers are provided with more transparent and accurate information on carbon content** when they are choosing their energy services and products, consulting on reforms in early 2021.



We will **consult on how the energy supplier thresholds of ECO can be removed** without incurring disproportionate costs on suppliers, including potentially introducing a buy-out mechanism as part of reforms to the scheme beyond 2022.



We will **consult on how the energy supplier thresholds of WHD can be removed** as part of reforms to the scheme beyond 2022 to ensure administrative simplicity and consistency.



We will **assess what market framework changes may be required to facilitate the development and uptake of innovative tariffs and products** that work for consumers and contribute to net zero, engaging with industry and consumer groups throughout 2021 before a formal consultation.



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We will **take powers to regulate smart appliances** based on principles including interoperability, data privacy and cyber security, legislating when Parliamentary time allows.

CHAPTER 02

Power

OUR GOAL

Electricity is a key enabler for the transition away from fossil fuels and decarbonising the economy cost-effectively by 2050.

We will:

- ▶ **Accelerate the deployment of clean electricity generation** through the 2020s
- ▶ **Invest £1 billion in UK's energy innovation programme** to develop the technologies of the future such as advanced nuclear and clean hydrogen
- ▶ Ensure that the transformation of the electricity system **supports UK jobs and new business opportunities, at home and abroad**



POWER

The strategic context



Decarbonising the power sector has led the UK's efforts to reduce greenhouse gas emissions.

In 1990, electricity generation accounted for 25 per cent of UK emissions. In 2018, it was only 15 per cent.⁴⁶ 30 years ago, fossil fuels provided nearly 80 per cent of electricity supply.⁴⁷ Today, the country gets over half of its power from low-carbon technologies.⁴⁸ The rapid growth of renewables has been a critical feature of this transformation. Renewable capacity has grown fivefold since 2010, driven by the deployment of wind, solar and biomass. The UK had 10GW of operational offshore wind by 2019, up from just over 1GW in 2010.⁴⁹

>50%

of the UK's power comes from **low-carbon technologies** today

5x

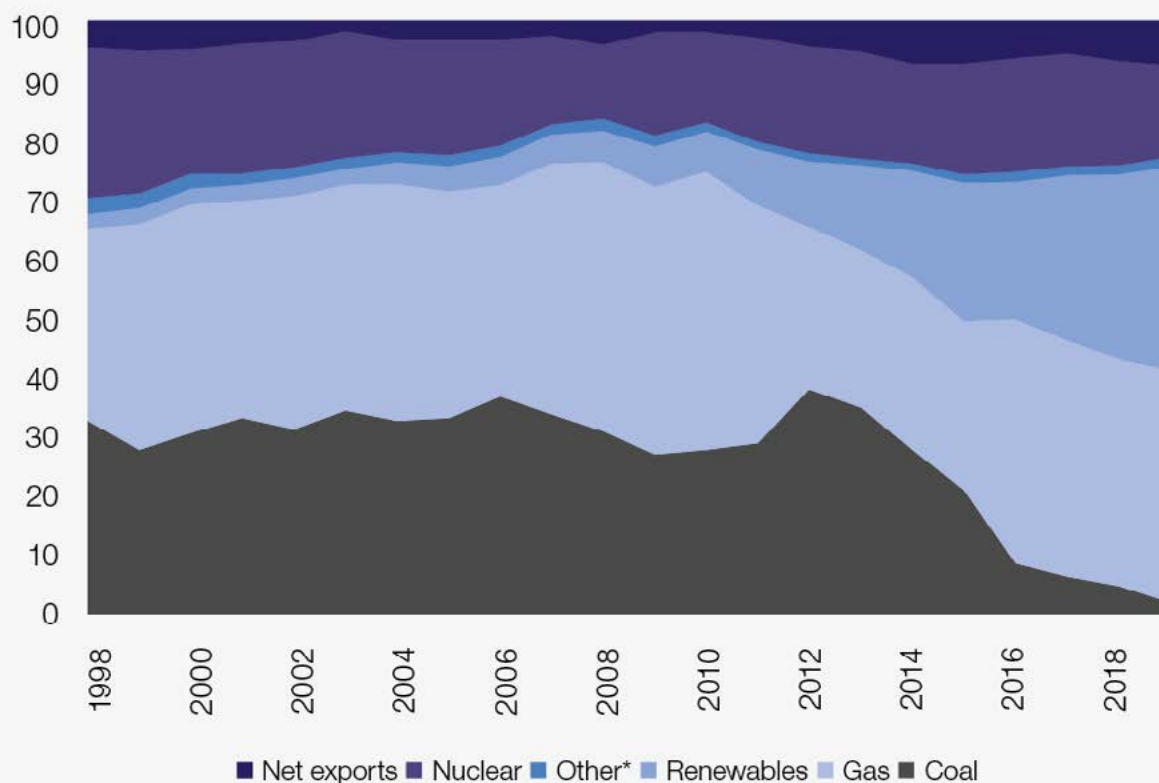
renewables capacity has grown five-fold since 2010

~9GW

increase in operational offshore wind since 2010

FIGURE 3.1 - CHANGE IN POWER SUPPLY

1998 - 2019



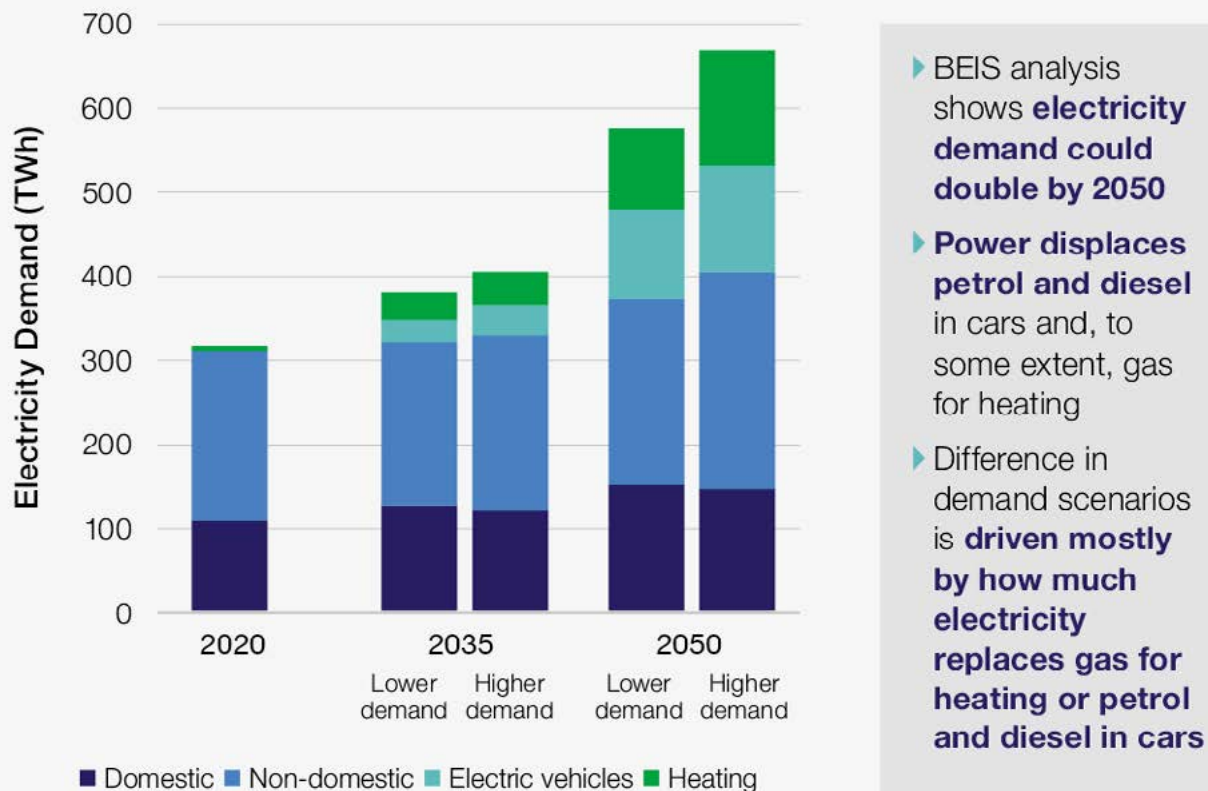
Source: Energy Trends, table 5.1. *Other includes oil, pumped storage, and other thermal generation.

Renewables now account for over one third of electricity generation, up from seven per cent in 2010. Yet, this green revolution has been delivered without disruption to the reliability of our electricity supply and the scale of deployment has contributed to a significant reduction in the cost of renewables. Increasingly, green power is the cheapest power.⁵⁰

Building on this foundation, we need to go further. With the exception of Sizewell B and Hinkley Point C, which is under construction, all of the existing nuclear power plants are due to have ceased generating by the end of 2030. We have already committed to ending coal in the electricity mix no later than 2025.

Today, as a signal of our further ambition and to encourage other countries along the path to phasing out coal, we are publishing a consultation over the option to bring forward our coal closure date to 2024.⁵¹ Subject to this consultation, we will introduce legislation to give legal effect to the end date.

While retiring capacity will need to be replaced to keep pace with existing levels of demand, our modelling suggests that overall demand could double out to 2050. This is because of the electrification of cars and vans and the increased use of clean electricity replacing gas for heating. As a result, electricity could provide more than half of final energy demand in 2050, up from 17 per cent in 2019.⁵²

FIGURE 3.2 - ELECTRICITY DEMAND, NET ZERO SCENARIOS

Source: BEIS analysis

This would require a four-fold increase in clean electricity generation with the decarbonisation of electricity increasingly underpinning the delivery of our net zero target.

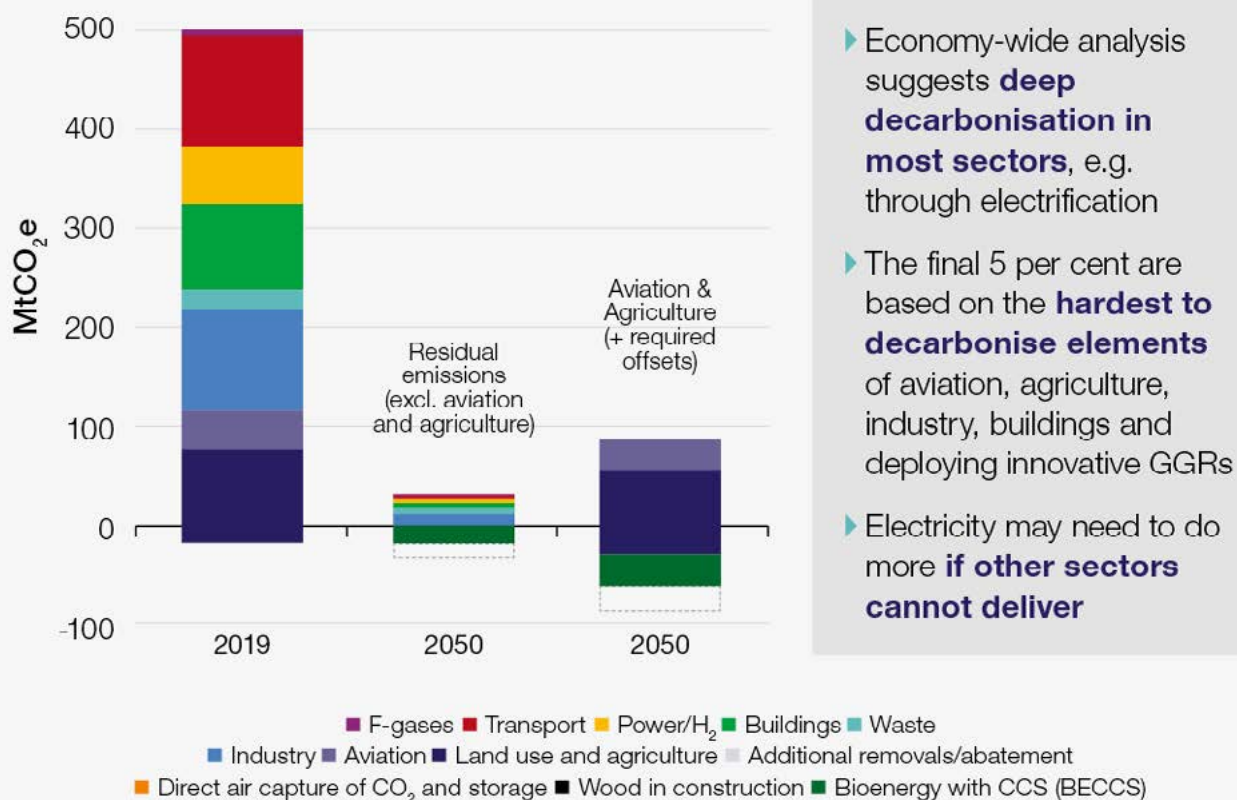
Given the pivotal role of electricity in delivering net zero emissions, we must aim for a fully decarbonised, reliable and low-cost power system by 2050. Low emissions in power does not necessarily mean higher costs. Carbon intensity, the amount of CO₂ emitted to generate 1kWh of electricity, can fall to very low levels without costs rising significantly. This will depend on the level of demand, and the cost and availability of other low-carbon technologies, particularly low-cost clean hydrogen.

Our understanding of what is required from the electricity sector to support the delivery of net zero emissions will change over time.

Our views will be informed by what we learn about the costs of decarbonising other sectors of the economy and by the costs and availability of negative emissions technologies, such as Bioenergy with Carbon Capture and Storage (BECCS) or Direct Air Carbon Capture and Storage (DACCS).

We are not targeting a particular generation mix for 2050, nor would it be advisable to do so. We have already reduced power sector emissions 58 per cent between 2010 and 2018,⁵³ and to stay on a course for a fully decarbonised system we will continue that progress through the 2020s and have an overwhelmingly decarbonised power system in the 2030s.

The electricity market should determine the best solutions for very low emissions and reliable supply, at a low cost to consumers.

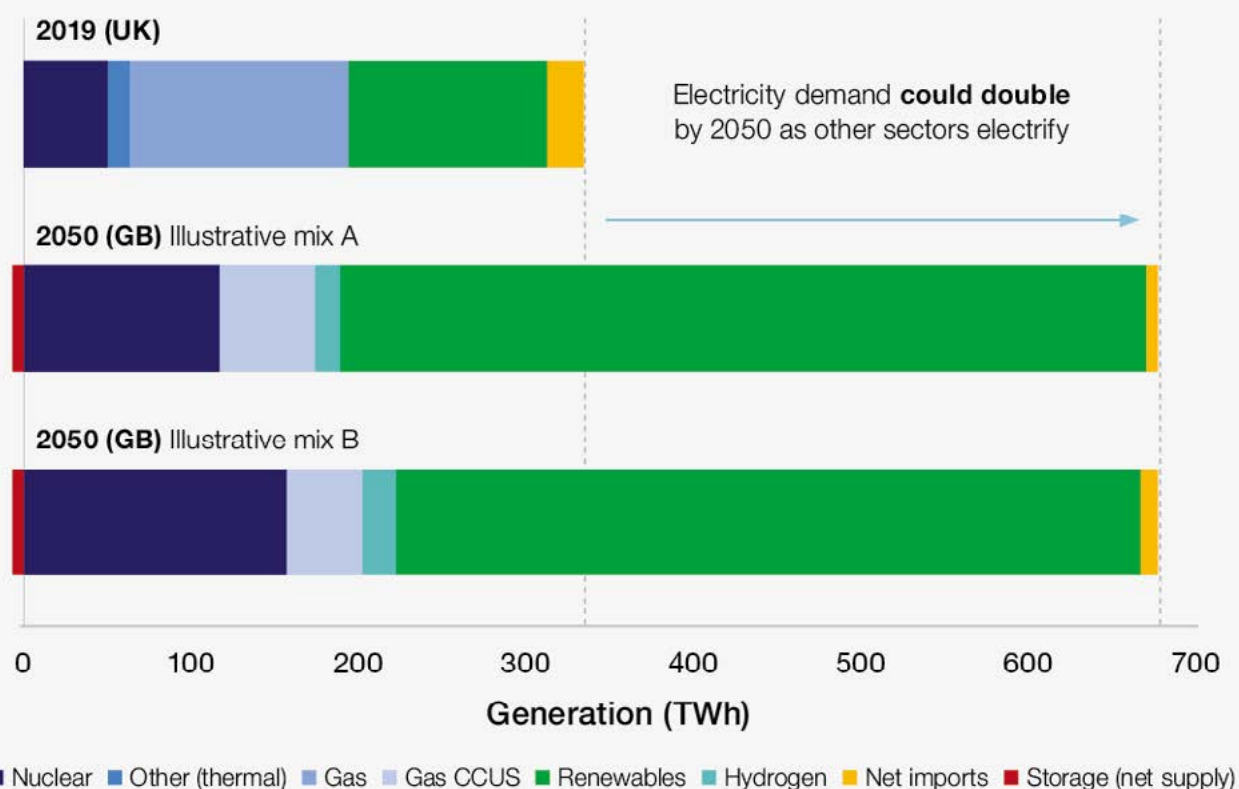
FIGURE 3.3 - UK EMISSIONS, NET ZERO SCENARIO

Source: CCC 2020 Progress Report

Competition should be a spur to greater investment in technologies which are cheaper and more efficient; or to the innovation which will reduce the costs of existing options. We have seen very rapid falls in the costs of renewables over the last five years and want to maintain the market conditions which stimulate these cost reductions. The government's role is to ensure a market framework which promotes effective competition and delivers an affordable, secure and reliable system, consistent with net zero emissions by 2050. This market framework should enable the deployment of the most efficient, low-cost technologies and mitigate delivery risk associated with a particular technology. We will intervene to address any potential market failures, as government did through the introduction of the Capacity Market, to ensure enough supply at periods of peak demand.

We will continue to invest in innovation which helps commercialise new technologies and reduce overall technology costs.

While we are not planning for any specific technology solution, we can discern some key characteristics of the future generation mix. A low-cost, net zero consistent system is likely to be composed predominantly of wind and solar. But ensuring the system is also reliable, means intermittent renewables need to be complemented by technologies which provide power, or reduce demand, when the wind is not blowing, or the sun does not shine. Today this includes nuclear, gas with carbon capture and storage and flexibility provided by batteries, demand side response, interconnectors (see 'Energy system' chapter) and short-term dispatchable generation providing peaking capacity, which can be flexed as required.

FIGURE 3.4 - ELECTRICITY MIX TODAY & ILLUSTRATIVE 2050 MIXES

Source: Energy Trends, table 5.1 and 6.1; BEIS analysis.

By 2050, we expect low-carbon options, such as clean hydrogen and long-duration storage, to satisfy the need for peaking capacity and ensure security of supply at low cost, likely eliminating the reliance on generation from unabated gas.

Figure 3.4 illustrates how the system could meet a doubling of demand, while reducing emissions. It shows just two of many scenarios which decarbonises electricity to very low levels of emissions at low cost. It serves to emphasise how much additional generation capacity we will need to build and how much electricity it produces to satisfy high levels of demand. Very different mixes can also provide low-cost solutions for the same demand scenario.

We are publishing the details of our electricity system analysis alongside this white paper.⁵⁴ We have modelled almost 7,000 different

electricity mixes in 2050, for two different levels of demand and flexibility, and 27 different technology cost combinations. It has produced a dataset comprising of over 700,000 unique scenarios, allowing us to identify common features of a low emissions, low-cost electricity system.

The analysis allows us to better prepare for an electricity system which is consistent with net zero emissions, even if we do not know the precise generation mix in 2050. It informs the actions we need to take to support the deployment of clean electricity technologies, including how we can direct our innovation support most effectively. We can target the technologies which have a key role in the system of the future, such as low-carbon peaking capacity and long-duration storage, which enable us to integrate high volumes of low-cost intermittent generation.

Our key commitments

AFFORDABLE CLEAN ELECTRICITY

This white paper sets out the actions which we are taking to put the country on the path to a low-cost, clean electricity system by 2050.

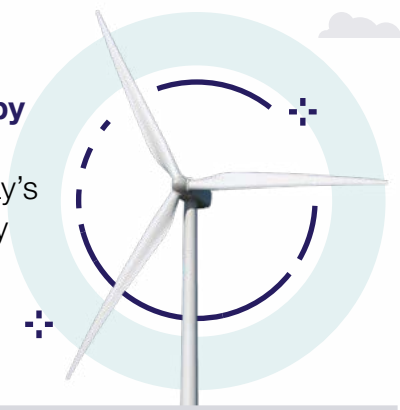
It will comprise the technologies which allow us to drive deep reductions in carbon emissions at a low cost, while maintaining the reliability and resilience of the system. Our actions are a strong signal to project developers and the wider investor community about the government's commitment to delivering clean electricity. This should stimulate the continued deployment of key low-carbon technologies in the near term, while encouraging innovation in the technologies of the future which offer the greatest potential to reduce costs.

RENEWABLES

► **We will target 40GW of offshore wind by 2030, including 1GW floating offshore wind, alongside the expansion of other low-cost renewable technologies.**

A highly competitive Contracts for Difference (CfD) allocation round in 2019 led to the procurement of 5.5GW of offshore wind and 275MW of remote island wind, at strike prices around £40/MWh (2012 prices) for projects expected to start generating electricity by 2024.⁵⁵ This contrasts with prices for offshore wind of £150/MWh for projects which became operational in 2017.⁵⁶

Our ambition is to have **40GW offshore wind by 2030**, a fourfold increase on today's installed capacity



As announced in the Prime Minister's Ten Point Plan for a Green Industrial Revolution, we will continue to hold regular CfD auction rounds every two years to bring forward a range of low-cost renewable technologies. The next auction in late 2021 will be open to onshore wind, solar photovoltaics and other established technologies, as well as offshore wind. Subject to sufficient projects coming through the planning pipeline to maintain competitive tension, we plan to double the capacity awarded in the last round with the aim to deploy around 12GW of low-cost renewable generation. Onshore wind and solar will be key building blocks of the future generation mix, along with offshore wind. We will need sustained growth in the capacity of these sectors in the next decade to ensure that we are on a pathway that allows us to meet net zero emissions in all demand scenarios.



Following our recent Call for Evidence on the potential of marine energy projects, we have set an ambition of deploying 1GW of floating offshore wind by 2030, supported by CfDs and innovation funding. Acting now will drive higher volumes of deployment in the 2030s and beyond, subject to cost reductions. We will work closely with the devolved administrations, the Crown Estate and Crown Estate Scotland to address issues such as seabed leasing and protecting the marine environment and to ensure the UK captures the economic benefits of deploying the technology. This will provide the foundation for a sustainable, competitive supply chain and enable floating offshore wind projects to scale up and accelerate cost reduction.

We will consider the role of wave and tidal energy, following further evaluation of the commercial and technical evidence. We will also identify and utilise synergies between hydrogen and the deployment of offshore wind.

It is vital that CfDs offer value for money to consumers and continue to deliver low prices. We will structure the 2021 and future auctions to keep the CfD allocation process highly competitive, supported by a number of technical changes to the auction. Alongside this white paper, we are issuing a new Call for Evidence seeking views on how the CfD scheme could evolve beyond the 2021 auction, including how longer-term changes to the CfD or wider electricity market design can enable the effective integration of increasing renewables capacity.⁵⁷

We want to understand how generators can best be exposed to market signals which stimulate innovation and incentivise generators to minimise the overall system costs of large amounts of renewables. We will also be asking about the broader evolution of the electricity market (see ‘Energy system’ chapter). We will seek a balance between options for further reform of the market with maintaining the success of the CfD in deploying low-cost renewables at scale.

We will establish a Ministerial Delivery Group, which brings together the relevant government departments to oversee the expansion of renewable power in the UK. This group will provide the cross-government coordination and collaboration necessary to achieve our ambition for renewable electricity. It will tackle barriers such as the impact of wind turbines on radar systems, maintaining a flourishing and biologically diverse marine environment and the development of appropriate network infrastructure to support future renewables deployment. We will also work to reduce consenting delays and ensure that planning guidelines and environmental regulations are fit for purpose. The Ministerial Delivery Group will make use of existing cross-government mechanisms, such as the Offshore Wind Enabling Actions programme, a £4.3 million initiative to be run jointly by Defra and BEIS and funded by HM Treasury (HMT).

POWER CCUS

► **We will support the deployment of at least one power CCUS project, to be operational by 2030, and put in place the commercial framework required to help stimulate the market to deliver a future pipeline of power CCUS projects.**

In the power sector, gas-fired generation with CCUS can provide flexible, low-carbon capacity to complement high levels of renewables. These characteristics mean that deployment of power CCUS projects will play a key role in the decarbonisation of the electricity system at low cost.

We will support at least one power CCUS plant to come forward and be operational by 2030 and will put in place a commercial framework which will enable developers to finance the construction and operation of a power CCUS plant and stimulate a pipeline of projects. This will enable at least one power CCUS project to be developed in one of the four industrial clusters as part of our mission to decarbonise them (See ‘Industrial energy’ chapter). Following the publication of the government response to our CCUS business models consultation in August 2020,⁵⁸ we will introduce a business model based on the existing CfD framework, adapted so that price signals incentivise power CCUS to play a role in the system, which complements renewables. We set out our plans for the deployment of transport and storage infrastructure in the ‘Industrial energy’ chapter.

► **We will consult on steps to ensure that new thermal plants can convert to low-carbon alternatives.**

Since 2009, our Carbon Capture and Readiness requirements have ensured that planning consent is only granted to thermal plants for which it will be technically and economically feasible to retrofit CCUS. However, we believe the current 300MW minimum threshold creates a costly market distortion, by disincentivising the deployment of gas plants larger than 300MW, which tend to be more efficient. The threshold also means that the requirements only apply to a small proportion of new build thermal plants. Furthermore, the requirements do not reflect recent technological advances, including alternative options for decarbonising gas plants, such as conversion to firing clean hydrogen. Therefore, we intend to consult in early 2021 over proposals to update the requirements to reflect technological advances and apply them more broadly, by removing the 300MW threshold.

NUCLEAR

► **We will aim to bring at least one large-scale nuclear project to the point of Final Investment Decision (FID) by the end of this Parliament, subject to clear value for money and all relevant approvals.**

Nuclear power continues to be an important source of reliable clean electricity, currently supplying around 16 per cent of our needs.⁵⁹ It is an energy-dense technology which provides large volumes of power from very little land area and can reduce system costs at low levels of emissions. In 2016, the government agreed contracts related to the first new nuclear power station in a generation.

~7%

of the country's current electricity needs will be **delivered by Hinkley Point C**

10,000

jobs could be supported during construction of a large-scale nuclear power plant

30%

expected **reduction in the cost of nuclear new build projects** by 2030

Hinkley Point C is due to commission in the mid-2020s and will deliver around seven per cent of the country's current electricity needs - enough to power the equivalent of around six million homes.⁶⁰ But, with the existing nuclear fleet largely retiring over the next decade, we propose to go further. Our analysis suggests additional nuclear beyond Hinkley Point C will be needed in a low-cost 2050 electricity system of very low emissions. We must be ready for this.

We aim to bring at least one further large-scale nuclear project to the point of FID by the end of this Parliament, subject to clear value for money for both consumers and taxpayers and all relevant approvals.

As noted in the Ten Point Plan, a large-scale nuclear power plant could support a peak of around 10,000 jobs during construction.⁶¹ We will remain open to further projects later if the nuclear industry demonstrates that it is able to reduce costs and deliver to time and budget.



We expect the sector to deliver the goal it set for itself in our Nuclear Sector Deal, published in 2018,⁶² to reduce the cost of nuclear new build projects by 30 per cent by 2030.

Last year, we consulted on a Regulated Asset Base (RAB) model for private investment in new nuclear generation.⁶³ Today we are publishing a summary of the responses which have indicated that a RAB model remains credible for funding large-scale nuclear projects.⁶⁴

The government will continue to explore this, alongside a range of financing options, with the developer of the next large-scale project in the pipeline and other relevant stakeholders, including other nuclear developers. Raising enough private capital to finance a nuclear power station is challenging given the significant investment needed for a developer to reach a point of FID. In considering the financing options, we will examine the potential role of government finance during construction, provided there is clear value for money for consumers and taxpayers.

ADVANCED NUCLEAR INNOVATION

- ▶ **We will provide up to £385 million in an Advanced Nuclear Fund for the next generation of nuclear technology aiming, by the early 2030s, to develop a Small Modular Reactor (SMR) design and to build an Advanced Modular Reactor (AMR) demonstrator.**

The UK continues to be a leader in the development of nuclear technologies.

SMRs have the potential to provide cost-competitive nuclear power as early as the 2030s. Pending regulatory approval, innovative manufacturing techniques and modular construction could mean that SMRs are faster to build than large-scale nuclear plants and are potentially suitable for deployment in a wider number of sites across the country.

SMALL MODULAR REACTOR

Small Modular Reactors (SMRs) are usually based on proven water-cooled reactors similar to current nuclear power station reactors, but on a smaller scale. They use nuclear fission to generate low-carbon electricity. SMRs are called modular reactors as their components can be manufactured in factories using innovative techniques and then transported to site to be assembled.



£385m

Advanced Nuclear Fund created



£400bn

estimated worth of SMRs and AMRs by 2035

Subject to future HMT Spending Reviews, we have provided a £385 million in an Advanced Nuclear Fund with up to £215 million investment to develop a domestic SMR design that could potentially be built in factories and then assembled on site. It is expected to unlock up to £300 million private sector match-funding.

To help bring advanced nuclear technologies to the market, we will also invest an additional £40 million in developing the regulatory frameworks and supporting UK's supply chain. As the first major commitment of the programme, in 2021 we will open the Generic Design Assessment to SMR technologies, the regulatory process through which developers can obtain approval for their proposed design approach.

Supporting the development of our supply chain now will increase our chances of having indigenous expertise capable of leading the world in developing the nuclear technologies of the future - SMRs and AMRs - a global market estimated by some to be worth approximately £250 billion to £400 billion by 2035.⁶⁵

ADVANCED MODULAR REACTOR

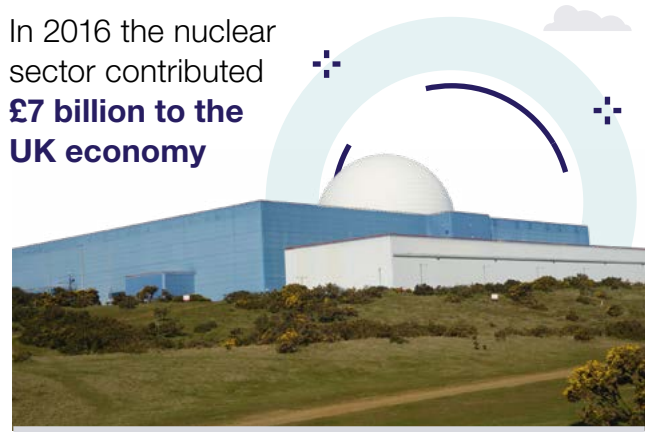
Advanced Nuclear Reactors (AMRs) are reactors which use novel cooling systems or fuels and may offer new functionalities (such as industrial process heat). These reactors could operate at over 800°C and the high-grade heat could unlock efficient production of hydrogen and synthetic fuels.

We are also committing up to £170 million of the Advanced Nuclear Fund to a R&D programme on AMRs – the next generation of nuclear technologies. Our aim is to build a demonstrator by the early 2030s at the latest to prove the potential of this technology and put the UK at the cutting edge against international competitors.

► We aim to build a commercially viable fusion power plant by 2040.

Fusion energy would offer low-carbon, continuous, and effectively unlimited power generation. The basic science and engineering involved in the production of fusion energy is now well advanced and fusion energy is expected to play an important role over the longer term to decarbonise global energy production.

In 2016 the nuclear sector contributed **£7 billion to the UK economy**



The UK is a world leader in the most promising fusion technologies with research capabilities across the technical challenges of fusion. This means that the UK is uniquely well-placed to lead the future commercialisation of this technology. The government has already committed over £400 million towards new UK fusion programmes. The aims are to develop a concept design for the Spherical Tokamak for Energy Production (STEP) – expected to be the world's first compact fusion power plant, to be built in the UK by 2040 – and to invest in facilities and infrastructure to make the UK a global fusion industry hub. In December 2020, the STEP programme published an open call for communities across the UK to apply to be the host site for STEP.⁶⁶

NET ZERO INNOVATION PORTFOLIO

The Ten Point Plan announced a new £1 billion Net Zero Innovation Portfolio that will help bring down the cost of the net zero transition, nurture the development of better products and new business models, and influence consumer behaviour.

A £1 billion Net Zero Innovation Portfolio aims to accelerate the commercialisation of innovative low-carbon technologies, systems and processes in power, buildings and industry to set the UK on the path to net zero and create world-leading industries and new jobs. The portfolio will focus on ten priority areas to decrease the costs of decarbonisation and underpin innovation across the whole energy system.

As well as accelerating the commercialisation of novel clean energy technologies, innovation also plays an important role in driving economic growth, anchoring new technology to the UK, delivering levelling-up across the country and reducing our significant exposure to the risks of climate change.

An ambitious and well-designed energy innovation strategy could, by 2050, annually generate £54 billion of business opportunities for the UK.⁶⁷

The current BEIS £505 million Energy Innovation Programme is delivering some of the UK's most significant advances in low-carbon technologies, leveraging £200 million industry investment:

- ▶ **The UK's first CCUS plant** at Tata Chemicals, Cheshire (£17 million total investment)
- ▶ **The world's largest "Cryogenic" energy storage plant** at Manchester (over £70 million total investment)
- ▶ **The UK's largest innovative heat pump trial** (750 homes, over £15 million total investment)
- ▶ **The UK's first Venture Capital fund solely focussed on Cleantech** (over £40 million total investment).

NET ZERO INNOVATION PORTFOLIO - PRIORITY AREAS



**Advanced
Modular
Reactors**



**Floating
offshore wind**



Hydrogen



Bioenergy



**Industrial fuel
switching**



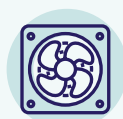
**Advanced
CCUS**



Homes



**Disruptive
technologies**



**Direct air
capture**



**Energy storage
and flexibility**

BIOENERGY INNOVATION

- **By 2022, we will establish the role which BECCS can play in reducing carbon emissions across the economy and, as part of a wider biomass strategy, set out how the technology could be deployed.**

Biomass is unique amongst renewable technologies in the wide array of applications in which it can be used as a substitute for fossil-fuel based products and activities, from power generation to hydrogen production and even new forms of plastics. Along with its ability to deliver negative emissions, this makes biomass one of our most valuable tools for reaching net zero emissions.

BIOMASS

Biomass refers to any material of biological origin (including wastes) which is used as a fuel for bioenergy (conventional combustion, gasification, energy from waste and low-carbon fuels like hydrogen) or in products (such as chemicals, bio-plastics and timber for construction).

In the government's response to Climate Change Committee's (CCC) latest annual progress report to Parliament, we announced that we will publish a new Biomass Strategy in 2022. As part of this strategy, we will set out the results of a review of the amount of sustainable biomass available to the UK, and how this resource could be best utilised across the economy to help achieve our net zero greenhouse gas emissions target by 2050.

Our review will assess the UK's current biomass sustainability standards, which are already some of the world's most stringent, to see where and how we can improve them even further. Our review will also consider the role biomass can play in delivering our wider environmental targets, including on air quality.

We will shortly issue a call for evidence: 'Biomass for net zero', to inform the development of our strategy. We will issue a preliminary position paper by summer 2021, once the evidence has been reviewed.

Critical to our consideration will be the role of BECCS in our energy system. BECCS plants could deliver negative emissions, by capturing the carbon released during biomass combustion, gasification and other processes, provided supply chain emissions are sufficiently low. There are a number of applications for BECCS across the economy, including clean hydrogen production, power generation, waste management and in heat for industrial processes and we need to ensure that it is deployed where it has the greatest value in reducing emissions.

For example, current support for electricity generation, which converted from coal to using biomass as a fuel source, expires in 2027. BECCS could provide a long-term future for this capacity.



THE POTENTIAL OF GREENHOUSE GAS REMOVAL (GGR) TECHNOLOGIES

Greenhouse gas removal technologies actively remove greenhouse gases from the atmosphere and are diverse, ranging from engineered to nature-based solutions. The CCC has been clear that, in order to achieve net zero by 2050, GGRs will be necessary to balance residual emissions from some of the most difficult to decarbonise sectors, such as parts of the agriculture and aviation sectors. The CCC has estimated 75MtCO₂ of negative emissions could be required annually in order to reach net zero greenhouse gas emissions by 2050.⁶⁸

The government is already taking steps to accelerate the development and deployment of GGRs in the UK.

In June 2020, we announced up to £100 million of funding for research and development of DACCS and other GGR methods.⁶⁹ This funding seeks to demonstrate feasible GGR approaches at scale, as well as better our understanding of governance and ethics of GGRs. We have also published a call for evidence earlier in December,⁷⁰ which seeks views on mechanisms and governance principles to help bring GGR technologies like DACCS to deployment in the UK. Alongside this, both BEIS and the National Infrastructure Commission will conduct research projects to develop the evidence based on GGRs in order to support future policy in this area.

A PLANNING FRAMEWORK FOR ENERGY INFRASTRUCTURE

- ▶ **We will complete a review of the existing energy National Policy Statements (NPS), with the aim of designating updated NPS by the end of 2021.**

The suite of energy NPS establish the need for new energy infrastructure and set out a framework for the consideration of applications for development consent. We have decided that it is appropriate to review the NPS, to ensure that they reflect the policies set out in this white paper and that we continue to have a planning policy framework which can deliver the investment required to build the infrastructure needed for the transition to net zero. Work on this review will start immediately, with the aim of designating updated NPS by the end of 2021.

This white paper shows that the need for the energy infrastructure set out in energy NPS remains, except in the case of coal-fired generation. While the review is undertaken, the current suite of NPS remain relevant government policy and have effect for the purposes of the Planning Act 2008. They will, therefore, continue to provide a proper basis on which the Planning Inspectorate can examine, and the Secretary of State can make decisions on, applications for development consent. Nothing in this white paper should be construed as setting a limit on the number of development consent orders which may be granted for any type of generating infrastructure set out in the energy NPS. Other restrictions outside the planning regime (in particular the Emissions Performance Standard) mean that no new coal infrastructure projects can come forward.

THE ECONOMIC BENEFITS OF CLEAN ELECTRICITY

The UK should harness more of the economic benefit from the accelerated deployment of renewable technologies. This will help position the whole of the UK to reap economic benefits.

- ▶ **We will support the delivery of the industry's target of 60 per cent UK content in offshore wind projects by 2030, through more stringent requirements for the CfD supply chain plan process.**

We will invest in the growth of the UK's offshore wind manufacturing infrastructure to create jobs and opportunity in the UK supply chain. We will use our Offshore Wind Sector Deal with the renewables sector to ensure that domestic deployment creates jobs and raises skills levels across the country, and to support overseas trade and investment opportunities for UK-based companies. We will require developers who are awarded a CfD, to honour their supply chain plans.

- **We have announced a £160 million scheme and launched a competitive process in early December to support the development of offshore wind manufacturing infrastructure.**

The £160 million funding announced in October 2020 and the competitive process launched in early December will support the development of major port-side infrastructure hubs, strengthening UK offshore wind manufacturing. This will have a major impact on our ability to develop a competitive UK supply chain for domestic and overseas markets.⁷¹ It will help attract inward investment to manufacturing in the UK and increase our global competitiveness and expertise. The investment will support major new offshore wind manufacturing capacity which is needed to develop a competitive industrial base capable of servicing UK and international markets. Our Ten Point Plan set out how the investment alongside 40GW offshore wind will support the industry's target to achieve 60 per cent UK content by 2030.⁷² And we will use it as the platform to target a five-fold increase in exports of offshore wind goods and services to at least £2.6 billion a year by 2030. The sector could bring £3 billion GVA a year by 2030, of which £1 billion is export related.⁷³

This new investment, could create around 2,000 construction jobs, representing high quality employment opportunities in many coastal regions around the country. This investment alongside other offshore wind commitments will enable the offshore wind sector to support up to 30,000 direct jobs and 30,000 indirect jobs in ports, factories and the supply chains by 2030.⁷⁴



£2.6bn

target annual exports of offshore wind goods and services by 2030



£7bn

contributed by the nuclear sector to the UK economy in 2016



60,000

direct and indirect jobs could be supported by the offshore wind sector by 2030

The nuclear sector also makes a significant contribution to the UK economy - some £7 billion GVA in 2016.⁷⁵ The nuclear industry currently employs around 60,000 people.⁷⁶ Building, operating and decommissioning our nuclear assets takes place in some of the most remote areas of the UK. Developing the domestic supply chain for the sector has the potential to transform the prosperity of these regions. It provides high-value and skilled employment opportunities, unlocking investment to support infrastructure projects and growing manufacturing and industrial capability.



CASE STUDY: GRIMSBY PORT REVIVAL

North East Lincolnshire is home to the Port of Immingham which is the UK's largest port by tonnage - handling around 11 per cent of the UK's cargo.⁷⁷ It serves a diverse range of industries and is an international gateway.

Today Grimsby sits in the 10 per cent of England's most deprived regions,⁷⁸ however it has strong maritime history and the wider strengths in the energy sector. Its location close to the majority of the UK's offshore wind farm developments presents a major opportunity for the Port of Grimsby and the town with around £10 million being invested in the port and facilities.⁷⁹

Since the first wind farms, notably Lincs and Lynn and Inner Dowling were built in 2009,⁸⁰ the Port of Grimsby has developed and is now recognised as the centre for operations and maintenance (O&M) services to the offshore wind farms. It is a major base for businesses such as Ørsted, E.ON, Innogy and GLID/Siemens

These global leaders in offshore renewable energy offer many high skilled jobs for the area. The rapid growth of the renewable energy industry in the UK has presented new economic opportunities for Grimsby in the last decade. Ørsted recently opened its expanded O&M base, creating the world's largest O&M base, employing 350 people (83 per cent workers live within one hour's distance⁸¹), – with the port estimating that over 650 are employed on offshore wind O&M services.⁸²

In addition, the Offshore Renewable Energy Catapult project, now based in Grimsby's Port Offices, plan to create a Centre of Excellence. This will serve as a leading testing facility for the development of next generation technologies benefiting the whole of the UK. Direct industry input into projects at the Operations and Maintenance Centre of Excellence is expected to be £90 million over the next 10 years.⁸³



At Hinkley Point C, the developer expects that 64 per cent of the construction contracts, by value, will go to UK-based companies.⁸⁴ But the potential for the domestic supply chain beyond Hinkley Point C is greater than this, given the capability of UK companies across the nuclear lifecycle; from enrichment and fuel fabrication, through new-build construction, plant operation, world leading R&D, future nuclear technologies to waste management and decommissioning and final disposal.

In the Nuclear Sector Deal, we committed to help the UK supply chain become more productive and competitive.⁸⁵ This includes supporting established companies to strengthen their ability to compete for high-value work and we will reduce barriers to entry for innovative companies, especially Small and Medium-sized Enterprises. We are working with the sector to develop a national and regional supply chain productivity improvement programme to achieve these objectives and target at least £2 billion of domestic and export contracts for UK companies by 2030.

Our key commitments



We will **target 40GW of offshore wind by 2030**, including 1GW floating wind, alongside the expansion of other low-cost renewable technologies.



We will **support the deployment of at least one power CCUS project**, to be operational by 2030, and put in place the commercial frameworks required to help stimulate the market to deliver a future pipeline of power CCUS projects.



We will consult on steps to **ensure that new thermal plants can convert to low-carbon alternatives**.



We will **aim to bring at least one large-scale nuclear project to the point of FID** by the end of this Parliament, subject to clear value for money and all relevant approvals.



We will **provide up to £385 million in an Advanced Nuclear Fund** for the next generation of nuclear technology aiming, by the early 2030s, to develop a SMR design and to build an AMR demonstrator.



We aim to **build a commercially viable fusion power plant** by 2040.



By 2022, we will **establish the role which BECCS can play in reducing carbon emissions across the economy** and, as part of a wider biomass strategy, set out how the technology could be deployed.



We will **complete a review of the existing energy NPS** and designate updated NPS by the end of 2021.



We will **support the delivery of the sector's target of 60 per cent UK content in offshore wind projects by 2030**, through more stringent requirements for the CfD supply chain plan process.



We have announced a £160 million scheme and launched a competitive process in early December to **support the development of offshore wind manufacturing infrastructure**.

EXPLAINER

Modelling energy



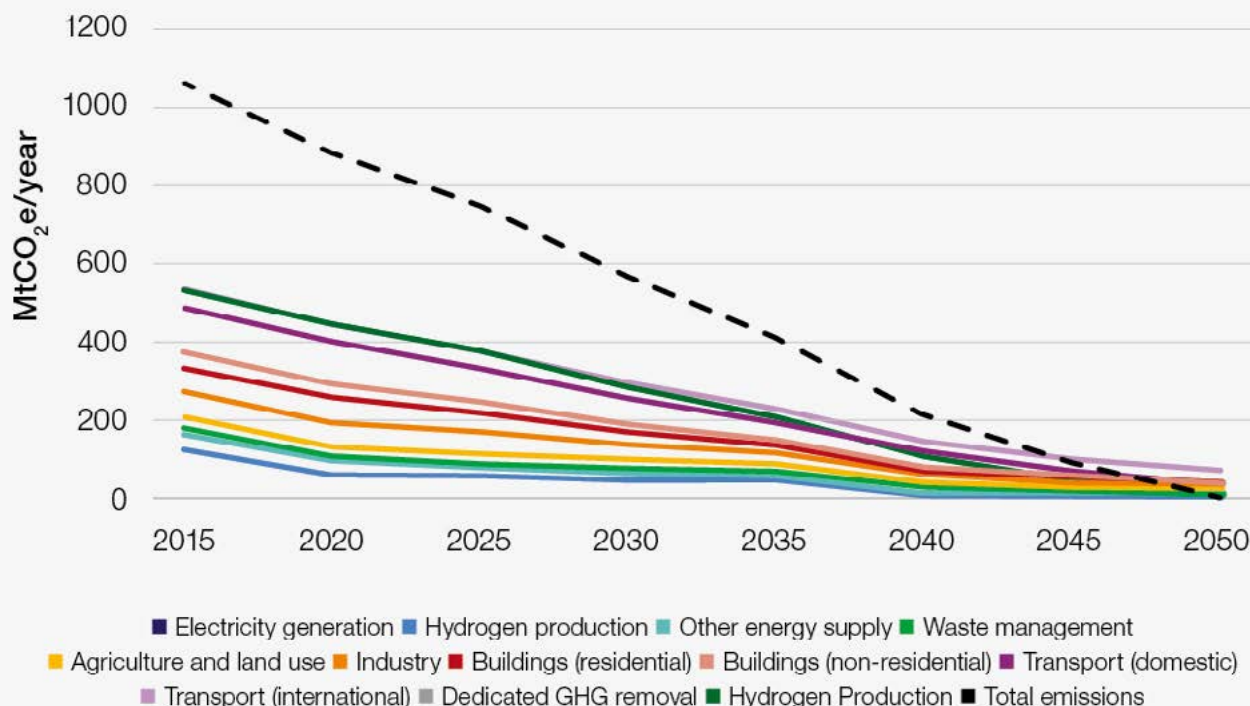
SETTING THE SCENE

Developing the policies we need to achieve net zero is challenging. We need to manage uncertainties ranging from the cost of fuel, when and whether certain technologies will be available, and how people will behave when they are asked to use new ways of heating their homes.

To help us do so, we can use models of the economy and the energy system. These digital tools help us understand the linkages and interdependencies between different parts of the system and how our policies impact consumers.

The models we use perform functions ranging from strategic analysis of long-term decarbonisation to improving our understanding of how proposed policies will work in practice. For example, our Mackay Carbon Calculator provides illustrative pathways to reaching net zero by 2050 (figure 4.1).⁸⁶

It is important that the results from models are understood and used correctly. This means reflecting uncertainties, being clear on assumptions and combining modelling evidence with, and testing it against, other forms of evidence.

FIGURE 4.1 – ILLUSTRATIVE PATHWAY TO NET ZERO EMISSIONS

Source: Mackay Carbon Calculator

Many of our models have been developed in-house and in close collaboration with academia. We now want to increase our ability to access the best modelling expertise available. We will implement a new modelling strategy that will increase transparency and collaboration. This will improve our insights and increase confidence in policy. We will build on the recommendations of the Energy Data Taskforce,⁸⁷ and have published the Mackay Carbon Calculator and the National Household Model.⁸⁸

OUR LAST MODELLING STRATEGY

- ▶ **Consolidated and simplified** the “modelling landscape” by developing models that can support more than one policy;
- ▶ **Built collaboration** by
 - Developing academic links for long term energy modelling;
 - Publishing our 2050 Calculator & National Household Model;
- ▶ **Improved how we treat the many inputs** to our models; and,
- ▶ **Implemented standard quality assurance processes.**⁸⁹

TRANSFORMING OUR MODELLING

Our modelling strategy will ensure our suite of models, data, assumptions and management processes are:

- ▶ **Effective** in supporting evidence-based policy making;
- ▶ **Accessible** for policy teams, open to all and trusted by the department and wider stakeholders;
- ▶ **Coherent** and coordinated;
- ▶ **Consistent** and / or transparent in the use of assumptions;
- ▶ **Efficient** in the use of resources; and
- ▶ **Robust** - capable of being maintained and meeting quality standards.

THE NEXT PHASE

The next phase of our modelling strategy will improve our approach to modelling:

- ▶ **Transparency:** We will set up and test a protocol for publishing our models. There will be specified exemptions such as models in development or models including with sensitive commercial or security information commercially.
- ▶ **Intra-energy system modelling:** We will review and update our long term, whole energy system models and their inter-operation with sector specific models, taking in the latest ideas from Digital Twins.⁹⁰

- ▶ **Infrastructure:** We will develop and implement our IT strategy to make it easier for analysts, contractors and collaborators to develop and maintain models by harmonising development languages and providing a development environment for our partners.

THIS APPROACH WILL:

- ▶ Increase the **agility** of government decision and ensure policies to reflect the **best evidence** by:
 - Collaborating with a range of stakeholders on our modelling approaches and
 - Ensuring our models and their inputs adapt to a fast-changing market.
- ▶ Ensure our we **use the latest methodologies, software and technology** by continuing to invest in partnering to develop models of our energy systems.
- ▶ Stimulate **innovation**.

TO EXECUTE OUR STRATEGY:

- ▶ **We will improve and test the proposition of open sourcing models** by:
 - Developing a protocol for releasing our models
 - Developing an Open Modelling Environment to share modelling capability in a trusted space;



- Investigating providing an open access data source for the National Household Model;
- Opening access to a new version our long term energy systems model; developed in collaboration with University College London, and;
- Running modelling improvement competitions to leverage 3rd party knowledge - initially running a competition to improve econometric equations at the heart of BEIS Energy Demand Model – used to produce our Energy and Emissions Projections.⁹¹

- **We will establish a protocol for regular publication of quasi-statistical publications** such as Energy and Emissions Projections using voluntary application of the Code of Practice for Statistics.⁹²
- **We have published an updated energy calculator.** The new calculator is named in honour of the late David Mackay. The Calculator was his brainchild. One important new feature will be the ability to alter start and finish dates for each lever. This is an important contribution for the global calculator community.

CHAPTER 03

Energy system

OUR GOAL

To deliver energy reliably, while ensuring fair and affordable costs and accelerating our transition to clean energy, we need to create investment opportunities across the UK to enable a smarter, more flexible energy system, which harnesses the power of competition and innovation to the full.

In partnership with the Office of Gas and Electricity Markets (Ofgem), we will:

- ▶ **Work to minimise the costs to consumers** of getting energy to homes and businesses, by promoting more innovation and competition in networks and in national and local energy markets
- ▶ **Ensure electricity networks are able to integrate increasing renewable generation** and more electric vehicles (EVs), while controlling system costs
- ▶ **Make sure that energy system information about supply and demand is used to drive greater efficiency and lower costs**, as well as promote more innovation and new services for consumers
- ▶ **Ensure that the system's rules and governing institutions support the transition away from fossil fuels** to clean energy



ENERGY SYSTEM

The strategic context



The UK's energy system is one of the most developed and successful anywhere in the world.

It was designed and built for the age of fossil fuels which, even today, are predominant in final energy use. Though they are now at record low levels, fossil fuels, primarily petroleum products and natural gas, still accounted for just over 79 per cent of energy supply in 2019, with electricity representing only 17 per cent of final energy use by consumers.⁹³

This dependency on fossil fuels will change dramatically over the next 30 years. By 2050, electricity could provide over half of final energy demand, as it displaces petrol and diesel in cars and light vehicles and, to some degree, gas for heat in homes. As we set out in the 'Power' chapter, this could mean that electricity demand doubles from today's 345TWh.⁹⁴

This change necessitates a very different approach, and not just because the energy system must support the deployment of clean energy technologies. It will also have to adapt to a world in which energy is far more decentralised.

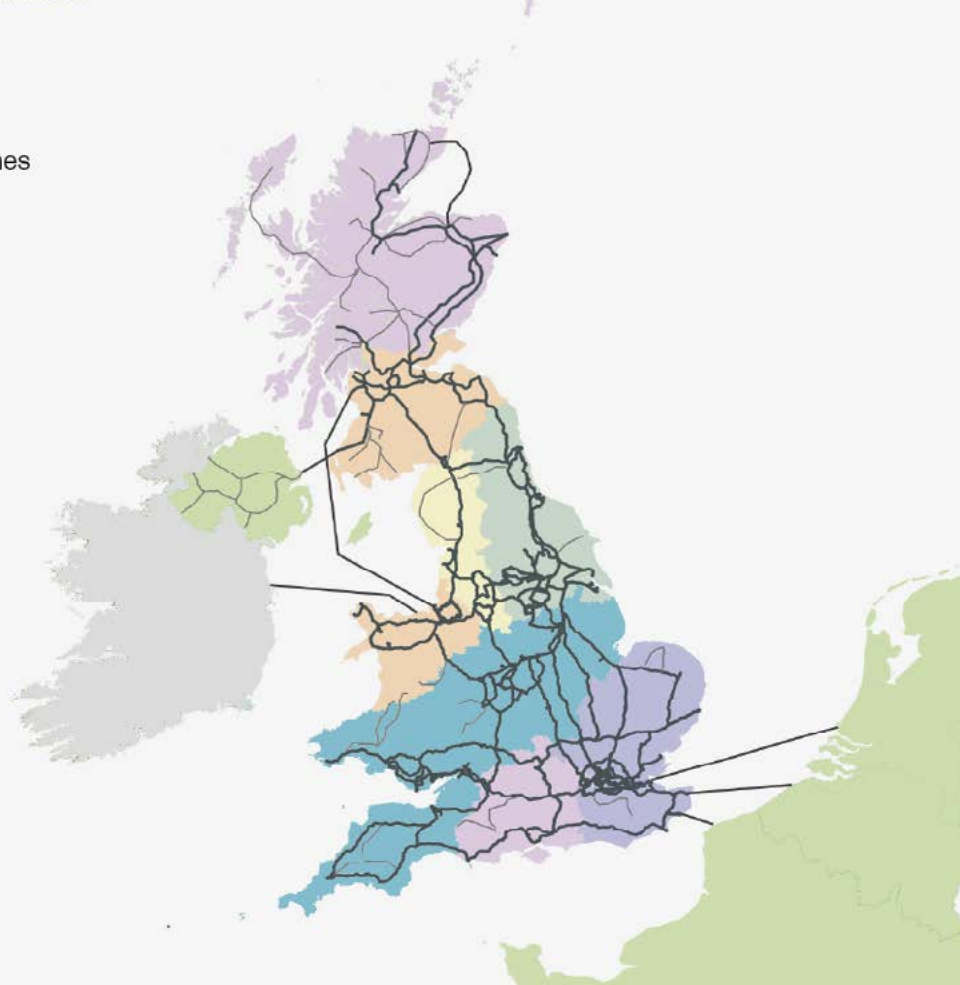
FIGURE 5.1 - UK ELECTRICITY NETWORKS AND DISTRIBUTION AREAS

Electricity network

- Major powerlines
- Other selected powerlines

Network operators

- Electricity North West
- Northern Powergrid
- Scottish Power
- Scottish & Southern
- UK Power Networks
- Western Power



Source: DUKES July 2020⁹⁵

ELECTRICITY DISTRIBUTION NETWORKS

Smaller regional networks that transport electricity from the transmission lines and small-scale generators, into our homes and businesses – the ‘A and B roads’ of our energy network. There are 14 licenced distribution network operators (DNOs), owned by six different groups.

ELECTRICITY TRANSMISSION NETWORKS

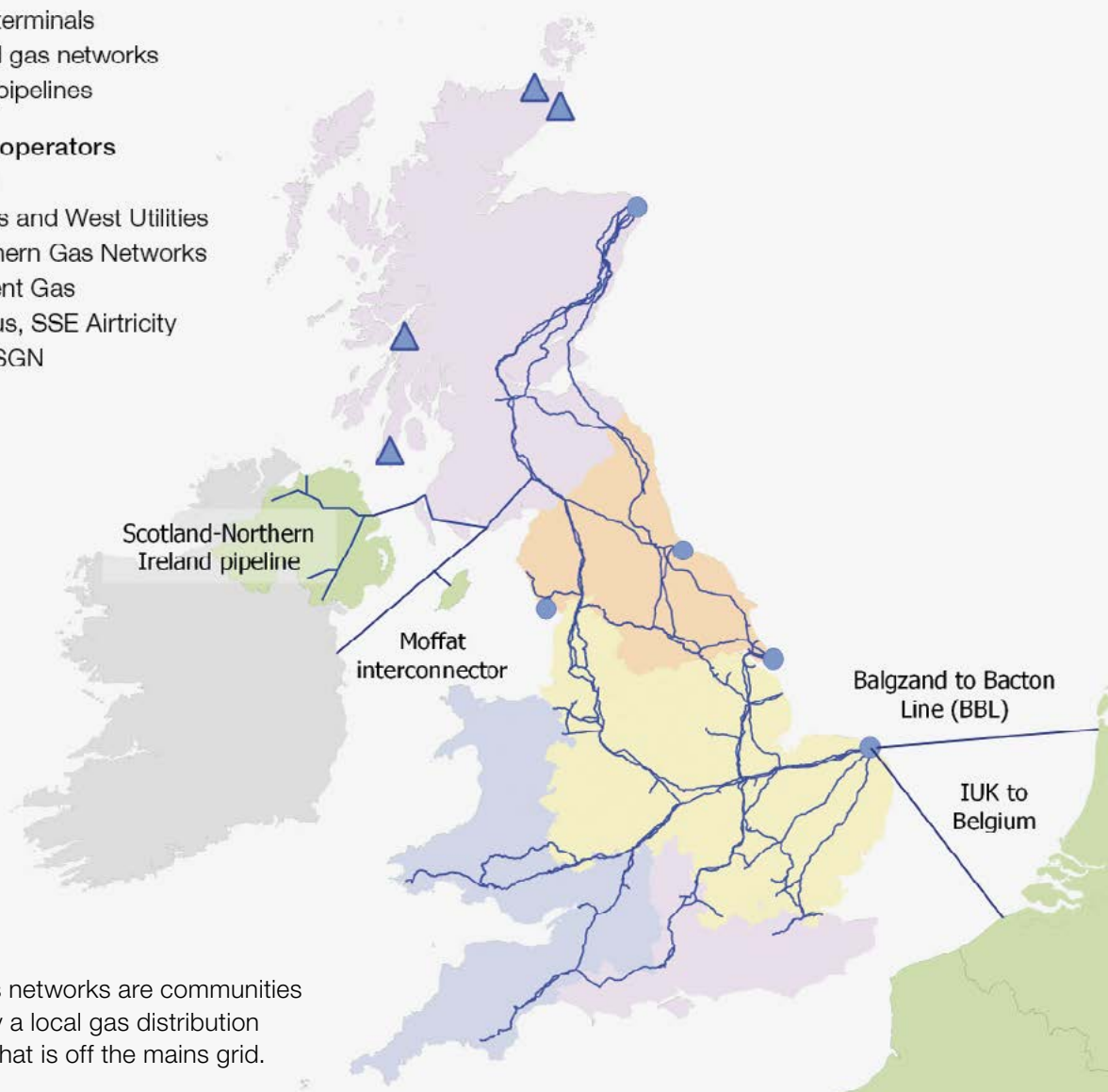
The high-voltage networks that transport electricity across Britain and nearby offshore waters – the ‘motorways’ of our energy network. Owned and maintained by three different Transmission Owners (TOs) for England and Wales; southern Scotland; and northern Scotland and the Scottish islands groups, and by individual Offshore Transmission Owners (OFTOs) for the connections between offshore windfarms and the onshore grid.

FIGURE 5.2 - UK GAS NETWORKS AND DISTRIBUTION AREAS**Gas network**

- Gas terminals
- ▲ Local gas networks
- Gas pipelines

Network operators

- SGN
- Wales and West Utilities
- Northern Gas Networks
- Cadent Gas
- Firmus, SSE Airtricity and SGN



GAS DISTRIBUTION NETWORKS

Smaller regional networks that transport gas from the transmission pipes, into our homes and businesses. There are eight licenced gas distribution networks (GDNs), owned by four different groups.

GAS TRANSMISSION NETWORK

The high-pressure pipes that transport gas to smaller networks, or directly to gas power stations and large industrial consumers. Owned and operated by National Grid Gas plc (NGG).

Gas currently represents almost **30 per cent of final energy consumption** and 40 per cent of electricity generation



Demand will be satisfied as much by local solutions as by a nationally organised and operated system. Smart technologies, enabled by pervasive digitalisation, are already opening new possibilities, facilitating a transformation to faster and more efficient solutions which will only accelerate over the coming decade.

The switch to clean electricity has particularly profound implications. Separate networks for electricity, gas for heating and petrol or diesel for cars and vans, which today run independently of each other, will increasingly merge into one system, as electricity becomes the common energy currency. It puts new demands on electricity, to reflect how we use heat and power our cars and will require a new approach to how the system is managed. And the energy system will have to adapt further, to accommodate the production and use of clean hydrogen or the transport and storage of carbon dioxide from industry or power generation.

The costs of transporting energy and managing the balance between supply and demand make up around 25 per cent of an average household's energy bill currently.⁹⁶ As we move to clean energy, the system will comprise a more complex series of functions which it will need to discharge while keeping costs affordable.

79%

of **energy supply** in 2019 came from **fossil fuels**

17%

of consumers **final energy use** was **electricity**

>50%

of final energy demand could be **provided by electricity** by 2050

The prize is an energy system which is not only cleaner but also smarter; one that gives customers more control, delivering the energy we need efficiently, and at a fair cost.

Securing this outcome requires a comprehensive approach, with evolution across all elements of the energy system so that it is fit for the future. It is not just about ensuring a cost-effective and resilient network of pipes and wires, critical though this is. It means exploiting a new digital infrastructure which will complement the system's physical infrastructure to liberate the potential of smart, flexible technologies.

THE SMART ELECTRICITY SYSTEM

The electricity network is now becoming more decentralised.

This means there will be more numerous and smaller sites of generation across the country, not just the large, centralised power stations with which we are familiar. There will be new sources of demand, as millions of EVs and heat pumps connect to the system. A previously one-directional system is transforming into something more dynamic.

But it is not a matter of adding ever more generating capacity and cables. The transformation of the electricity system is an opportunity to exploit new forms of system flexibility in how energy is generated and consumed. This flexibility allows supply and demand to be shifted in time or location, so they are matched in the most efficient way – keeping costs down for consumers. For example, smart technology and time-of-use tariffs can help consumers charge EVs during off-peak periods – when energy is cheaper and cleaner.

Our analysis suggests that a smarter, more flexible system could unlock savings of up to £12 billion per year by 2050 (2012 prices), compared to a system with low levels of flexibility⁹⁷ – primarily because being able to respond more quickly and shift electricity around more easily means less generation and network needs to be built. This will lower costs for the customer of the future.

By 2050, the domestic market for smart systems and flexibility solutions, including EV smart chargers and smart network equipment, could contribute almost £1.3 billion to the nation's economy, with exports of these products and services adding a further £2.7 billion (2020 prices). The domestic market for smart systems equipment and related services could support 10,000 jobs by 2050, with a further 14,000 jobs supported by export markets.⁹⁸

ELECTRICITY SYSTEM OF THE PAST

Few large and predictable power plants



Generation

Based on large power lines



Network infrastructure

Top to bottom



Energy flows

Centralised, mostly national



Markets

Passive, only paying

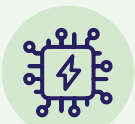


Customers

Many smaller sources but less predictable



Power lines and storage aided by smart digital tech



Both directions

Decentralised and interconnected



Empowered, participating



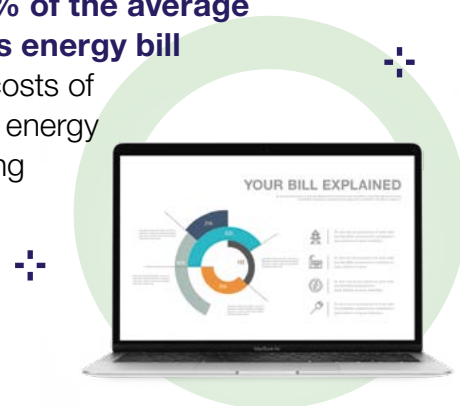
ELECTRICITY SYSTEM OF THE FUTURE



We have to instil competition deep into the operation of our energy markets to drive cost reductions and open the system to innovative new services for the benefit of consumers, while also incentivising the significant private sector investment that will make it possible to update our energy system. And we need an approach to managing the operation of the system which is flexible and responsive, and aligned to the demands of a net zero future.

Around 25% of the average consumer's energy bill

is from the costs of transporting energy and balancing supply and demand



Our key commitments

EFFICIENT ELECTRICITY MARKETS

Electricity markets need to adapt as the deployment of renewable generation increases.

Balancing supply and demand becomes more complex because most renewables are, by their nature, intermittent and generate electricity only when the wind blows or the sun shines.

Gas-fired power stations have traditionally provided the flexibility needed to match supply to demand at peak hours, or when renewables output is low. Increasingly, flexibility will come from new, cleaner sources, such as energy storage in batteries, increased interconnected capacity from neighbouring electricity markets, or from consumers using smart technologies to reduce how much energy they use or shift when they use the energy to different times in the day. New forms of flexibility could lower future costs for consumers, by minimising expensive network reinforcement or reducing the need for additional generation, especially peaking capacity which needs to be deployed quickly to meet spikes in demand.

ELECTRICITY SYSTEM OPERATOR

The whole transmission system is operated by a single Electricity System Operator (ESO), who is responsible for keeping it stable and secure. National Grid ESO perform this function.

- **We will publish a new Smart Systems Plan in spring 2021, jointly with Ofgem, and define electricity storage in law, legislating when Parliamentary time allows.**

We need open, competitive markets which harness the full value of flexibility. In 2017, the government and Ofgem published the first Smart Systems and Flexibility Plan.⁹⁹ We have implemented two-thirds of the policies in the plan and are on track to deliver it in full by 2022, removing barriers to energy storage, enabling smart homes and businesses and properly rewarding providers of flexibility services. But we are now ready to take the next step in driving flexibility deep into the energy system.



In partnership with Ofgem, we will publish a new Smart Systems Plan in spring 2021, which will include a new framework for monitoring flexibility across electricity markets. We will legislate when Parliamentary time allows to define electricity storage in law, removing another barrier to flexibility.

► **Through the Net Zero Innovation Portfolio, we will launch a major competition to accelerate the commercialisation of first-of-a-kind longer duration energy storage, as part of our £100 million investment in storage and flexibility innovation, with delivery from spring 2021.**

Storing excess low-carbon generation over longer periods of time could enable us to decarbonise the energy system more deeply at lower costs.

Novel energy storage technologies show promising cost reductions¹⁰⁰ but some have yet to be demonstrated at scale. First-of-a-kind demonstrations are required to enable cost reduction and de-risk private investment. The Prime Minister's Ten Point Plan announced a further £100 million to address energy storage and flexibility innovation challenges, one of the key priority areas in the over £1 billion Net Zero Innovation Portfolio.

To promote energy storage innovation, we will further accelerate the commercialisation of innovative technologies, excluding proven technologies such as lithium ion and pumped hydro storage. Our support will build on the success of previous funding under the current Energy Innovation Programme.

It will focus on long-duration storage technologies that could be deployed at large scale and provide novel services or system benefits. The first competition to address energy storage and flexibility innovation challenges will be launched in spring 2021 with stakeholder engagement and information days.

Some flexibility solutions could be better delivered through local markets, in which organisations with a more in-depth knowledge of their communities can provide solutions to local need more quickly than responses at the national level. But local and national actions need to complement one another. We will work towards a market framework which ensures that national and local electricity markets are fully co-ordinated and satisfy the full suite of system requirements. We look to the Electricity System Operator (ESO), Distribution Network Operators (DNOs) and market participants to work closely together to facilitate this enhanced co-ordination, and government will keep progress on this under review to ensure the system enables optimal levels of flexibility.

DNOs, the companies which own the regional electricity networks, are already creating local flexibility markets. In 2020, they awarded contracts for around 1.2GW of flexibility services, including the first contracts to provide local services which pay households for using the aggregated electricity capacity from a collection of domestic batteries.¹⁰¹ We will encourage more local solutions and open up as many services as possible to competition. We expect network operators to go much further, fully opening their networks to flexibility technologies while mitigating real or perceived conflicts of interest.

CASE STUDY

Creating New Marketplaces

Piclo Flex is an independent flexibility marketplace which allows DNOs and flexibility providers to find and contract with each other. It enables distributed resources such as electric vehicles or battery energy storage to identify where flexibility is needed via a dashboard, receive notification of relevant auctions, and bid for DNO payments. Overall, the platform helps to identify flexibility market opportunities and lowers barriers for entry for flexibility providers.

As part of the £505 million BEIS-funded Energy Innovation Programme, Piclo is now expanding its platform to support trading with the ESO, as well as trading between flexibility providers. Another competition winner, Electron, are also creating innovative digital solutions for flexibility trading.

Actions should include steps to implement standardised flexibility products as soon as possible and ensure that distributed flexibility is able to participate in all markets. We will keep open the option of legislating in support of local flexibility markets, should DNOs fail to make sufficient progress.

Due to the unique characteristics of electricity, there is a need to match supply and demand on a second-by-second basis. The government works in partnership with the ESO and Ofgem to ensure the reliable operation of the system and the security of electricity supplies. Security of supply will always be a priority, but our approach must also adapt to reduce carbon emission and costs.

Our markets should also incentivise the integration of the different types of energy assets which are now connecting to the energy system. We expect Ofgem and the ESO to ensure existing balancing services are fully transparent and competitively procured, while enabling new markets to emerge. We support the steps which they are taking to facilitate wider access to balancing services and embed more efficient processes into the operation of balancing markets, including establishing closer-to-real time markets and enabling greater automation.

As well as making sure the system is stable on a day-to-day basis, we need the assurance over the course of each year that there is enough generation capacity to satisfy even exceptional periods of demand or to back-up renewables when the wind does not blow, or the sun is not shining. The Capacity Market (CM) is our primary policy mechanism for delivering this security of electricity supply. It provides generators and flexibility providers with a payment for reliable capacity to ensure they deliver more electricity, or reduce demand, when required.

To date, the CM has supported investment in over 10GW of new capacity, including smart technologies such as battery storage and demand-side response.¹⁰² We have made a number of reforms since its introduction in 2014, such as allowing certain renewables to participate and implementing carbon emissions limits in future auctions. In our five-year review, published in 2019, we committed to retaining the CM as a guarantee of system reliability and to making further incremental improvements to its design.¹⁰³ The next review will take place by 2024. We will ensure that the mechanism acts in concert with other markets to incentivise investment in the right type of capacity, in the right place at the right time.

Over the longer term, as generation moves towards a predominantly renewables mix, we want electricity markets to incentivise the right behaviours from generators and offer value for money to consumers, while continuing to ensure low-carbon solutions can deploy at the scale needed for net zero emissions. Our current market framework emphasises the cost of fuels such as gas and coal, but renewable technologies, such as wind, do not use fuel at all. It is also poor at valuing some services which will become increasingly important to the system, such as local balancing.

Increasing levels of renewable generation are likely to impact wholesale market prices and the ways in which markets determine which assets can most efficiently dispatch power, or reduce use, to balance the system. We need markets to incentivise both significant levels of new investment and efficient operation, in a system which mixes existing generation with increasing levels of renewables and the flexible technologies which complement them. We will support the technologies required for this transition and look for ways to adapt our policies to reflect emerging market dynamics; for instance, through our call for evidence on the future of renewable support schemes, published alongside this white paper, and in our new Smart Systems Plan, to be published in spring 2021. Beyond this, we will consider how our policies should continue to evolve, developing our approach as required in consultation with industry and other stakeholders.

NETWORK INFRASTRUCTURE

Electricity and gas transmission networks transport energy large distances around the country, while regional distribution networks connect our homes and places of work to the grid.

The vast majority of households are connected to the electricity network. The relatively few homes that are off grid, have their own electricity generator and might self-generate, using solar photovoltaics for example. Britain's gas network is one of the most efficient, resilient and advanced operations in the world, connecting over 23 million users through 284,000 km of pipelines.¹⁰⁴ Around four million households live off the gas grid, many of them in remote locations and using stored oil or gas for heating and for hot water.¹⁰⁵

Britain has been at the forefront of introducing competition to networks and regulating these natural monopolies. This approach has served consumers well, promoting innovation, and lowering costs. Since privatisation, our gas and electricity networks have become more resilient and delivered better value for customers. The cost of transporting a unit of electricity has fallen by 17 per cent since the mid-1990s, while investment has increased. Reliability and customer service have improved, and the number of power cuts has almost halved.¹⁰⁶

The transformation of our energy system will require growing investment in physical infrastructure, to extend or reinforce the networks of pipes and wires which connect energy assets to the system and maintain essential resilience and reliability. As well as creating a low-carbon system we need enhanced preparedness for climate risks. Government is supporting the efforts of key stakeholders in this important endeavour.

Under the Climate Change Act's Adaptation Reporting Power over 90 organisations have committed to report on their preparatory actions by the end of 2021, including those responsible for electricity generation, and the transmission and distribution of gas and electricity.¹⁰⁷

While the gas network will need continual updating, the electricity network faces a complete step-change in approach and scale. Working with Ofgem, we need to deliver investment in our existing electricity network at the lowest possible cost to consumers while ensuring the network can keep pace with burgeoning demand for power, for example, from the accelerated adoption of EVs and heat pumps.

► **We will legislate, when Parliamentary time allows, to enable competitive tendering in the building, ownership and operation of the onshore electricity network.**

We need market and regulatory frameworks which promote greater competition and more innovation in the construction and operation of energy networks. Competition in network assets is key to reducing network costs. Since 2009, awarding the ownership and operation of offshore wind network connections through a competitive tender process is estimated to have saved consumers in excess of £800 million.¹⁰⁸ We now need a similar competitive regime for onshore networks, where currently only incumbent network operators can build, own and operate network assets.

Britain's gas network connects 23 million users

through 284,000 km of pipelines



Allowing other parties to compete for onshore network projects will deepen the pool of capital available for the significant amount of investment needed in our networks as we transition to clean energy. Competitive pressure in these networks will improve efficiency, saving consumers more money, and encourage further innovations in system design and operation. It will also provide Ofgem with better price information, which it can utilise in setting its periodic price control mechanism.

We therefore intend to introduce legislation, when Parliamentary time allows, to enable competitive tendering for building, owning and operating onshore electricity network assets. We intend the legislation to allow the Secretary of State to appoint an appropriate party to run the tender processes. We propose that competitive tendering could be opened up at the distribution network level, as well as in the transmission network, should evidence suggest that this will secure value for consumers. This competitive regime will extend widely, addressing network constraints across Wales, Scotland and England. We also intend to open network innovation funding to third parties and encourage more whole-system innovation in gas and electricity networks. We will consider amending legislation to achieve this, should it be necessary.

- **We will support the rollout of charging and associated grid infrastructure along the strategic road network, to support drivers to make the switch to EVs ahead of the phase out of the sale of new petrol and diesel cars and vans by 2030, and hybrids with significant zero emission capability by 2035.**

Following extensive consultation with car manufacturers and dealers, the Prime Minister has confirmed that the UK will end the sale of new petrol and diesel cars and vans by 2030, ten years earlier than planned. The sale of hybrid cars and vans that can drive a significant distance with no carbon emissions will continue until 2035.

This accelerated transition requires scaling-up the rollout of EV chargepoints and, in turn, an associated expansion in electricity generation and network capacity, to meet the increase in demand for power. With the necessary investment in new infrastructure and the adoption of smart charging, we are confident that the system will cope with the transition.

As part of a £2.8 billion package announced in the Prime Minister's Ten Point Plan, the government will provide funding of £1.3 billion to accelerate the rollout of chargepoints for EVs in homes, workplaces, streets and on motorways across England, so people can more easily and conveniently charge their cars. We will invest £950 million of this funding in future proofing grid capacity along the strategic road network, to prepare ahead of need for 100 per cent take-up of zero emissions cars and vans.



CASE STUDY

EV Charging on the Strategic Road Network

Over 95 per cent of people in England use the Strategic Road Network at least once a year.¹⁰⁹ We will support the roll out of charging infrastructure along England's Strategic Road Network by investing £950 million in future proofing grid capacity at motorway and major A road service areas. This will ensure the private sector can continue to expand the charging network at pace in the 2020s.

By 2030, we expect the network to be extensive and ready for more people to benefit from the switch to electric cars. We are planning for there to be around 2,500 high powered chargepoints across England's motorways and major A roads. By 2035 we expect around 6,000 high powered chargepoints across England's motorways and major A roads.¹¹⁰ This will be a vital investment for our future, and key to reducing consumer anxiety about long-distance journeys.

We expect the mass uptake of EVs to create significant new demand for power, but it also represents an opportunity for enhanced system flexibility. Smart charging can help mitigate peak demand; for example, charging overnight rather than in the early evening when an EV owner might plug in their vehicle after returning home from work but also the time when electricity demand tends to peak. Vehicle-to-grid technology can then utilise the electricity stored in car batteries to supply power or services to the grid during periods of high demand. To capture these system benefits, the deployment of charging infrastructure needs to run ahead of the uptake of EVs. Only then will consumers have the confidence that they can charge their vehicles conveniently and cost-effectively.

The Prime Minister's Ten Point Plan also set an ambition to reach 600,000 electric heat pump installations per year by 2028, as one option to accelerate the decarbonisation of heating. Along with the rollout of EVs, the electrification of heat will further drive the need for anticipatory investment in the network but equally create opportunities to exploit system flexibility. Deployed in conjunction with storage and smart meters, heat pumps are able to avoid periods of high demand, benefitting the grid, and reducing running costs.

We are working closely with Ofgem to ensure that the regulator's network price control mechanism enables the investment needed in EV charging infrastructure, heat pumps and other low-carbon technologies. Price control must be as agile as possible in approving future network upgrade projects when the need becomes clear, while keeping costs down, now and in the future.

Given the key role of electricity distribution networks in being able to accommodate low-carbon technologies such as EVs and heat pumps, the government wrote to Ofgem in October 2020 to outline relevant policy in advance of Ofgem setting its final methodology for the next distribution price control, which covers the period 2023 to 2028.¹¹¹ Our letter highlighted the importance of appropriate investment to enable timely connection of new low-carbon technologies, and gathering and sharing the data needed to optimise the use of networks. We are also working with Ofgem, and partners across the energy and transport systems to address barriers which can prevent the efficient connection of chargepoints to the electricity grid. This will include ensuring there is easily accessible and accurate information for commercial customers on the costs and opportunities of rolling out chargepoints in different locations, to give them confidence to make informed choices around the switch to EVs.

Interconnection increases the ability of the GB electricity market to trade with other markets, enhances the flexibility of our energy system and has been shown to have clear benefits for decarbonisation. Alongside this white paper, we are publishing a report into the impact of interconnectors on decarbonisation, which demonstrates how a higher level of interconnector capacity could decrease cumulative emissions in Great Britain by up to 199MtCO₂e by 2050, as well as reducing total system costs.¹¹²

We will work with Ofgem, developers and our European partners to realise at least 18GW of interconnector capacity by 2030. This represents a three-fold increase from current levels and will position us as a potential net exporter of excess green energy, helping to keep wind turbines generating even when GB electricity demand has been met.

► **To minimise the impact on local communities, we will implement a more efficient approach to connecting offshore generation to the mainland grid.**

The current regime for connecting offshore wind farms to the onshore grid has encouraged single point-to-point connections. Each project has a separate cable route and associated onshore infrastructure. We recognise the impact this is having on the coastal communities which host this infrastructure and will act quickly to take the necessary steps to address the situation, particularly given our ambition to have 40GW offshore wind by 2030. We have launched the Offshore Transmission Network Review to improve the delivery of transmission connections for offshore wind generation.¹¹³ This will consider the full impacts on affected communities, particularly on the east coast of England, while making sure the whole of the UK benefits from a more strategic approach.

The review will seek the appropriate balance between environmental, social and economic costs. It will also consider the potential of hybrid, multi-purpose interconnectors, which are already being explored by developers in the UK and the Netherlands, to get the most from our offshore wind and transmission assets. These hybrid projects could integrate the transmission links we need to connect offshore wind to our grid with interconnectors to neighbouring markets.

A green circle containing the text '40GW' in a bold, white, sans-serif font.

40GW

offshore wind by 2030 is our ambition

A green circle containing the text '£6bn' in a bold, white, sans-serif font.

£6bn

in consumer savings could be delivered by 2050

These projects would allow us to sell excess green power in other markets, or, when our wind output is low, import electricity through cross-border trade.

Initial outputs from the ESO, delivered as part of the review, have shown that taking a more coordinated approach could deliver up to £6 billion in consumer savings by 2050, significantly reducing environmental and social impacts on coastal communities.¹¹⁴ This analysis showed benefits not just for the east of England, but also Scotland and Wales. We are working closely with the Scottish and Welsh Devolved Administrations through the review.

In order to start delivering these benefits, we will encourage projects already in development, where early opportunities for coordination exist, to consider becoming pathfinder projects. This will help inform the design of the enduring regime. We will consider changes to the current regulatory framework which enable developers to implement innovative approaches, including on anticipatory investment. For the 2030s and beyond, we will redesign the current regime to incentivise more extensive coordination and minimise environmental, social and economic costs.

DIGITAL INFRASTRUCTURE

We need a modern digital infrastructure to underpin markets and optimise physical networks. This requires new ways of creating, collecting, analysing and sharing energy data from different sources.

► **We will build world-leading digital infrastructure for our energy system, based on the vision set out by the independent Energy Data Taskforce, publishing the UK's first Energy Data Strategy in spring 2021, in partnership with Ofgem.**

Data will help us to discover cheaper ways of delivering the energy we need by making information available to those who can provide solutions to reduce costs and improve services to consumers. For example, better data can help local authorities make the best decisions about where to install chargepoints for EVs.

Open and secure data is also essential to the efficient integration of low-carbon technologies, such as solar panels, heat pumps and batteries, into our electricity networks. Information about the scale and nature of demand, the capability of networks, or the location and size of generation and storage capacity will enable markets to optimise the use of assets across the system. This information can be combined with data from transport, homes and commercial buildings to enable whole-system strategic planning and investment decisions. Smart meter data can help DNOs to identify system constraints and enable them to direct investment more efficiently, including where network reinforcement is required to support an increase in heat pumps or EVs.

In all such activities, we will ensure that new technologies are introduced in a way that empowers consumers and protects their data at all times.

CASE STUDY

Batteries and Machine Learning

Habitat Energy are using artificial intelligence and machine learning to provide optimisation and trading services to owners of battery storage and other flexible energy assets. Habitat uses algorithms to process data from individual assets and trading platforms to optimise the batteries across multiple markets.

This data-driven approach maximises the revenue that can be achieved while also carefully managing the degradation of the battery to preserve asset life. Improved co-ordination between markets and better quality data about network condition and performance enable innovators like Habitat to optimise assets to meet system needs, thereby reducing costs for consumers.



In 2018, the government and Ofgem launched the independent Energy Data Taskforce. The Taskforce's final report in 2019 highlighted how the move towards a modern, digital energy system is being hindered by poor quality or missing data, while data which is valuable can be hard to find or subject to restricted access.¹¹⁵ The report set out a strategy to fill data gaps, improve the quality of data and make data more open.

We are implementing all of the Taskforce's recommendations through 'Modernising Energy Data', a joint programme with Ofgem and Innovate UK. We will publish an energy data and digitalisation strategy jointly with Ofgem in spring 2021. The strategy will set out the progress that we have made against specific recommendations and show how better use of data is realising our objective of a fully digital and clean energy system.

Our approach will be aligned with the overarching principles set out in the National Data Strategy and aims to help establish the energy sector's role in growing the UK's data economy.¹¹⁶

The Taskforce showed that a lack of access to energy data creates a barrier to innovation in the new technologies and services required to achieve net zero emissions. We are therefore creating a national energy data catalogue to make data more visible and reduce the costs of accessing this information. A prototype of the service will be launched by summer 2021. Market participants will be able to use this data to identify opportunities for creative new solutions, such as supplying more efficiently groups of customers who have similar needs.

Data owners often default to not sharing the information they create. We will develop a ‘data triage’ process which provides practical support to energy companies for making data more readily available, while ensuring cyber-security and data privacy. It will represent a clear guide for market participants on how to share data appropriately. Ofgem will consult on this guidance and associated licence conditions by summer 2021. It will complement the digitalisation strategies of the network companies which have recently been published to set out operators’ plans for improving the use of data.

We will also develop the tools and processes which allow innovators to make full use of the data once they have access to it. The Modernising Energy Data innovation competitions will enable providers of new services to link energy data with information from other sectors such as transport, heat and buildings, integrating the UK’s different infrastructure.¹¹⁷

For example, the £2 million Modernising Energy Data Access competition will help develop the digital structures needed for innovators to build new apps and products that are compatible across different systems and sectors. The early outputs from these competitions are expected to be available by autumn 2021.

As the energy system becomes increasingly reliant on digital technologies, cyber security will be ever more important for the stability and security of the energy system. Our smart metering system has already been developed with security experts from government and industry and we will continue to ensure cyber security plays a key role in the actions we are taking to facilitate a smart, digital and secure energy system.

OUR COMMITMENTS TO MODERNISE ENERGY SYSTEM DATA



Getting data into the open

A clear new process to guide industry



Making sure data is easy to find

Open-access Energy Data Catalogue



Fully harnessing the value of data

Government-funded Modernising Energy Data innovation competitions

UK's first Energy Data and Digitalisation Strategy

THE ROLE OF NATURAL GAS

Gas currently represents almost 30 per cent of final energy consumption and 40 per cent of electricity generation.¹¹⁸

We will continue to rely on natural gas for some years, even as we work to largely eliminate carbon emissions from the entire energy system including those from gas.

► **We will consult on updates to the Gas Act to ensure we decarbonise gas supplies while continuing to provide the right price signals to market participants.**

We will therefore make sure the natural gas markets and networks evolve in a way which enables continued investment and ensure secure supplies but also promotes the use of low-carbon options, wherever possible. This will reduce emissions now and help build the networks of the future which will need to accommodate technologies such as hydrogen and Carbon Capture, Usage and Storage. We will need investment in the gas network to support the ambition set out in the Prime Minister's Ten Point Plan for a potential Hydrogen Town before the end of the decade.

But while natural gas continues to play a role in powering and heating our homes, we will need to maintain security of supply and ensure network operators have the right market and regulatory signals to ensure the necessary levels of investment in resilient, efficient infrastructure.

GAS SYSTEM OPERATOR

The whole transmission system is operated by a single Gas System Operator (GSO), who is responsible for keeping it stable and secure. National Grid Gas Transmission (NGGT) perform this function.

Our gas markets operate effectively but it is important they continue to provide the right incentives consistent with our overall strategic goals. We will therefore review the overarching market framework set out in the Gas Act to ensure the appropriate powers and responsibilities are in place to facilitate a decarbonised gas future. This will include a review of gas quality standards to enable the widest range of gasses to be used to decarbonise energy. We will work with Ofgem to remove distortions within the gas market, such as reviewing the Domestic Load Connection Allowance which acts as a subsidy for extensions to the gas grid rather than allowing competition with other lower carbon options. These changes are important to make sure the right price signals are in place to maintain security of supply while also enabling the decarbonisation of gas.

Starting in 2021, through a series of workshops and consultation, we will work with network operators, suppliers and consumer groups on the future of gas as we transition to a clean energy system. Our dialogue with stakeholders will also consider the implications for networks, gas wholesale and retail markets and for final energy use by consumers.



ENERGY SYSTEM INSTITUTIONS AND GOVERNANCE

The markets and networks that deliver our energy are governed by a series of standards and rules.

Our current standards are geared to the safety of our energy system and the rules we have in place protect customers and ensure fair competition. This process is overseen by institutions including Ofgem, and the system operators who keep supply and demand in balance.

► **We will ensure that the institutional arrangements governing the energy system are fit for purpose for the long term, consulting in 2021 over organisational functions, including system operation and energy code governance.**

Our approach to system governance needs to evolve. The roles of Ofgem, the electricity and gas system operators and the transmission and distribution network operators still largely reflect the model from 30 years ago and need to be updated. As we decarbonise the energy system, the regulator, networks, industry and government will need to work together to consider the potential solutions.

Interactions within the energy system are becoming more complex. The system operators need to take on new responsibilities and the regional network owners need to play a more proactive role in delivering an open, flexible and efficient system.

We need the operation of national and local energy markets to be managed impartially, without conflict of interest, ensuring they are fully open to competition. We need a robust process for setting and enforcing system rules, an approach which ensures that the rules promote competition and innovation, not act as a barrier to change. There is also a need for a greater co-ordination to drive collaboration between different parts of the energy system which are currently too siloed.

We need to consider, at both the transmission and distribution level, whether the roles which discharge these functions are undertaken by government, Ofgem, industry parties such as the system operator, or by an entirely new body. We will review the right long-term role and organisational structure for the ESO, in light of the reforms to the system operator instituted in April 2019. It is possible that there will need to be greater independence from the current ownership structure, should it be appropriate to confer additional roles on the system operator.

These new roles should help the system achieve our net zero ambitions and meet consumers' needs. Without them, we risk having an energy system which makes less effective investment and operational decisions, resulting in excessive costs for consumers or a failure to reduce emissions in line with our net zero target.

The detailed technical and commercial rules of the energy system, established in a collection of codes and engineering standards, also need an overhaul to ensure that they are fit for purpose as we transition to a clean energy system. Many rules have only seen minimal change since the 1950s.

We will consider the best future framework for energy codes and consult on options for reform in 2021, building on the government and Ofgem's joint review of code governance¹¹⁹ and the work of the independent panel on engineering standards.¹²⁰

Ofgem is clear that helping to deliver a clean energy system consistent with net zero emissions protects consumers' interests, which is Ofgem's principal statutory objective. However, as the pace of this transformation accelerates, it will be important that Ofgem has clear sight of the government's policy priorities for the decarbonisation of energy, including how we approach the electrification of road transport and heat.

► **We will set out our vision for energy as a guide to Ofgem, by consulting in 2021 on a Strategy and Policy Statement for the regulator.**

The Strategy and Policy Statement will set out the strategic priorities of our energy policy, the outcomes we seek to achieve and the roles of government, Ofgem and other parties which are collectively responsible for delivering these goals. Subject to Parliamentary approval, the Strategy and Policy Statement will require the Secretary of State and Ofgem to carry out their regulatory functions in a manner which is consistent with securing the government's policy outcomes, including delivering a net zero energy system while ensuring secure supplies at lowest cost for consumers. This will enable not just Ofgem, but energy consumers and industry as well, to better understand the government's ambitions for the energy sector.

Our key commitments



We will **publish a new Smart Systems Plan in spring 2021**, jointly with Ofgem, and define electricity storage in law, legislating when Parliamentary time allows.



Through the Net Zero Innovation Portfolio, we will **launch a major competition to accelerate the commercialisation of first-of-a-kind longer duration energy storage**, as part of our £100 million investment in storage and flexibility innovation, with delivery from spring 2021.



We will legislate, when Parliamentary time allows, **to enable competitive tendering** in the building, ownership and operation of the onshore electricity network.



We will **support the roll out of charging and associated grid infrastructure along the strategic road network**, to support drivers to make the switch to EVs ahead of the phase out of the sale of new petrol and diesel cars by 2030, and hybrids by 2035.



To minimise the impact on local communities, we will **implement a more efficient approach to connecting offshore generation to the mainland grid**.



We will **build world-leading digital infrastructure for our energy system**, based on the vision set out by the independent Energy Data Taskforce, publishing the UK's first Energy Data Strategy in spring 2021, in partnership with Ofgem.



We will **consult on updates to the Gas Act**, ensuring we decarbonise gas supplies while continuing to provide the right price signals to market participants.



We will **ensure that the institutional arrangements governing the energy system are fit for purpose for the long term**, consulting in 2021 over organisational functions, including system operation and energy code governance.



We will **set out our vision for energy as a guide to Ofgem**, by consulting in 2021 on a Strategy and Policy Statement for the regulator.

EXPLAINER

Transport



SETTING THE SCENE

Transport is an important aspect of our everyday lives and fundamental in connecting us together.

Our cars, buses, trains and planes allow us to travel long distances to meet with our families, friends and colleagues; and our lorries, vans, and ships ensure our goods and mail are delivered safely to our businesses and homes.

Yet while transport helps to connect people and places, boosting economic growth and opportunity, it now contributes over a quarter (28 per cent) of UK domestic greenhouse gas (GHG) emissions.¹²¹

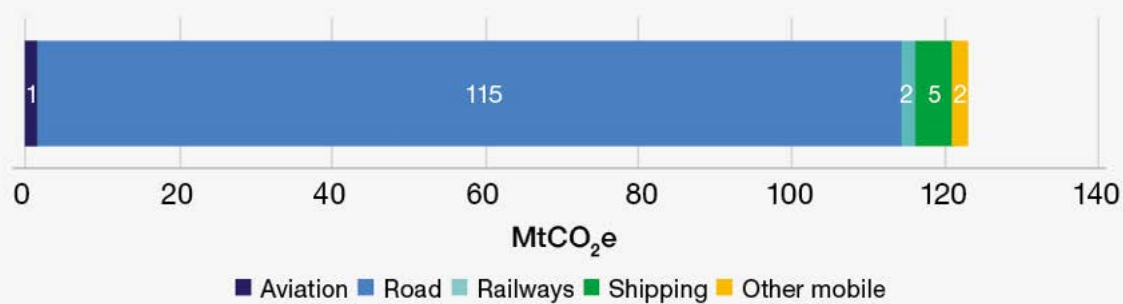
Over 90 per cent of these emissions come from our roads, with passenger cars, heavy goods vehicles and light duty vehicles contributing the most. Despite dramatic progress to improve fuel efficiency of new passenger cars, emissions reductions have been largely offset by their increased use.¹²²

The Department for Transport will publish its plan to decarbonise the UK's entire transport system in spring 2021, putting us on a pathway to reach net zero. The Transport Decarbonisation Plan is focused on six strategic priorities.



FIGURE 6.1 - DOMESTIC AND ROAD TRANSPORT EMISSIONS

Domestic transport emissions 2018



Road transport emissions 2018



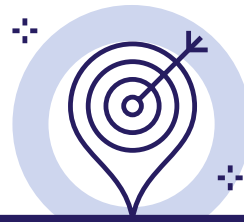
Source: BEIS Analysis

SIX STRATEGIC PRIORITIES FOR THE TRANSPORT DECARBONISATION PLAN, TO DELIVER A NET ZERO TRANSPORT SYSTEM



ACCELERATING MODAL SHIFT TO PUBLIC AND ACTIVE TRANSPORT

- ▶ Help make **public transport and active travel** the natural first choice for daily activities
- ▶ **Support fewer car trips** through a coherent, convenient and cost-effective public network; and explore how we might use cars differently in future
- ▶ **Encourage cycling and walking** for short journeys
- ▶ Explore how to best **support the behaviour change** required



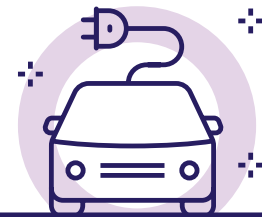
PLACE-BASED SOLUTIONS

- ▶ **Consider where, how and why emissions occur** in specific locations
- ▶ Acknowledge a single solution will **not be appropriate for every location**
- ▶ **Address emissions at a local level** through local management of transport solutions
- ▶ **Target support for local areas**, considering regional diversity and different solutions



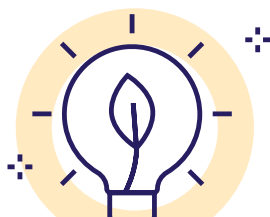
DECARBONISING HOW WE GET OUR GOODS

- ▶ **Consider future demand** and changing consumer behaviour for goods
- ▶ **Transform 'last-mile' deliveries** - developing an integrated, clean and sustainable delivery system
- ▶ **Optimise logistics efficiency** and explore innovative digitally-enabled solutions, data sharing and collaborative platforms



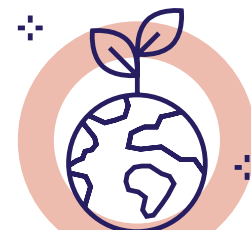
DECARBONISATION OF VEHICLES

- ▶ **Support the transition to zero emission road vehicles** through:
 - Regulatory framework
 - Strong consumer base
 - Market conditions
 - Vehicle supply
 - Refuelling and recharging infrastructure
 - Energy system readiness
- ▶ **Maximise benefits** through investment in innovative technology development and development of sustainable supply chains



UK AS A HUB FOR GREEN TRANSPORT TECHNOLOGY AND INNOVATION

- ▶ Utilise the UK's world-leading scientists, business leaders and innovators to position the UK as an internationally recognised leader of environmentally sustainable technology and innovation in transport
- ▶ Build on expertise in the UK for technology development and capitalise on near market quick wins



REDUCING CARBON IN A GLOBAL ECONOMY

- ▶ Lead international efforts in transport emissions reduction
- ▶ Recognise aviation and maritime are international by nature and require international solutions
- ▶ Harness the UK as a global centre of expertise, driving low-carbon innovation and global leadership, boosting the UK economy



THE ELECTRIC VEHICLE REVOLUTION IS ALREADY UNDERWAY

The emissions from passenger cars and light goods vehicles make up over two thirds of all transport emissions, so decarbonising those forms of transport is a priority.

Following extensive consultation with car manufacturers and sellers, the Prime Minister has confirmed that the UK will end the sale of new petrol and diesel cars and vans by 2030, ten years earlier than planned. From 2035, all new cars and vans must be zero emissions at the tailpipe. Between 2030 and 2035, any new cars and vans sold that emit from the tailpipe must have significant zero emission capability, for example plug in and full hybrids. The meaning of ‘significant zero emission capability’ will be defined by consultation in 2021. The government has also committed to providing a delivery plan in 2021 to realise these new ambitious phase out dates. The delivery plan will provide key milestones, and government will work with stakeholders to ensure these phase out dates can be met.

The UK car industry already manufactures a significant proportion of Europe’s electric vehicles (EVs), including one of the most popular models in the world.

To support this acceleration, the Prime Minister has announced:

- ▶ **£1.3 billion to accelerate the rollout of chargepoints for EVs** in homes, workplaces, streets and on motorways across England, so people can more easily and conveniently charge their cars.
- ▶ **£582 million in grants for those buying zero or ultra-low emission vehicles** to make them cheaper to buy and incentivise more people to make the transition.

▶ **Nearly half a billion to be spent in the next four years for the development and mass-scale production of electric vehicle batteries** (gigafactories) and other strategic technologies, as part of our commitment to provide up to £1 billion to support development of the electric vehicle supply chain, boosting investment in the automotive sector, including existing clusters of activity in the Midlands and North East.

In 2019, the UK was the third largest market for ultra-low emission vehicles (ULEVs) in Europe and is a global leader in their development and manufacture.¹²³ Nearly 10 per cent of zero emission cars bought in Europe in 2019 were built in the UK.¹²⁴ As at 30 June 2020, there were nearly 320,000 ULEV vehicles registered in the UK, up from just over 140,000 at the end of 2017. The vast majority of those ULEVs are cars, accounting for nearly 300,000 vehicles.¹²⁵

EVs will create significant new demand for electricity, and we are already taking action to ensure the energy system now, and in the future, is ready for this shift. The transition to mass uptake of EVs will also have a big impact on how households consume energy. This is why the government has established the Electric Vehicles Energy Taskforce, to ensure consumers are placed at the heart of this journey.

We expect the mass uptake of EVs to create significant new demand for power but also offer opportunities for enhanced system flexibility. As discussed further in the ‘Energy system’ chapter smart charging and vehicle-to-grid technology can provide benefits for the consumer and the grid.

320,000 ultra low emission vehicles registered in the UK as of June 2020

#3

In 2019 the **UK was the third largest market for ULEVs** in Europe

Under the Automated and Electric Vehicles Act 2018 government have the powers to mandate all smart functionality for chargepoints, enabling consumers to drive home from work, plug their car in, and automatically charge when electricity is cheaper, or greener, rather than in the evening, when it is more expensive. We intend to bring forward regulations in 2021 to mandate that private EV chargepoints must be smart, and in the 'Buildings' chapter we discuss the ongoing work to introduce chargepoints into all new homes and non-residential buildings. Consumers will need to access accurate, trusted information to enable them to make an informed decision about electric vehicle charging. Government wants consumers to have confidence that they will be offered choice, convenience, and appropriate protections.

Information from these chargepoints will inform planning and operation of electricity systems, and help customers save money. Government is working to ensure security and privacy measures are in place to protect chargepoint users.

As well as building new network infrastructure where needed, it is important that we use the existing network to enable the deployment of chargepoints at the lowest cost to the consumer. The 'Energy system' chapter sets out how we will further support the roll out of charging infrastructure along the strategic road network.

CASE STUDY

Bus2Grid

In January 2018, the Office for Low Emission Vehicles and the Department for Business, Energy and Industrial Strategy awarded almost £30 million, through an Innovate UK vehicle-to-grid programme, where EVs can supply electricity to the grid at times of high energy demand.

Bus2Grid is part of this programme and is exploring the commercial value and social benefits to the energy and passenger transportation systems. The project will develop services to support National Grid, local Distribution Network Operators (DNOs), bus operators and transport authorities and at the same time will consider bus fleet consumer engagement approaches necessary for its commercial implementation. Bus2Grid claims to be developing the "world's largest bus to grid site" and is bolstered by a diverse project consortium, including: SSE Enterprise, automotive manufacturer Build Your Dreams (BYD), the Distribution Network Operator UK Power Networks (UKPN) and the University of Leeds.

The project is a first of a kind large scale, multi-megawatt, demonstration of vehicle-to-grid technology in electric bus depots located in London. This process is managed by an aggregation platform that enables the 28 e-bus batteries to interact with the energy system by charging or exporting energy to support the grid in times of high energy demand.¹²⁶

ALTERNATIVES FOR HEAVY DUTY VEHICLES

After passenger cars, heavy goods vehicles (HGVs) are the biggest contributor to domestic transport emissions in the UK, and zero emissions solutions for HGVs, particularly the heaviest vehicles, are much less developed by comparison.

The Prime Minister's 'Ten Point Plan for a Green Industrial Revolution' announced that we will consult on a date for phasing out the sale of new diesel HGVs.

Battery Electric Vehicles (BEVs) are well placed to deliver the bulk of decarbonisation for cars and vans and now also smaller HGVs in short distance and medium weight applications, such as urban distribution. However, the solution for larger, long-haul, road freight vehicles is not yet clear and so we will invest £20 million next year in freight trials to pioneer hydrogen and other zero emission truck technologies to support industry to develop cost-effective, zero emission HGVs in the UK.

In our 'Oil and gas' chapter we mention the work being undertaken in the downstream oil and gas sector on low-carbon fuels, and we are continuing to explore alternatives, including through a £40 million innovation programme looking at the best fuel/vehicle combinations to decarbonise construction, mining and other off-road heavy vehicles by 2030.

We are also supporting the decarbonisation of buses. Early next year, the Department for Transport will publish a National Bus Strategy, which will set out ambitious plans to transform the sector, including delivering higher frequency of service, simpler fares, improved routes and more green buses.

As set out in the Ten Point Plan and the Spending Review 2020, the government will invest £120 million in 2021/22 to start the delivery of the 4,000 zero emission buses announced by the Prime Minister in February. Government will support both battery electric buses and hydrogen buses where the market favours their use.

RAIL DECARBONISATION

For areas of the rail network with significant freight flows or long-distance high-speed services, electrification is a proven technology that is able to support these service types.

Analysis suggests that electrification may also be the best whole-life cost solution for more intensively used areas of the network. Away from these areas of operation the deployment of emerging technologies such as battery traction and hydrogen rolling stock on both an interim and permanent basis may offer alternative solutions to help in achieving decarbonisation of rail at a lower cost.

AVIATION AND MARITIME

We are making the UK the home of green ships and planes.

We have established the Jet Zero Council to accelerate the development and adoption of new technologies to help develop our strategy to reach net zero aviation, along with investing £15 million into FlyZero as well as running a £15 million competition to support the production of sustainable aviation fuels in the UK.

As we are preparing the Transport Decarbonisation Plan, which will also include actions to get the maritime sector on track to net zero, we continue to implement the commitments in Clean Maritime Plan, building on the government's ambitious vision for the future of UK zero emission shipping. This includes the launch of a £20 million Clean Maritime Demonstration Competition, which will support the UK design and development of clean maritime technology, including hydrogen, and will lay the foundation for a network of real-world projects.

On 16 November, the Department for Transport published the Union connectivity review: call for evidence.¹²⁷ The review, led by Sir Peter Hendy, will look at how the quality and availability of transport infrastructure can support quality of life in communities across the UK while also aiding economic recovery and will consider the environmental impact of current and future infrastructure. Sir Peter is expected to publish his final recommendations in summer 2021.



£20m

competition to support the design and development of **clean maritime technology**



£15m

competition to support the production of **sustainable aviation fuels in the UK**



40,000

new jobs supported by accelerating the shift to zero emission vehicles

As we decarbonise across transport, energy requirements will change in many sectors, from trains, to boats and planes. This will create new demands on our energy systems. Accelerating the shift to zero emission vehicles could support around 40,000 new jobs by 2030. More details on ensuring all modes of transport are on a pathway to net zero will be set out in the forthcoming Transport Decarbonisation Plan.

CHAPTER 04

Buildings

OUR GOAL

Delivering our net zero target means largely eliminating emissions from domestic and commercial buildings by 2050.

We will:

- ▶ **Drive greatly improved energy performance** in both existing and new buildings to reduce consumption and help keep bills affordable
- ▶ **Support the transformation of heating for homes and workplaces** from oil and gas to clean energy sources
- ▶ **Use the switch to clean energy to support up to 50,000 jobs** across the UK by 2030





BUILDINGS

The strategic context



We need the energy we use to heat or cool our homes and workplaces to be reliable and affordable, and support comfortable, healthy surroundings in which to live and work.

But emissions from homes and from commercial and public sector buildings account for 19 per cent of total UK greenhouse gas emissions.¹²⁸ It makes buildings the second largest source of emissions after transport. Buildings also indirectly contribute to power sector emissions through electricity-using products in our homes.

#2

buildings are the **second largest source of emissions in the UK**

90%

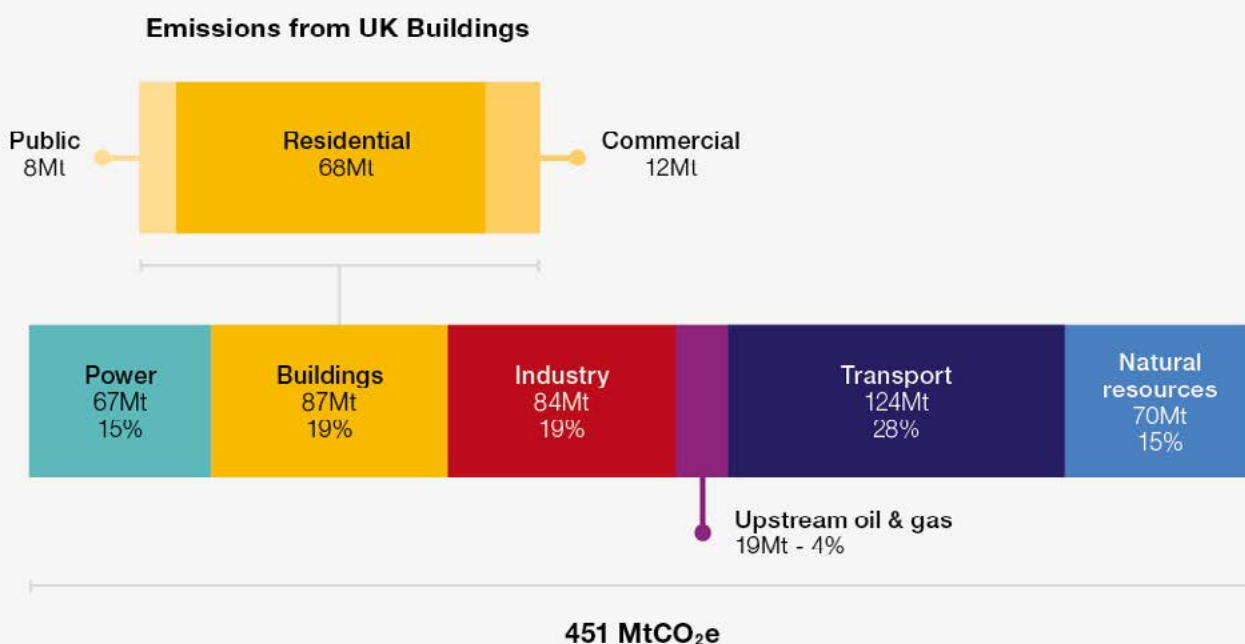
of homes in England currently use fossil fuels for heating, cooking and hot water

66%

of homes are at **Energy Performance Certificate D or worse**

FIGURE 7.1 - UK TERRITORIAL EMISSIONS ¹²⁹

2018



Source: BEIS Analysis of 'Final UK GHG emissions national statistics' and NAEI

Our challenge is to transform how buildings use energy in line with our net zero target. We need to minimise the disruption to consumers as we go through this change and keep bills affordable, while safeguarding the quality of the environment in our building stock.

Almost 90 per cent of homes in England currently use fossil fuels, predominantly for heating but also for cooking and hot water.¹³⁰ The vast majority of these homes, some 85 per cent, are connected to the gas grid.¹³¹ Those that are not connected use mostly oil, liquified propane gas or electricity, or are connected to a shared heat network. While proportions differ between Scotland, Northern Ireland, Wales and England, fossil fuels dominate heating across the UK.¹³²

The installation of energy efficiency measures and tighter building regulations have improved the energy performance of buildings, lowering consumption and helping to reduce household dual fuel bills by an average of £30 to £40 per year over the last 10 years.¹³³ Emissions from buildings across the UK have fallen by 18MtCO₂e, 17 per cent, over the last 30 years.¹³⁴ But we need to go further and secure a reduction in emissions by 2050 five times greater than we have achieved over this period.

ENERGY PERFORMANCE CERTIFICATE

Energy Performance Certificates

(EPCs) are required in the UK to provide a prospective owner or tenant with information on the energy performance of a building and recommendations for improvement. EPCs for homes use an A-G rating scale based on the modelled energy bill costs of running the building.

The energy performance of too many existing homes is not good enough. Around 16 million homes in England, 66 per cent of the total, are at Energy Performance Certificate D or worse.¹³⁵ In the private rental sector, existing legislation requires that all buildings have a minimum standard of energy performance only of Band E at the point of rental. The modelled annual energy cost of the average Band C rated home is around £750 less than the average Band E rated home, assuming both homes are being adequately heated (see figure 7.2).¹³⁶

There are about 1.8 million non-domestic properties in England and Wales.¹³⁷ Buildings in the commercial and public sectors account for around a third of the total final energy consumed for buildings purposes (i.e. excluding industrial, agricultural or transport).¹³⁸ Large premises of 1,000 square meters or larger represent only 10 per cent of commercial and industrial buildings but emit over half of all the carbon from the building stock.¹³⁹



90%

said it is important or very important that the UK makes a **full transition towards greener heating systems**



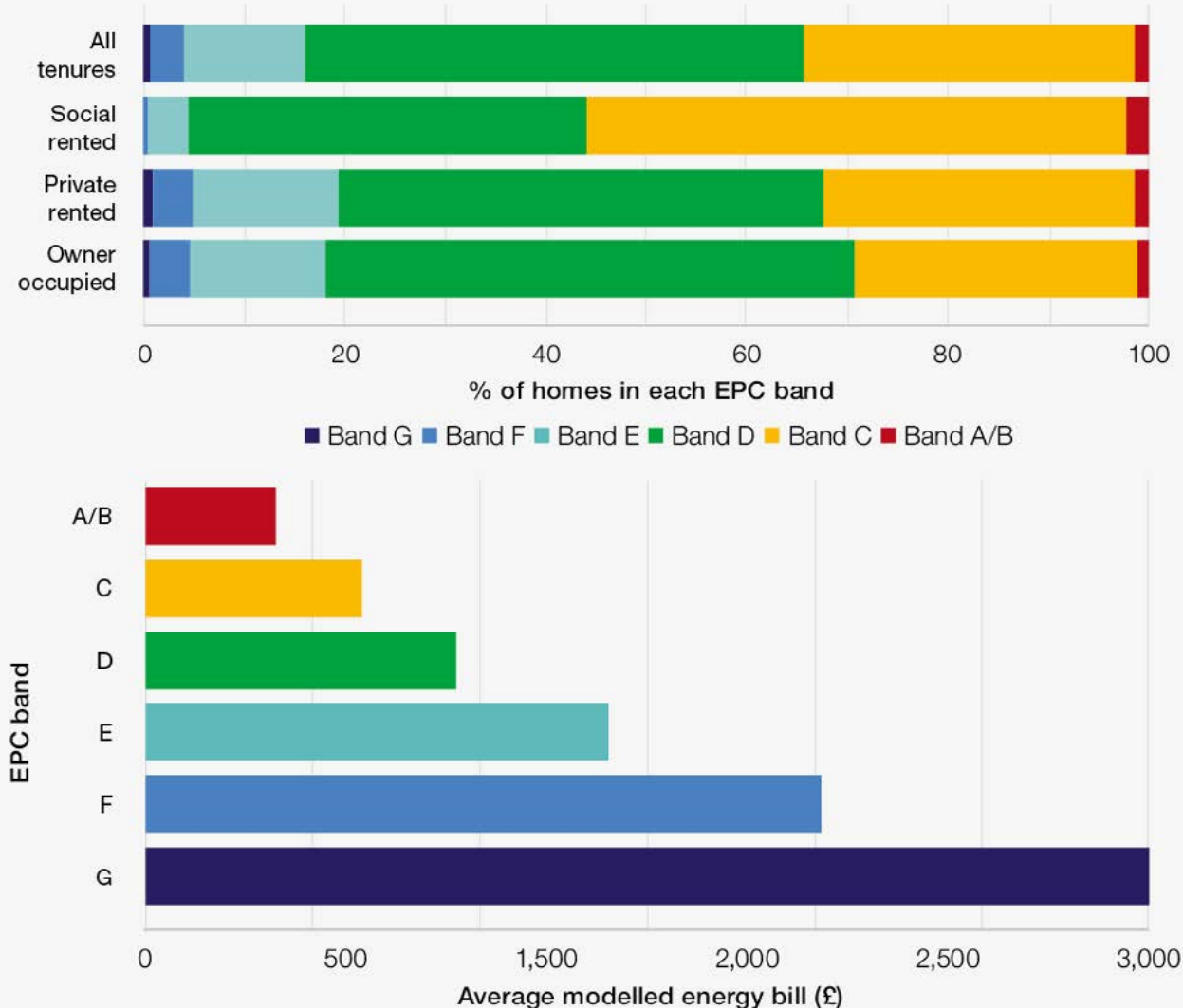
£9.2bn

commitment to invest in the energy efficiency of homes, schools and hospitals

Public awareness is low about the connection between climate change and how we heat homes and workplaces. Research by BEIS suggests that the majority of the population has not heard of low-carbon heating technologies.¹⁴⁰ Almost a third of gas-users stated they were on 'environmentally-friendly heating', suggesting a general under-appreciation of what the transition to low-carbon heating could mean in practice. Encouragingly, however, the survey shows that there is strong support for carbon reduction policies. Almost 90 per cent of respondents said it is important or very important that the UK makes a full transition towards greener heating systems.

Tackling emissions from buildings will take many years to deliver but it is a journey which must start now. The 2020s must be a decade of action to put the country on the path to net zero emissions by 2050. Depending on fossil fuels for heat or tolerating wasteful loss of energy in poorly insulated buildings is not sustainable. Action now will put us on a pathway to affordable, green and healthier buildings. Inaction will mean more disruption when we do eventually address the challenge, as well as higher bills and a lower quality of life in our homes and places of work.

FIGURE 7.2 - EPC RATING OF HOMES IN ENGLAND AND AVERAGE MODELLED ENERGY BILL BY EPC BAND



This white paper builds on our Manifesto commitment to invest £9.2 billion in the energy efficiency of homes, schools and hospitals. It sets out concrete actions to reduce how much energy we use and to support the move to low-carbon heat. We will publish a dedicated Heat and Buildings Strategy in early 2021 which will set out our ambitious plans in further detail, including the suite of policy levers that we will use to encourage consumers and businesses to make the transition.

Offices, retail space, hospitality and industrial buildings account for **around 80 per cent of private sector buildings energy demand**



Our key commitments

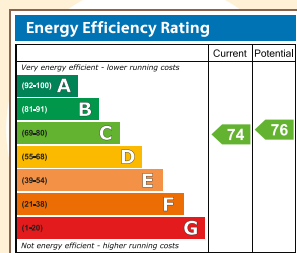
IMPROVED BUILDING ENERGY PERFORMANCE

Ensuring our homes and workplaces use energy efficiently makes good financial sense, as well as supporting better health and well-being.

Energy efficiency measures help bill payers to reduce consumption and keep bills affordable. The asset value of homes can increase based on improved energy performance. Conversely, poor energy performance means that too many bill payers pay more than they should to heat or cool their homes and workplaces comfortably.

In November 2020, the Prime Minister announced £1 billion of funding to continue our support for the decarbonisation of buildings through improved energy efficiency. This will be allocated across several existing government schemes, including the Green Homes Grant Voucher Scheme, the Public Sector Decarbonisation Scheme and Social Housing Decarbonisation Fund.

Upgrading all UK homes to EPC C could provide **annual energy bill savings of £7.5 billion**



NEW BUILDINGS

► **The Future Homes Standard will ensure that all new-build homes are zero carbon ready.**

The Future Homes Standard will require new-build homes to be fitted with low-carbon heating, and high levels of energy efficiency. Homes built to the Future Homes Standard will be zero carbon ready and have 75 to 80 per cent lower carbon emissions than those built to current standards. We will seek to implement the standard as soon as possible. As a stepping stone to the Future Homes Standard, we have consulted on an interim uplift in standards which would result in a 31 per cent reduction in carbon emissions from new homes compared to current standards.¹⁴¹ We will publish the government response to the consultation and set out a roadmap to the Future Homes Standard, as soon as possible.

We have separately published guidance for drafting building specifications to support the installation of smart meters in new build homes to avoid the need for costly retrofitting. We will work with the industry to incorporate smart technologies, such as heating controls, into the methodology for assessing the energy performance of homes.



This will give occupants the ability to manage their energy consumption easily, reduce their energy bills and maximise the use of energy from renewable sources.

We have committed to consulting on mitigating overheating risk in new homes and a range of methods will be considered to demonstrate compliance with new requirements.

We will consult shortly on increased standards for non-domestic buildings so that new buildings have high levels of energy efficiency and low-carbon heating. We are also taking action on introducing new building regulations to require electric vehicle chargepoints in all new homes and in non-residential buildings.¹⁴² We will respond to the consultation in early 2021.

EXISTING HOMES

► **We want as many existing homes as possible to hit EPC Band C by 2035, where practical, cost-effective and affordable.**

While we face the huge challenge of preparing almost 27 million existing homes for a clean energy future, we have already taken significant steps to reduce the carbon footprint of homes, in line with our Manifesto pledge. The Green Homes Grant Voucher and Local Authority Delivery schemes, together worth £2 billion, were launched in September 2020 and the Prime Minister's Ten Point Plan confirmed that the schemes will be extended for another year, helping to support the development of the supply chain and grow the market ahead of the introduction of regulatory measures later in the 2020s.

The £1.5 billion voucher element offers homeowners and landlords a voucher covering up to two thirds of the cost of upgrading energy performance, to a maximum of £5,000. A voucher of up to £10,000 is available for low-income households, with no contribution required. Low-income households can also benefit from the £500 million of the Green Homes Grant that has been ringfenced for Local Authority Delivery.¹⁴³

The schemes could enable more than 600,000 homes in England to be more energy efficient, saving these households up to £600 year on their energy bills.¹⁴⁴ Vouchers can be spent on a range of measures from cavity wall and loft insulation and air-source heat pumps, to draught proofing and replacing single glazing with double or triple glazing.

We will also take action to improve the energy efficiency of homes in the private rental sector. In September 2020, we issued a consultation on proposals for an estimated 2.8 million privately rented homes to meet a minimum energy performance standard of EPC Band C by 2028, where practical, cost-effective and affordable.¹⁴⁵ These proposals could reduce energy bills by an average of £230 per property annually, cutting fuel poverty, saving 9.5MtCO₂e by 2032 and supporting 80,000 jobs in the energy sector annually between 2025 and 2028.¹⁴⁶

44 per cent of all social rented homes in England, approximately 1.8 million, have an EPC Rating below C.¹⁴⁷ In our manifesto, we committed to invest in upgrading a significant number of these homes to at least EPC Band C. In July 2020, the government announced £50 million for 2020/21 to kickstart delivery of this ambition, piloting innovative retrofit projects across the UK and committed further funding in the Prime Minister's Ten Point Plan, announced in November.¹⁴⁸



£50m

to support delivery of **upgrading homes to meet EPC band C**



£2bn

Green Homes Grant voucher scheme, plus further funding this year

- **We will consult on regulatory measures to improve the energy performance of owner occupied homes, and are consulting on how mortgage lenders could support homeowners in making these improvements**

Meeting our commitments to decarbonise and improve the energy performance in buildings will require the mobilisation of around £100 billion of capital across homes, businesses and the public sector over the 2020s alone.¹⁴⁹ It is investment that must come principally from businesses and homeowners, and from landlords of domestic and commercial premises. Growing the market for green finance products will be essential to leveraging this scale of private capital and demands a partnership between the financial services sector and suppliers, manufacturers and energy services companies. We are consulting on how mortgage lenders can help homeowners to improve the energy performance of their homes. The proposals are intended to kickstart the green home finance market and support homeowners to improve the energy efficiency of their homes as we move towards our target of reaching as many existing homes as possible at EPC Band C or above by 2035.¹⁵⁰

CASE STUDY

Whole House Retrofit Grant

In summer 2019, the government launched the Whole House Retrofit Grant competition as part of the government's £505 million Energy Innovation Programme. The aim of the programme was to demonstrate the importance of taking a 'whole house retrofit' approach to improving the energy performance of the UK's buildings and in doing so, tackle one of the most challenging components of our decarbonisation agenda. The competition is based around an innovative 'fabric first' approach, while also introducing some low-carbon heating elements.

As an initial push towards achieving the government's Buildings Mission target of halving the cost of retrofits by 2030, the Whole House Retrofit programme also seeks to achieve cost reductions through process innovations and economies of scale and scope. Ultimately this will make it both cheaper and easier for all homeowners to improve the energy performance of their properties.

Retrofits should also deliver improvements in the health and well-being of occupants, including reduction of risk to summertime overheating and damp or mould growth.

The three projects selected are led by Local Authorities. More than 300 houses will be retrofitted in total, with a focus on socially rented properties across a range of housing archetypes. The projects are aiming to achieve retrofit cost reductions of between 5 and 20 per cent per property, making the properties not only warmer and more comfortable to live in, but less costly to run as well. The work will help pave the way for further cost reductions, and mass deployment of the whole-house approach as we head towards 2030.

At the same time as driving down install costs, a further objective of the competition is to increase expertise in the workforce and build capability of the supply chain, while ensuring resident health and comfort is placed at the centre of the whole house retrofit process.

Alongside a package of incentives, we can create a long-term regulatory framework to improve the energy performance of homes. We will seek primary powers to enable this. This will provide certainty to the market and clear signals to homeowners. We will consult in 2021 on options for these measures.

In September 2020, the government launched the Energy Performance Certificates Action Plan, which set out a pathway to improve the EPC system. The Action Plan will help to increase the energy efficiency of the building stock by exploring ways to increase the quality of EPCs, build consumer trust and increase engagement.

It will support policies which strengthen regulatory compliance and ensure that the data infrastructure underpinning EPCs is fit for the future. We anticipate that changes may be needed to the Energy Performance of Buildings (England and Wales) Regulations 2012 to deliver progress. We will need a new primary power to change the legislation after the Transition Period ends on 1 January 2021, which we will seek through an appropriate legislative vehicle in 2021, if Parliamentary time allows.

We also need to make energy-using products, such as household appliances, more efficient, helping to reduce bills and encourage innovation. Policies to increase the energy efficiency of products have been an effective lever and represent one of the most cost-effective ways to reduce energy bills and carbon emissions. The findings from our recent call for evidence will help to inform a best-in-class regulatory framework for energy-using products.

Our current estimates show that, taken together with related energy labelling requirements, ecodesign requirements will lead to emissions reductions of 8MtCO₂e to 2020.¹⁵¹ Through our world-class energy-related products policy, to be launched in spring 2021, we will push for greater energy and carbon savings. This year the government published a Call for Evidence and Consultations for ecodesign and energy labelling regulations across a range of products. We are currently reviewing the scope of our powers for achieving our energy efficiency ambition and, if necessary, will look to take additional powers through legislation.

COMMERCIAL & INDUSTRIAL PROPERTIES

► All rented non-domestic buildings will be EPC Band B by 2030, where cost-effective.

Offices, retail space, hospitality and industrial buildings account for around 80 per cent of private sector buildings energy demand.¹⁵² Around a half of all energy consumed in commercial and industrial buildings in England and Wales is in the rented sector, placing the onus on landlords to make energy efficiency and heating improvements.¹⁵³ We will therefore tighten minimum standards for this sector to reach EPC Band B by 2030 where cost-effective.

We will consult shortly on improving the implementation and enforcement of this target. This will reduce carbon emissions, help make businesses more productive and grow the energy efficiency market.

We are proposing a performance-based rating scheme for large commercial and industrial buildings to provide businesses and their investors with more information on how to reduce energy consumption and lower both carbon emissions and energy bills. We will consult in early 2021 on how the scheme will work and plan to launch the first phase by 2022/23.

Improving energy efficiency is one of the most cost-effective mechanisms for businesses to reduce their energy bills, while reducing their carbon emissions. But a lack of information and the upfront capital costs of installation can deter investment by small businesses in measures such as insulation and energy management systems. We will continue to explore how we can stimulate a thriving market for business energy efficiency through the proposed new energy efficiency scheme focused on small businesses. As well as providing access to advice, the scheme will facilitate the installation of efficiency measures through either an auction process or an energy efficiency obligation so they can improve the energy performance of their premises. We will consult on our proposals in 2021.

The Energy Savings Opportunity Scheme aims to drive energy and carbon savings in businesses by improving the quality of the audits of the energy used by their buildings, industrial processes and transport. We will consult in 2021 on strengthening the scheme, taking forward options identified in the comprehensive scheme evaluation and Post Implementation Review published in February 2020.



PUBLIC SECTOR BUILDINGS

► **As announced in the Prime Minister's Ten Point Plan, we will extend the Public Sector Decarbonisation Scheme for a further year**

Public sector buildings account for nine per cent of emissions from buildings.¹⁵⁴

There is a particular onus on the public sector to demonstrate leadership by improving the energy performance of its building stock. By doing so, it can support a growing private sector energy services sector, helping to support jobs and new business opportunities.

As part of our Manifesto commitment to reduce emissions from the public sector, the Chancellor has already committed the first £1 billion of our funding pledge to upgrade schools, hospitals and other

buildings. The Public Sector Decarbonisation Scheme, which was launched at the end of September 2020, will help the public sector play its part in delivering net zero emissions, with improved energy efficiency and clean heat investment.¹⁵⁵

The £1 billion first tranche of funding is expected to cut emissions by up to 1.3MtCO₂e by 2032, equivalent to taking nearly 45,000 cars off the road. In addition to catalysing green investment in the public sector, the scheme will support the supply chain, providing clean energy jobs in communities throughout UK.

A FAIR AND AFFORDABLE TRANSITION

The benefits of well-insulated homes, on health and well-being and on bills, should not be the preserve of households which can afford to pay for energy efficiency measures.

People in fuel poverty will not be left behind. Indeed, our support will mean that fuel poor homes will be amongst the first beneficiaries of the energy transition. In line with our net zero goal, we will reduce energy consumption and lower energy bills by upgrading homes, focusing on the least energy efficient housing stock first.

There is currently no minimum energy efficiency standard which applies in the social rented sector except the requirement in the Decent Homes Standard which stipulates that homes should provide a reasonable degree of thermal comfort and be free of excess cold. This expectation is broadly equivalent to EPC Band F. The government has committed to a review of the Decent Homes Standard to consider how it can better support the decarbonisation and energy performance of homes, particularly with regard to the ambition set out in the Clean Growth Strategy that all homes should meet EPC C by 2035, where practical, cost-effective and affordable. We will work closely with the housing sector to carry out this review.

The government has also committed to further funding for the Social Housing Decarbonisation Fund, which will upgrade a significant amount of the social housing currently below EPC Band C to at least that standard.

Details of our multi-billion-pound plan to transform the poorest quality housing will be set out in our updated Fuel Poverty Strategy for England, due to be published in early 2021.

FUEL POVERTY

The government definition of fuel poverty is where a household has fuel costs that are above average and, were they to pay that amount, would be left with a residual income below the official poverty line.

Building on 'Cutting the Cost of Keeping Warm', our 2015 strategy, this refreshed update will set out our approach to tackling fuel poverty in the context of net zero emissions and the nation's recovery from the COVID-19 pandemic. In addition to outlining our plan for reducing fuel bills through improved energy efficiency, the new strategy will set out how we will ensure the fuel poor benefit from a fair and functioning energy market. We will also provide details of our guiding principles for future fuel poverty policies.

ENERGY COMPANY OBLIGATION

► We will extend the Energy Company Obligation from 2022 to 2026 to support fuel poor consumers.

The current Energy Company Obligation (ECO) is an obligation on larger energy suppliers to provide energy efficiency and heating measures for fuel poor consumers across Great Britain. Since the programme began in 2013, nearly 2.9 million measures have been installed in over 2.1 million homes.¹⁵⁶ Eligible households can save up to £300 on their energy bills, compared to an identical household.¹⁵⁷ Households are eligible if they receive certain benefits or live in the least efficient social housing, or if they are referred by their local authority.

We will continue to prioritise low-income and vulnerable households and focus on those living in the least efficient homes to make their dwellings warmer and healthier. The next iteration of ECO will run from 2022 to 2026 and will focus primarily on improving the worst-quality homes across Great Britain, complementing the upcoming Home Upgrade Grant scheme in England and equivalent schemes in the Devolved Administrations. The Home Upgrade Grant scheme will upgrade the energy performance of the worst-quality off-gas grid homes in England by supporting the installation of energy efficiency measures and low-carbon heating. Both schemes will focus support on low-income households.

WARM HOME DISCOUNT

► **We will expand the Warm Home Discount to around three million low-income households until at least 2025/26 and will consult on reforms to the scheme to better target fuel poverty.**

It can be a challenge for fuel poor households simply to pay their bills. The Warm Home Discount, currently worth £350 million per year, is a key policy to alleviate fuel poverty. Now in its tenth year, the scheme continues to provide £140 off electricity bills to over

two million low-income and vulnerable households each winter, when they need it the most. Over £2.7 billion of direct assistance has been provided by participating energy suppliers under the scheme.

Government recently concluded a consultation on extending the current scheme until March 2022. Further to this, we will extend the scheme from 2022 to 2025/26 and expand the total spending envelope from £350 million to £475 million¹⁵⁸ per annum to support around 750,000 additional households in or at risk of fuel poverty with paying their energy bills and almost three million households in total. This represents £1.9 billion of extra support for households in or at risk of fuel poverty.

We will also consult on reforms to improve fuel poverty targeting, such as using government data to provide automatic rebates to most recipients - making the scheme administratively simpler - and allowing smaller suppliers to participate at lower cost. Better targeting of Warm Home Discount will support a fair transition to a clean energy future for fuel poor households. It will contribute to our fuel poverty interim milestone for as many fuel poor households as reasonably practicable to achieve a minimum energy efficiency rating of Band D by 2025.

CLEAN HEAT TECHNOLOGIES

As well as tackling energy performance, we need to decrease the emissions from heating and cooling our buildings.

We stand on the verge of a major transformation as clean energy alternatives replace fossil fuels. We need to complete this transformation while ensuring households continue to enjoy a reliable heating system and a comfortable, healthy and affordable home environment.

To achieve net zero emissions, we will have to transition completely away from traditional natural gas boilers for heating homes on the gas grid. There are currently around 1.7 million fossil fuel boiler installations every year¹⁵⁹ but by the mid-2030s we expect all newly installed heating systems to be low-carbon or to be appliances that we are confident can be converted to a clean fuel supply. There is no single technology alternative to fossil fuels.

Electric heat pumps and hydrogen, green gas and shared heat networks all have their part to play. So, while we are clear on the eventual outcome, we will be flexible in how we achieve it, always looking for the most cost-effective, consumer-friendly approach and open to innovative solutions.

We want to give households, suppliers, installers and equipment manufacturers long lead times to prepare for this transition. We will target the point of least disruption to consumers and minimise the impact on the housing market and will therefore look to use natural trigger points, such as the replacement cycle for existing heating systems. And we need to ensure consumers are receiving fair value as they switch to clean heat, which means working with the market to reduce costs and addressing barriers to the deployment of new technologies.

► **We will consult on whether it is appropriate to end gas grid connections to new homes, in favour of clean energy alternatives.**

We need to ensure that the right legislation is in place to support the heating market through the transition to net zero. We will review the overarching regulatory framework set out in the Gas Act 1995 to ensure the appropriate powers and responsibilities are in place to facilitate a decarbonised gas future. In particular, to ensure the Gas Act is in line with the Future Homes Standard, we will seek views on the feasibility of ending the connection of new build homes to the natural gas grid.

ELECTRIFICATION

► **As announced in the Prime Minister's Ten Point Plan, we will grow the installation of electric heat pumps from 30,000 per year to 600,000 per year by 2028, supporting up to 20,000 jobs by 2030.**

Heat pumps are a proven and commercially viable way to transform heat in buildings, which is also available now. Currently, however, fewer than one per cent of homes in England use a heat pump.¹⁶⁰

HEAT PUMP

A very efficient electrically-driven device that extracts heat from the air, ground or water and concentrates it to a higher temperature and delivers it elsewhere, for example to a central heating system. It can replace fossil fuel heating, such as a gas or oil boiler.

We want to open the market of homes not on the gas grid to heat pumps or other clean energy alternatives, representing some 50,000 to 70,000 installations a year.¹⁶¹ We will therefore consult in early 2021 over new regulations to phase out fossil fuels in off-grid homes, businesses and public buildings, including a backstop date for the use of any remaining fossil fuel heating systems.

In setting a clear target for deploying the technology, there is an opportunity to expand the existing UK heat pump manufacturing base and exploit future export potential. The UK has a growing expertise in heat network design and is already home to several manufacturers of heat pumps. Annual global heat pump sales are expected to roughly double between 2019 and 2030 from 11.4 million to 20.8 million units.¹⁶²

We need to take advantage of future export opportunities, particularly to markets in north-western Europe where high demand is expected.

But electrification is not just a solution for off-grid buildings. We believe that significantly increasing the deployment of heat pumps for on-gas grid homes through the 2020s, on a voluntary basis, will be beneficial, whatever the eventual mix of technologies for clean heat in 2050. We recognise that, to achieve this, we will have to increase business and public confidence in heat pump technology.

In April 2020, we launched our proposal for a Clean Heat Grant, due to launch in 2022, as a successor scheme to the domestic Renewable Heat Incentive. We will publish a government response in 2021. The Clean Heat Grant will be targeted at households and small, non-domestic buildings to support the installation of heat pumps and, in certain circumstances, biomass. The scheme will build upon the Green Homes Grant which provides support for heat pump deployment in the near-term.

Reducing emissions from buildings will require an annual market for heat pumps by 2028 at least 20 times the size of today's market, a scale which can help realise the economic benefits of a domestic supply chain. We will work with equipment manufacturers, wholesalers and installers to ramp up supply chain capacity and reduced technology and installation costs. In early 2021, we will consult on policy approaches to underpin the development of the UK heat pump market, including voluntary up-take by consumers in current on-gas-grid homes.

The electrification of heat has implications for the GB electricity system, given the increased demand for power and the prospect of different demand patterns which arise from using power for heat.

We need to electrify heat in buildings in a way which reduces the need for additional generation and network capacity. This could mean using thermal, hot water or battery storage, potentially in combination with a smart time of use tariff, enabled by smart metering, to shift heating demand away from more expensive peak periods. Managing this transition is a key priority for the development of our plans for low-carbon electricity generation, detailed in the 'Power' chapter, and a smart energy system, as set out in the 'Energy system' chapter.

We are also considering how to further reduce market barriers to the deployment of energy efficiency, and how demand reduction is rewarded for the benefits it provides to the energy system. We want permanent electricity demand reduction to be a viable alternative to simply building more generation or network capacity. We will explore options to achieve this goal, building on the response to our call for evidence on Facilitating Energy Efficiency in the Electricity System, launched in July 2019.

GREEN GAS

► We will increase the proportion of biomethane in the gas grid.

Biomethane is currently the only green gas commercially produced in the UK. It can be injected into the gas grid to accelerate the decarbonisation of gas supplies.

BIOMETHANE

A form of gas that is produced by processing biomass. It can be used for the same purposes as natural gas, like producing electricity or heat, and can use the same infrastructure for transmission and end-user equipment.

Budget 2020 confirmed that a green gas levy imposed on gas suppliers will fund a new support scheme to achieve this goal, the first of its kind applied to gas in Britain. The costs of the levy are expected to be passed onto gas bill payers. We are considering the responses to our consultation on the green gas levy design and intend to publish a government response in early 2021.

Subject to the outcome of the consultation, we expect the Green Gas Support Scheme (GGSS) to launch in autumn 2021 and run for four years. It will support continued deployment of anaerobic digestion biomethane plants in order to increase the proportion of green gas in the grid. We anticipate that the GGSS could deliver annual generation of 2.8TWh of renewable heat in 2030/31,¹⁶³ the equivalent of the gas requirements roughly 230,000 homes.¹⁶⁴ This scheme will be designed to minimise any associated negative environmental impacts from the anaerobic digestion process, such as ammonia emissions.

We believe that through these new measures, building on the success of existing government policies, we have the potential to treble the amount of biomethane in the grid between 2018 and 2030.

CLEAN HYDROGEN

► **As announced in the Prime Minister's Ten Point Plan, we will work in partnership with industry to evaluate hydrogen as an option for heating our homes and workplaces and develop plans for a possible pilot hydrogen town before the end of the decade.**

Clean hydrogen could potentially provide a way to decarbonise our gas supplies on a much larger scale than reliance on biomethane alone.

This could offer consumers a future heating option which works for them in a very similar way to natural gas today, but no carbon emissions. However, unlike electric heat pumps and heat networks, the feasibility of using hydrogen for clean heat needs further testing and development. The practicalities and cost of safely converting or replacing existing networks and appliances to operate with pure hydrogen need to be fully evaluated.

The UK is already a world leader in investigating the use of hydrogen for heating. Both the government and the gas industry are currently running major studies and testing projects. We will increase the funding available for testing and trialling projects, working with the industry to ensure that the overall programme of work is comprehensive and fully coordinated. A range of further Research and Development (R&D) and testing projects are required, including an assessment of the options for major new hydrogen infrastructure, such as gas transmission networks and inter-seasonal storage.

Trials of hydrogen will also be key to evaluating the practicalities of converting existing boiler appliances and the way in which consumers experience hydrogen for heating in their own homes and workplaces. The Prime Minister's Ten Point Plan for a Green Industrial Revolution set out key milestones for a pioneering programme of trials. We will support industry to begin a Hydrogen Neighbourhood trial by 2023, and a large Hydrogen Village trial by 2025. The knowledge and experience gained in delivering trials in communities, together with the results of our wider R&D and testing programme, will enable a strategic decisions around the mid-2020s over the long-term role of hydrogen for heating and develop a plan for a potential Hydrogen Town before the end of the decade.



► **We will consult on the role of ‘hydrogen ready’ appliances in 2021.**

In advance of strategic decisions on the role of hydrogen for heating, we will assess the case for encouraging, or requiring, new gas boilers to be readily convertible to hydrogen, so-called ‘hydrogen-ready’ boilers, in preparation for any future conversion of the gas network. We are already supporting the development of prototype ‘hydrogen-ready’ boilers, cookers and fires, through the Hy4Heat programme, which is due to conclude in summer 2021. Subject to the results of Hy4Heat, we plan to issue a call for evidence later in 2021 to seek views from stakeholders.

To facilitate the transition and development of the gas network, we will continue to work with the Health and Safety Executive to enable up to 20 per cent hydrogen blending on the network by 2023. This is subject to the success of testing and trials.

HEAT NETWORKS

We will use a new Heat Network Transformation Programme to co-ordinate our support for the roll out of district heating systems, including the switch to low or zero-carbon heat sources.

► **We are committing £122 million of funding towards a new Heat Network Transformation Programme and will implement local authority zoning by 2025.**

HEAT NETWORK

A heat network, sometimes called district heating, is a system of insulated pipes that takes heat and cooling generated from a central source and distributes it to a number of domestic and non-domestic buildings.



Around half a million households in the UK take heat and hot water from shared heat networks.¹⁶⁵ These systems lend themselves particularly well to densely populated towns and cities. Networks with low-carbon heat sources, such as waste-heat recovery, large heat pumps, solar thermal or possibly hydrogen boilers, will reduce emissions from heating and can help consumers with lower energy bills. We are currently investing up to £320 million through the existing Heat Networks Investment Project (HNIP), using grants and loans to accelerate the growth of the market. This scheme will come to an end in 2022.

As part of our new Heat Network Transformation Programme, we are committed to funding the Green Heat Network Fund as the successor to HNIP.

This will deliver additional low-carbon networks, particularly focusing on the recovery of waste heat and the use of heat pumps. We published a consultation on the design of the scheme in November 2020. In addition, we will fund a widespread improvement in the performance of legacy networks and boost supply chains and workforce skills, as the basis of a comprehensive transformation programme for heat networks.

We intend to legislate in this Parliament for the regulation of heat networks to protect consumers and reduce carbon emissions. We will take powers to reduce the 90 per cent reliance on natural gas in heat networks, as well as enable consumer protection for heat network customers.

CASE STUDY

Tolent Construction

The UK's first large scale mine energy district heating system is being developed at Seaham, County Durham by Tolent Construction, with the help of the North East Local Energy Hub and in partnership with Durham County Council and the Coal Authority. The project has secured investment of £175 million with construction starting in December 2020.

The government has provided financial support to the council to develop the heat scheme through £3.8 million of Heat Network Investment Programme funding, £150,000 Garden Village grant and technical support from the Coal Authority, stimulating over £170 million of private sector funding.

The project is set to create 960 new jobs. A training academy will be established on site and will give young people apprenticeship opportunities to develop their skills to become trades men and women, as well as other professions.

The district heating will be made up of 1,500 homes, a primary school, shops and an innovation centre all heated by mine water heating, pumped using solar photovoltaics for carbon free heat. One quarter of properties in the UK sit on the coalfields giving huge potential to mine water heating as a low-carbon sustainable heat source.

£320m

invested to 2022 through the existing **Heat Networks Investment Project**

£270m

further funding from 2022 through the **Green Heat Network Fund**

£122m

allocated to the **Heat Network Transformation Project**

These powers will require heat networks to switch to low-carbon fuel sources as part of a natural replacement cycle, thereby minimising disruption to consumers connected to a network.

We will support Local Authorities to designate new heat network zones, no later than 2025. Zoning entails the identification of areas which can be readily connected to a low-carbon heat network and mandating connection unless it is not cost-effective to do so. The certainty of connection for projects, which zoning affords, will ensure that heat networks are better able to grow and deliver lower-cost, clean heat for consumers. We will consider how local heat network zoning can be most effectively integrated with wider local area planning for the environment, infrastructure and place. We will work with local authorities to optimise delivery of this and related interventions by working with local authorities and through our consultation due to be published in spring 2021.

THE ECONOMIC BENEFITS OF TRANSFORMING ENERGY IN BUILDINGS

Upgrading the energy performance of our building stock cuts energy bills and, for businesses, helps to reduce other day-to-day operating costs which they face.

The Energy Efficiency Infrastructure Group estimates that upgrading all UK homes to EPC C could provide annual energy bill savings of £7.5 billion.¹⁶⁶ Better energy efficiency can therefore support a persistent uplift in productivity and consumer spending to drive economic growth, particular as the country recovers from the COVID-19 pandemic.

And transforming the nation's homes with improved energy performance and new clean heat solutions will also grow the UK's manufacturing base and construction industry. It offers the prospect of hundreds of thousands of high-quality green jobs right across the UK. Building projects are typically labour intensive so scaling up delivery will support more jobs per pound spent than in most other areas of the transition to net zero emissions. The measures announced by the Chancellor in July 2020, worth £3.05 billion, will alone support up to 140,000 jobs over the next year.¹⁶⁷

Improving the quality of our building stock will contribute substantially to our agenda to level up the country. Wales and, in England, the North East, the West Midlands, the North West and the Yorkshire and the Humber region have the highest per capita energy efficiency investment need across the UK.

► **We will develop a strategy for upskilling through the 'Green Jobs Taskforce' and a National Skills Fund, to be launched in 2021.**

Analysis by the London School of Economics estimates that over six million people have skills which will be affected by the transition to clean energy, representing 21 per cent of current jobs.¹⁶⁸ This is a major opportunity to develop new skills across a range of career pathways and ensure key sectors, such as construction, which employs around 2.2 million people, are fit for a clean energy future.¹⁶⁹ Principally, we will need more installers to retrofit existing buildings with energy efficiency and clean heat measures or ensure new-build homes are zero carbon ready. In September 2020, we launched the Green Homes Grant Skills Training Competition to provide £6.9 million funding to a range of energy efficiency and low-carbon heat skills providers and support delivery of the Green Homes Grant scheme.¹⁷⁰

We are establishing a Green Jobs Taskforce with key industry bodies to produce an action plan for net zero skills across a range of sectors with the goal of two million net zero jobs by 2030. The taskforce will pinpoint the skills needed now and over long term. It will support high quality green jobs and a diverse workforce, and manage the transition for people working in high carbon industries. The action plan will be published in spring 2021.

Our key commitments



The Future Homes Standard will **ensure that all new-build homes are zero carbon ready**.



We want as many **existing homes as possible to hit EPC Band C by 2035**, where practical, cost-effective and affordable.



All rented non-domestic buildings will be EPC Band B by 2030, where cost-effective.



We will **consult on regulatory measures to improve the energy performance of homes**, and are consulting how on how mortgage lenders could support homeowners in making these improvements.



We will **extend the Public Sector Decarbonisation Scheme** for a further year.



We will **extend Energy Company Obligation from 2022 to 2026** to support fuel poor consumers.



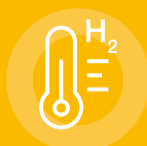
We will **expand the Warm Home Discount to around three million low income households** until at least 2025/26 and will consult on reforms to the scheme to better target fuel poverty.



We will **consult on whether it is appropriate to end gas grid connections to new homes** being built from 2025, in favour of clean energy alternatives.



We will **grow the installation of electric heat pumps** from 30,000 per year to 600,000 per year by 2028, supporting up to 20,000 jobs by 2030.



We will **work in partnership with industry to evaluate hydrogen as an option for heating** our homes and workplaces and develop plans for a possible pilot hydrogen town before the end of the decade.



We will **increase the proportion of biomethane in the gas grid**.



We will **consult on the role of 'hydrogen ready' appliances** in 2021.



We are **committing £122 million of funding towards a new Heat Network Transformation Programme** and will implement local authority zoning by 2025.



We will **develop a strategy for upskilling through a 'Green Jobs Taskforce'** and a National Skills Fund, to be launched in 2021.

CHAPTER 05

Industrial energy

OUR GOAL

By 2050, emissions from industry will need to fall by around 90 per cent from today's levels.¹⁷¹

We will:

- ▶ **Create a sustainable future for UK manufacturing industry** through improved energy efficiency and the adoption of clean energy technologies
- ▶ **Establish the UK as a world leader in the deployment of CCUS and clean hydrogen**, supporting up to 60,000 jobs by 2030
- ▶ Ensure that the transformation of our industrial sectors **supports jobs, higher skills and new business opportunities** across the country
- ▶ **Introduce a UK Emissions Trading Scheme** which will be the world's first net zero emissions trading scheme, and will underpin the decarbonisation of energy in the UK



INDUSTRIAL ENERGY

The strategic context

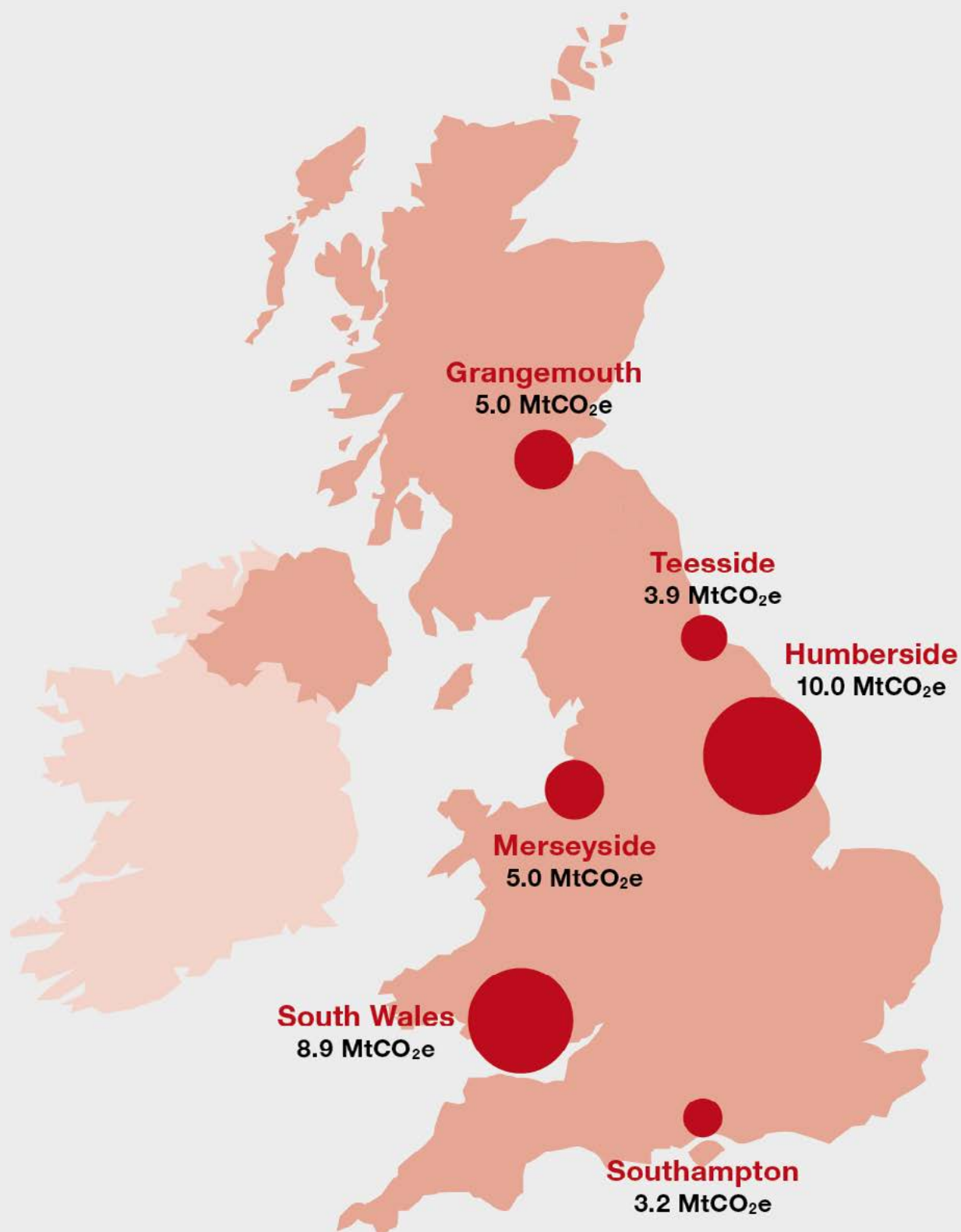


Manufacturing industry drives the UK economy. In 2018, the industrial sector contributed £170 billion to Gross Value Added (GVA), 42 per cent of British exports and employed 2.6 million people across the country.¹⁷²

Almost all industry is located outside London and the South East and provides high value jobs across the four nations.¹⁷³ Investment in low-carbon technologies and renewing our industrial infrastructure will therefore help level up the UK and promote a green economic recovery.

Manufacturing and refineries, which form the bulk of industrial emissions, still account for around 16 per cent of the UK's greenhouse gas emissions.¹⁷⁴ Although emissions from industrial activity have fallen by half since 2000,¹⁷⁵ driven partially by greater energy efficiency in industrial processes, the sector will need to achieve significant decarbonisation over the next 30 years.

About half of emissions from manufacturing and refining are concentrated in the UK's major industrial clusters (see Figure 8.1).¹⁷⁶ These hubs are critical drivers of local and regional economic activity and a vital component of the UK's national economy.

FIGURE 8.1 - LOCATIONS OF CLUSTERS AND 2018 EMISSIONS

Source: NAEI Emissions from NAEI large point sources 2018. Clusters defined as all large emitters within 30km of a cluster centre

Improved efficiency in the energy performance of buildings and industrial processes will lay the groundwork for the transformation of industrial energy. But we cannot rely on energy efficiency alone to reduce emissions in line with our 2050 goal. Manufacturing industry will need to capture their carbon for onward storage and switch from using fossil fuels to low-carbon alternatives.

The successful decarbonisation of industry will mean overcoming a number of obstacles in manufacturing sectors which operate in highly competitive international markets and, in some cases, on tight profit margins. Lowering emissions and adopting clean energy technologies requires capital investment and could impact operating costs. It will be necessary to build additional infrastructure, such as the pipes and storage to transport captured carbon from industrial processes. Long lead-times to plan, design and install emissions-capture technologies, coupled with limited opportunities to undertake construction works, could present further barriers to businesses, even when they wish to act.

We will work with businesses to overcome these challenges and deliver the successful transformation of our vital industrial base. Markets are best placed over the long run to implement the most cost-effective solutions which deliver net zero industrial emissions, supported by a long term carbon price signal. But, for now, we cannot rely on market forces alone to see industry through the transition.

Manufacturing and refineries still account for around **16 per cent of the UK's greenhouse gas emissions**



The UK's industrial sectors need our continued support, particularly through the initial phase of decarbonisation, in which the risks and costs are highest. Our approach during the 2020s will be to stimulate action, investing in the critical infrastructure which enables the deployment of low-carbon technologies. We will support industry with the costs of improving energy performance and reducing emissions. We will maintain the ability of UK-based companies to compete and win in global markets and ultimately position them to capitalise on new commercial opportunities arising in a global net zero economy.

The cost of energy impacts the competitiveness of UK-based industry. We have taken steps to protect the manufacturing sectors which are most exposed to the impact of the UK's relatively higher electricity prices, compared to other major European markets. In 2019, we provided around £442 million to support qualifying energy intensive industries, including reductions in the policy costs of the transition to renewable electricity and compensation to partly offset the indirect impacts on electricity prices from the European Union Emissions Trading System (EU ETS) and the Carbon Price Support (CPS).

Our key commitments

A NEW STRATEGIC APPROACH TO CLEAN INDUSTRIAL ENERGY

In the 2030s, markets will be best placed to determine the most efficient approach to decarbonising industrial emissions. Our actions in the 2020s will create the right conditions to enable this transition.

► **We will publish an Industrial Decarbonisation Strategy in spring 2021 to set out the details of how the government will support the decarbonisation of manufacturing industry.**

Our strategy will set out a vision for a prosperous, low-carbon UK industrial sector in 2050. Working closely with our partners in the devolved administrations, we will establish how the transition to clean energy will support the UK's industrial competitiveness and a resilient, green economic recovery, including opportunities to exploit new markets at home and abroad.

A low-carbon and more resource efficient economy is not just about transforming existing industries and enabling a long-term sustainable future. It is the basis for new industrial sectors to flourish. It will catalyse innovation for new technologies, boost UK manufacturing and support thriving construction and operations sectors. It is a transformation which can help all the UK's manufacturing regions to become centres for the production of low-carbon goods. It will enhance long-term regional competitiveness, support a green recovery and insulate businesses from the impacts of a rising carbon price.

Domestic action is a platform for the UK's global leadership on climate change. With our leading role in industrial decarbonisation, we will be able to export technology, know-how and skills to the rest of the world. If global industry were to reduce emissions by around 70 per cent by 2050, relative to 2012 levels, UK exports of clean energy technologies in 2050 could support around £1.4 billion in annual GVA and support 18,000 jobs.¹⁷⁷



► **In line with the increased ambition set out in the Ten Point Plan we will increase the Industrial Clusters Mission to support the delivery of four low-carbon clusters by 2030 and at least one fully net zero cluster by 2040.**

We will start with a focus on the UK's industrial clusters – centres where related industries have congregated and can benefit from utilising shared clean energy infrastructure, such as carbon capture utilisation and storage (CCUS) and low-carbon hydrogen production and distribution. Decarbonisation in clusters will enable economies of scale, reducing the unit cost for each tonne of carbon abated. Clusters provide high quality jobs which tend to pay above the UK average wage.¹⁷⁸

Transitioning to clean energy will bring opportunities to all four UK nations. Many clusters are located in regions in need of economic revitalisation and decarbonising those clusters can act as a driver of prosperity for the surrounding areas. Investments in key technologies like hydrogen and CCUS, together with broader interventions, such as through helping people to retrain, will be crucial to enhancing local economic growth and creating jobs. These actions will also deliver wider environmental benefits such as improved air quality. We will work with local government and businesses to consider how an integrated strategic approach can most effectively be developed to enable local places to capitalise on this opportunity to build back greener. Supporting the delivery of four low-carbon clusters will enable greater decarbonisation, leading the way for a more sustainable industry.

CARBON CAPTURE UTILISATION & STORAGE (CCUS)

The deployment of CCUS is fundamental to the decarbonisation of energy intensive industries such as steel, cement, oil refining and chemicals. CCUS can help secure the long-term future of these industries and enable production of clean hydrogen at scale.

► **We will invest £1 billion up to 2025 to facilitate the deployment of CCUS in two industrial clusters by the mid-2020s, and a further two clusters by 2030, supporting our ambition to capture 10MtCO₂ per year by the end of the decade.**

The UK is in a strong position to become a global technology leader in CCUS. We have the opportunity to develop a domestic supply chain by utilising the expertise of our existing oil and gas industry. Innovative start-up companies, spun out of the UK's world-class academic institutions, are focused on driving cost reductions and creating new UK-based innovative carbon capture technologies. With the potential to store more than 78 billion tonnes of carbon dioxide,¹⁷⁹ we can be a global leader in carbon storage services.

Deployment of CCUS could create new markets for UK businesses, at home and abroad, as other countries look to meet their emissions reduction commitments. Action now can harness the UK's strengths in engineering, procurement, construction, and management services, with export opportunities from CCUS estimated at £3.6 billion by 2030.¹⁸⁰

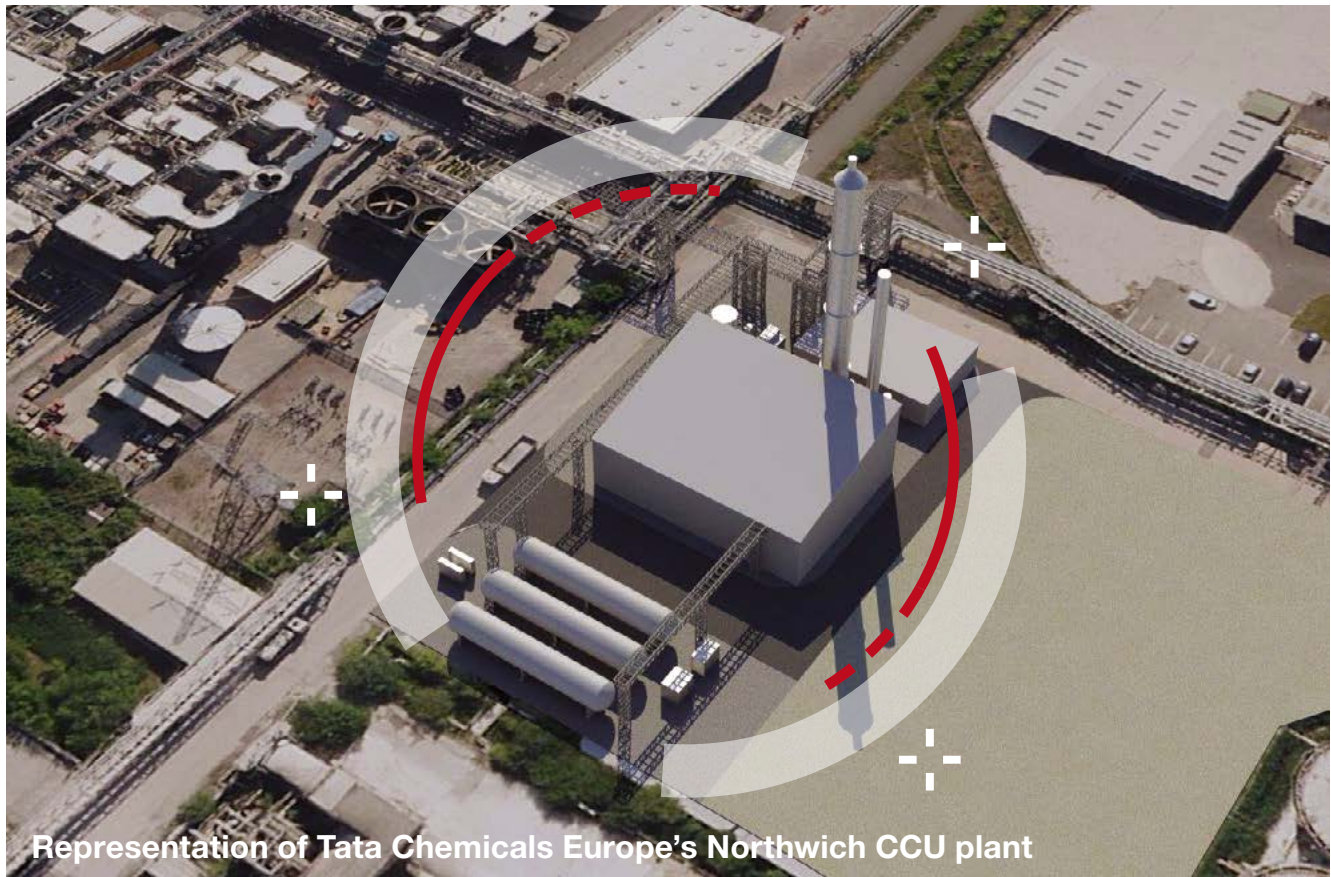
CCUS

The process of capturing carbon dioxide from industrial processes, power generation, certain hydrogen production methods and greenhouse gas removal technologies such as bioenergy with carbon capture and storage and direct air capture. The captured carbon dioxide is then either used, for example in chemical processes, or stored permanently in disused oil and gas fields or naturally occurring geological storage sites.

CASE STUDY

Tata Carbon Capture and Utilisation (CCU)

Tata Chemicals Europe (TCE) are constructing, with the support of a £4.2 million grant from the Energy Innovation Programme, the UK's first industrial-scale CCU demonstration plant at their site in Northwich, for the manufacture of high purity sodium bicarbonate. The plant will be commissioned in 2021 and will be capable of capturing up to 40,000tCO₂e per year, and will reduce carbon emissions at the plant by 11 per cent. TCE exports 60 per cent of its sodium bicarbonate production in the UK to over 60 countries across the globe. The CCU project will be a springboard for TCE to unlock further expansion into its export markets.¹⁸¹



Representation of Tata Chemicals Europe's Northwich CCU plant

We have created the Carbon Capture and Storage (CCS) Infrastructure Fund to commit the investment needed to realise this opportunity. In his Budget of March 2020,¹⁸² the Chancellor committed at least £800 million through the Fund to support CCUS deployment. As announced in the Prime Minister's Ten Point Plan, we are now raising our commitment to £1 billion up to 2025 to facilitate the UK's deployment of operational CCUS in four industrial clusters by the end of the decade. This new carbon capture industry could support up to 50,000 jobs in the UK by 2030.¹⁸³ Developing carbon transport and storage infrastructure will require large upfront capital expenditure, to construct offshore and onshore pipelines and develop storage sites and wells. We will help to put in place this critical network, as the foundation for the scaling up of CCUS across the UK.

For the majority of industrial sectors, CCUS is not yet a viable investment. The market currently does not provide a sufficiently robust price signal to make industrial carbon capture viable. In addition, low-carbon products do not attract a price premium, making investment harder to justify without a support mechanism. It can be hard for early investors to fully reap the benefits of learning and innovation which is generated from backing this first-of-a-kind technology. This is why we are designing and implementing a business model to provide revenue support and improve companies' confidence for investing in carbon capture solutions. We aim to finalise a new commercial framework by 2022.

CLEAN HYDROGEN

The production and use of clean hydrogen will be important in achieving net zero emissions by 2050.

As a gas that can be used as a fuel without emitting harmful greenhouse gasses, hydrogen will be critical in reducing emissions from heavy industry, as well as in power, heat and transport. When heavy goods transport or a process such as steel production relies on fuel for energy, hydrogen can provide a crucial, low-carbon alternative to fossil fuels.

► **We will publish a dedicated Hydrogen Strategy in early 2021 which positions the UK as a world leader in the production and use of clean hydrogen.**

Around 95 per cent of global hydrogen production is fossil-fuel based.¹⁸⁴ A complete switch to clean hydrogen is required, together with a major increase in production capacity. The UK currently makes up to 27TWh annually.¹⁸⁵ The Climate Change Committee (CCC) suggest we may need a ten-fold increase by 2050, with the option to go further depending on the scale of hydrogen use in heat, transport and power.¹⁸⁶

CLEAN HYDROGEN

Hydrogen that is produced with significantly lower greenhouse gas emissions compared to current methods of production – methods include reacting methane with steam to form hydrogen and then capturing the carbon dioxide by-product (steam methane reformation with CCUS) or using renewable electricity to split water into hydrogen and oxygen (electrolysis).

CASE STUDY

ITM Gigastack

ITM Power are a manufacturer of PEM (proton exchange membrane) electrolyzers, a technology which enables the generation of hydrogen from water. The company is based in Sheffield, UK. Coupled with a renewable energy supply, this production method is capable of producing zero carbon hydrogen. The Gigastack project explores the potential to scale up electrolyser size and integrate those units with offshore wind facilities. BEIS is currently supporting a consortium led by ITM Power along with Ørsted, Phillips 66, and Element Energy, funded as part of the £505 million Energy Innovation Programme.

£240m

available through
Net Zero Hydrogen Fund up to 2024/25

5GW

aim for low-carbon hydrogen production capacity by 2030

42TWh

annual low-carbon hydrogen production by 2030

A variety of production technologies will be required to satisfy the level of anticipated demand for clean hydrogen in 2050. This is likely to include methane reformation with CCUS, biomass gasification with CCUS and electrolytic hydrogen using renewable or nuclear generated electricity.

► **Working with industry, our aim is for the UK to develop 5GW of low-carbon hydrogen production capacity by 2030.**

The exact mix of different end uses for clean hydrogen in 2050 will depend on a variety of factors including cost, availability and technical application. Action is needed now to enable hydrogen to be deployed flexibly in the future. We will need production at scale by the mid-2020s to provide assurance on safety, security, cost and the potential for emissions reduction, before we scale up even further during the 2030s. To put the UK on this pathway, we are aiming for 5GW of clean hydrogen production capacity in 2030, equating to 42TWh, and supporting up to 8,000 jobs by 2030 across our industrial heartlands and beyond.¹⁸⁷ We hope to see 1GW of hydrogen production capacity by 2025 on route to our 2030 goal.

Action now to deploy hydrogen during the 2020s will stimulate domestic supply chains, enabling UK businesses to capture increasing international demand for hydrogen goods and services. Ensuring this happens will be an important part of our upcoming Hydrogen Strategy.

► **We will create a Net Zero Hydrogen Fund to support low-carbon hydrogen production, providing £240 million of capital co-investment out to 2024/25.**

The Net Zero Hydrogen Fund will deliver a major boost to production capacity, ensuring that clean hydrogen can be utilised for decarbonising industrial clusters and play its role delivering net zero.

The Fund will help establish the technology and will ensure that existing mechanisms, such as the Renewable Transport Fuel Obligation, provide an appropriate level of support for renewable hydrogen. However, achieving our 2030 ambition for clean hydrogen will also require the right commercial frameworks which encourage sustained private sector investment. We will put the necessary building blocks in place now to provide confidence that clean hydrogen can be produced reliably and cost-effectively. We will introduce a commercial framework by 2022, which enables project sponsors of all types of clean hydrogen to finance their projects. We will consult on our preferred model in 2021.

A UK EMISSIONS TRADING SCHEME

Creating a new UK carbon market will be the foundation on which the UK achieves net zero emissions cost-effectively.

► **We will implement the world's first net zero carbon cap and trade market, the UK Emissions Trading Scheme.**

The UK has been a pioneer of emissions trading since 2002. The European Union adopted our cap-and-trade approach to carbon pricing, and other countries around the world have followed our lead. There are now 28 trading systems operating across four continents.¹⁸⁸ Having left the EU, we are ready to lead the world again.

We will establish a UK Emissions Trading Scheme (ETS) to replace the UK's participation in the EU ETS. The UK ETS will be a market-based measure which will provide continuity for businesses. A cap is set on the greenhouse gases that businesses can emit (via the total number of allowances in circulation), which will decrease over time. Businesses then buy and sell emissions allowances through government auctions or secondary markets. The UK ETS will initially apply to energy-intensive industries, electricity generation and aviation.

This mechanism of carbon pricing supports businesses to decarbonise at the least cost. Businesses who can abate cheaply will do so, and those that cannot purchase additional allowances to cover their emissions. Knowing that the ceiling on emissions will lower transparently over time enables business to plan and invest to decarbonise, while at the same time protecting the competitiveness of businesses and minimising the risk of carbon leakage.

Following the introduction of the UK ETS, we will consult in due course on how to align the cap with an appropriate net zero trajectory, meaning the system will significantly contribute to ensuring the UK meets our commitment to net zero emissions by 2050. The operation of the cap will provide certainty about the decarbonisation trajectory over the long term. It will deliver a robust carbon price signal; giving businesses the confidence to mobilise the scale of capital investment necessary to deploy clean energy technologies; and to capture new trade opportunities on the back of the energy transition.

The UK ETS will also allow us to expand carbon pricing across the economy and encourage innovation in emerging decarbonisation technologies. We have committed to exploring expanding the UK ETS to the two thirds of uncovered emissions, and will set out our aspirations to continue to lead the world on carbon pricing in the run up to COP26. This will also include how the UK ETS could incentivise the deployment of greenhouse gas removal technologies. In addition to this, the UK is open to linking the UK ETS internationally in principle and we are considering a range of options, but no decision on our preferred linking partners has yet been made.

EMISSIONS TRADING SCHEME (ETS)

A method of putting a price on emissions. A cap is set on the total amount of certain greenhouse gases that can be emitted by participants. The cap is reduced over time so that total emissions fall. Within the cap, companies receive or buy emission allowances, which they can trade with one another as needed.

SUPPORT FOR BUSINESSES

Our strategy includes providing capital support to help industry become more energy efficient and to bring down the costs and risks of key decarbonisation technologies.

This investment will bring forward the date at which technologies such as CCUS and hydrogen can be commercially deployed in industry. However, we recognise that investors need revenue visibility of revenue, delivered by new business and commercial models, for the lifetime of a project, if they are to finance the upfront capital costs of decarbonisation projects.

► **We will bring forward details in 2021 of a revenue mechanism to bring through private sector investment into industrial carbon capture and hydrogen projects via our new business models to support these projects.**

The government is already providing capital support through a number of schemes for industry to decarbonise. The £18 million Industrial Heat Recovery Support programme is helping businesses reuse heat which would otherwise be wasted. The Climate Change Agreements Scheme reduces the amount of a tax that industry pays on energy, called the Climate Change Levy. It has supported industry with an estimated £200 million in tax discounts a year, in return for meeting agreed energy or carbon reduction targets and has now been extended by a further two years until March 2025.¹⁸⁹ The Industrial Energy Transformation Fund (IETF) was launched this year, with funding worth £315 million, to help businesses with high energy use to cut their bills and reduce carbon emissions.

Additionally, the £250 million Clean Steel Fund was announced in 2019 and is designed to support the resilience and longevity of the steel sector by supporting it onto a decarbonisation pathway consistent with net zero. We will also develop user-friendly digital services to improve access to funding for our stakeholders.

In addition, we intend to provide longer-term certainty to industry which goes beyond the need for time-bound support schemes dependent on direct government funding. Over the long term, cost reductions in low-carbon technologies, coupled with a robust carbon price signal and a thriving market for low-carbon products, will drive investment. In the near term, we will bring forward details of a revenue mechanism to bring through private sector investment in emerging technologies. Providing this visibility will enable industry to invest in new technologies, such as CCUS and clean hydrogen at scale, accelerating the decarbonisation of the sector and the economic opportunities which come with it.

Recognising this, we will bring forward further details in 2021 on the revenue mechanism which will encourage private sector capital into the new business models we are creating to support deployment of industrial carbon capture and clean hydrogen.

Our key commitments



We will **publish an Industrial Decarbonisation Strategy in spring 2021** to set out the details of how the government will support the decarbonisation of manufacturing industry.



In line with the increased ambition set out in the Ten Point Plan we will **increase the Industrial Clusters Mission to support the delivery of four low-carbon clusters by 2030** and at least one fully net zero cluster by 2040.



We will **invest £1 billion up to 2025 to facilitate the deployment of CCUS in two industrial clusters** by the mid-2020s, and a further two clusters by 2030, supporting our ambition to capture 10MtCO₂ per year by the end of the decade.



We will **publish a dedicated Hydrogen Strategy in spring 2021** which positions the UK as a world leader in the production and use of clean hydrogen.



Working with industry, our **aim is for the UK to develop 5GW of low-carbon hydrogen production capacity** by 2030.



We will **create a Net Zero Hydrogen Fund** to support low-carbon hydrogen production, providing £240 million of capital co-investment out to 2024/25.



We will **implement the world's first net zero carbon cap and trade market**, the UK Emissions Trading Scheme.



We will bring forward details in 2021 of a **revenue mechanism to bring through private sector investment into industrial carbon capture and hydrogen projects** via our new business models to support these projects.

CHAPTER 06

Oil and gas

OUR GOAL

Delivering our net zero target by 2050 means transforming the oil and gas sector in the UK.

We will:

- ▶ Work with the sector to **transform the UK Continental Shelf to be a net zero basin** by 2050
- ▶ Provide **opportunities for oil and gas companies to repurpose their operations away from unabated fossil fuels to abatement technologies** such as carbon capture, utilisation and storage (CCUS) or clean energy production such as renewables and hydrogen
- ▶ Agree a **transformational North Sea Transition Deal** to deliver new business opportunities, jobs and skills as the sector, as well as protect the wider communities which rely on the oil and gas sector
- ▶ Ensure that the licensing of domestic oil and gas exploration and production **continues to be compatible with our climate change ambitions**



OIL AND GAS

The strategic context



The UK's domestic oil and gas industry has a critical role in maintaining the country's energy security and is a major contributor to our economy

Much of the crude oil from the North Sea basin is exported, with the UK making extensive use of strong trading links to meet domestic refinery demand. Domestic production still met 46 per cent of the country's supply of gas in 2019, with the vast majority of this supplied from North Sea offshore production with a smaller proportion from the onshore oil and gas sector.¹⁹⁰

145k

jobs supported
directly or indirectly
across the UK in 2018

80%

drop in production of natural gas (compared to 2017) could be possible by 2050

0.9%

of 2019 UK GVA was contributed by the offshore oil and gas sector

The offshore oil and gas sector contributed about 0.9 per cent to the UK's GVA in 2019 and has paid around £350 billion in production taxes since 1970/71.¹⁹¹ The sector is a source of high-quality jobs, supporting directly or indirectly around 147,000 jobs in total across the UK in 2018.¹⁹² Many jobs supported by the sector are located in Scotland, particularly in Aberdeen, a global hub for the oil and gas industry. Critical supply chain clusters have grown in the North, East and South East of England. These jobs and the additional 113,000 induced by the sector help support the wider UK economy.

While the Oil & Gas Authority (OGA) estimates that there are still around 10 to 20 billion barrels of oil equivalent remaining in the UK Continental Shelf,¹⁹³ domestic production has more than halved since 2000.¹⁹⁴ The Climate Change Committee (CCC) estimates that production of natural gas could drop by up to 80 per cent by 2050, compared to levels in 2017.¹⁹⁵ However, the projections for demand for oil and gas, though much reduced, is forecast to continue for decades to come.

The UK's offshore oil and gas sector and the smaller onshore sector have both been severely affected by COVID-19. The pandemic led directly to the global collapse in demand for oil and resulted in a roughly 65 per cent drop in the price of Brent Crude between January and April 2020.¹⁹⁶ Oil and Gas UK (OGUK) estimate that the UK sector will respond by cutting expected capital expenditure by around 30 to 40 per cent and operating expenditure by around 10 to 20 per cent compared with anticipated expenditure at the start of the year, while maintaining production levels.¹⁹⁷ During the early months of the UK lockdown, staffing on offshore rigs was reduced by more than a third compared to early March.¹⁹⁸

The OGA estimates that there are still around **10 to 20 billion barrels of oil remaining in the UK Continental Shelf**



We have supported the oil and gas sector to bounce back from COVID-19 but a return to 'business as usual' is no longer an option. Government support is in the context of delivering our net zero target. The sector is already coming under significant pressure from investors and the public more widely to respond to the challenge. Shareholders, for example, are increasingly requiring listed companies to price carbon into their business models and demonstrate how they can reduce emissions from their operations or support the wider decarbonisation of the economy.¹⁹⁹

Many oil and gas companies are now responding to the challenge. Their investment decisions are beginning to anticipate a world without fossil fuels beyond 2050.²⁰⁰ There is great potential for the sector to play an important part in the energy transition and retain vital skills across key regional hubs around the country, supporting the CCUS and hydrogen "SuperPlaces" clusters announced in the Prime Minister's Ten Point Plan.²⁰¹

HOW UK COMPANIES ARE RESPONDING TO THE NET ZERO CHALLENGE

There is great potential for traditional oil and gas businesses to take advantage of the opportunities provided by the energy transition and transform their operating model, whether they are exploration and development companies, service providers, supermajors or independent companies.

Supermajors such as bp and Shell have set out major changes of strategy to achieve net zero by 2050, including addressing emissions that result of the use of their products. All have set aggressive emissions reductions targets. Other approaches include rebalancing their portfolios to increase their renewable energy holdings; investing in and partnering with renewable energy companies; investing in carbon dioxide sequestration, and expanding their consumer-facing offer, such as electric vehicle charging. Privately backed companies, such as Chrysaor, have also set out their emissions reductions targets, while investing in carbon capture and hydrogen in the UK.

We will continue to push for a high level of ambition amongst oil and gas companies, challenging them to go further to reduce their emissions consistent with our net zero target, while transitioning their operations into emerging energy technologies.

We expect to see the supply chain reflect this shift as well.

Wood

Wood Plc has taken substantial steps to transform its business from a traditional oilfield services provider into broader engineering and consultancy work operating across the energy sector. In 2014, 96 per cent of Wood's revenue was derived from oil and gas work including 65 per cent from upstream activity compared with 2020 where upstream activity now accounts for just one third of its total revenue.²⁰²

Today, Wood offers a blend of consulting, projects and operations solutions including a fast-growing renewables business. It has been involved in solar projects, increasing global wind capacity as well as CCUS studies and has an increased presence in the hydrogen market. In parallel, the company has continued its commitment to the oil and gas sector through helping partners achieve their own energy transition goals.



A recent survey by OGUK revealed that more than half of its members had already diversified into other energy sectors, even as oil and gas remained their primary source of income.²⁰³ The UK Petroleum Industry Association has set out scenarios and the technology pathways for how the refining and downstream sector can play an active part in achieving net zero emissions.²⁰⁴ Many supply chain companies are diversifying into other energy sectors.

Reducing emissions from oil and gas will need careful management to avoid disruption to our daily lives and minimise rising costs, as well as to mitigate wider economic impacts. It requires a policy and regulatory framework which continues to promote good environmental practice, alongside effective stewardship of the North Sea by both regulators and oil and gas operators. To achieve this, we expect industry to respond effectively to the net zero challenge but will encourage continued healthy levels of investment. Ensuring that the UK remains an attractive destination for global capital is the best way to secure an orderly and successful transition away from traditional fossil fuels.

Our key commitments

A NET ZERO BASIN BY 2050

It is critical that the sector focuses on cutting the emissions associated with offshore oil and gas production.

► **Working with the regulators, we will drive the reduction of greenhouse gas emissions from all offshore oil and gas operations to make the UK continental shelf a net zero basin by 2050.**

In 2018, upstream oil and gas activities in the UK accounted for four per cent of UK greenhouse gas emissions.²⁰⁵ According to OGUK, in order to meet net zero, the oil and gas sector will need to reduce its emissions from offshore production and operations to 0.5MtCO₂e by 2050, from 19MtCO₂e today.²⁰⁶ Methane will be a special focus, given its potency as a greenhouse gas.

The industry has signed up to the OGUK-led ambition to achieve net zero emissions across all its upstream activities, as set out in the OGUK's Roadmap 2035.²⁰⁷ It has already set itself the challenge of becoming a net zero basin by 2050, with a 50 per cent absolute emissions reduction by 2030 and 90 per cent by 2040.²⁰⁸ The sector was amongst the first industrial sectors in the UK to make such a commitment. We expect real and ambitious change from industry to deliver this commitment. We want the industry to go further and faster, wherever possible.

The World Bank estimated that, in 2019, global levels of gas flaring had increased to approximately 150 billion cubic metres of natural gas, emitting about 400MtCO₂e, in addition to the waste of the valuable resource.²⁰⁹

► **We will commit the UK to the World Bank's 'Zero Routine Flaring by 2030' initiative and will work with regulators towards eliminating this practice as soon as possible in advance of this date.**

The World Bank's 'Zero Routine Flaring by 2030' initiative invites governments and industry to put an end to the operational practice of routine flaring by 2030. Some UK Continental Shelf operators have reduced routine flaring but much more can be done to drive down the practice, notwithstanding the challenges posed by the maturity of the basin and its assets. The OGA will take a more robust stance to push for reductions in flaring and venting and the resulting greenhouse gas emissions, through its consents, field development process and project stewardship role.²¹⁰ As part of our discussions with the sector on emissions reduction in the North Sea Transition Deal, we will seek to end this practice before 2030.

We will also tackle regulatory and policy barriers to the use of clean electricity, such as offshore wind, to power offshore oil and gas facilities, as opposed to the current practice of using diesel or gas generators on platforms.

In addition to reducing emissions from direct operations, known as Scope 1 and 2 emissions, we will challenge the sector to address embodied emissions from the consumption of their products or from supply chain activities, so-called Scope 3 emissions.

SCOPE 1,2 AND 3 EMISSIONS

The Greenhouse Gas Protocol Corporate Standard classifies a company's GHG emissions into three scopes:

- ▶ **Scope 1:** emissions directly from owned or controlled sources
- ▶ **Scope 2:** indirect emissions from the generation of purchased energy
- ▶ **Scope 3:** indirect emissions (not included in Scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions

Many of the larger companies are already setting out plans for taking on this challenge. This will largely be achieved through changes to their corporate strategies to focus their business on abatement of emissions, and new low-carbon energy sources. The approach will vary according to the size and structure of individual companies. Any future government support is dependent on the sector adopting meaningful measures which reduce emissions and report transparently on progress, for example through adhering to the recommendations of the Taskforce on Climate-Related Financial Disclosures.

As we face the challenge of decommissioning end-of-life oil and gas infrastructure in the UK Continental Shelf, we will take account of the potential to use existing infrastructure in CCUS transport and storage supporting carbon capture from industry, power generation and hydrogen production. This will require giving appropriate consideration to responsible management of decommissioning costs.

▶ We will support the UK oil and gas sector to repurpose its existing infrastructure in support of clean energy technologies.

Using oil and gas assets at the end of their existing commercial life could realise significant cost savings in the deployment of CCUS and prove instrumental in getting the technology operational by the mid-2020s. Upfront capital cost savings for the developers of some CCUS projects could be in excess of £100 million, compared to the cost of building new offshore pipelines and associated infrastructure.²¹¹ The re-use of existing assets can also lower the carbon footprint of the construction process.

In August 2020, we published our response to a consultation on the re-use of oil and gas assets for CCUS projects.²¹² Our review has identified assets which could have the greatest potential for re-use in CCUS. We will now work with industry and regulators to provide clarity on the regulations for re-purposing assets and to develop technical guidance on how this can be done safely and securely.

A REGULATORY REGIME WHICH INCENTIVISES THE SWITCH TO CLEAN ENERGY

It is vital that our regulators are well positioned to address the net zero basin challenge and help deliver our ambition.

We will work closely with the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) and the Oil & Gas Authority, the principal offshore oil and gas regulators, to ensure that their roles, powers and priorities reflect the government's policy for delivering net zero emissions, without imposing significant additional regulatory burdens.

► **We will undertake a review of the Offshore Petroleum Regulator for Environment and Decommissioning to ensure that it is fully equipped to drive up environmental standards in its regulatory role, as well as supporting the sector's progress towards net zero emissions.**

OPRED is the environmental and decommissioning regulator for offshore oil and gas, gas storage and offshore carbon capture and storage activities. OPRED will increase its focus on the further reduction of greenhouse gas emissions from all offshore oil and gas operations and will put in place a regulatory framework to support emerging decarbonisation technologies. This will include OPRED utilising its existing data collection system to track progress on emissions reduction.

The total **value of UK subsea output in 2019 stood at almost £7.8 billion**, with over 45,000 people employed in the sector.



The principal objective of the OGA, the upstream licensing regulator, is to maximise the economic recovery of petroleum from the UK Continental Shelf, a statutory goal established in the wake of the oil price crash in 2014. The OGA has supported the production of oil and gas in the most cost-effective way possible but its focus has been evolving.

► **We aim to lay a new strategy for the Oil & Gas Authority before the end of 2020 to bolster the regulator's ability to focus the sector on helping deliver net zero emissions.**

The OGA consulted over the summer of 2020 about its intention to refresh its core aim, including a requirement for industry to take appropriate steps to support the delivery of the government's net zero target.²¹³ We agree with the OGA's assessment that the sector must go considerably faster in reducing its own carbon footprint or risk losing its social licence to operate. The changes proposed in the OGA's consultation have the potential to make a significant contribution to achieving our goal.



The industry has the skills, technology and capital to unlock innovative solutions which could be instrumental in helping to deliver net zero emissions successfully for the whole economy. It can play a critical role in the deployment of CCUS, hydrogen production and renewable electricity generation, particularly offshore wind. The OGA is clear that consideration of the sector's contribution to this goal is a proper part of Maximising Economic Recovery.

The OGA will take wide ranging action to implement its revised strategy. This will include benchmarking greenhouse gas emissions to drive performance and creating a new asset stewardship expectation for net zero. The OGA will update its guidance and its economic assessments, which support regulatory decisions, to include full carbon costs.

A new strategic approach will allow the OGA to take a much greater role in driving the sector's contribution to the clean energy transition. It will further enhance the OGA's role as an environmentally responsible steward.

To respond to the changing landscape in which the UK oil and gas sector is operating, we are currently undertaking a review of policy on the future licensing of domestic offshore oil and gas exploration and production. This review seeks to ensure the continued compatibility of the UK's licensing regime with our climate obligations and delivering our net zero target by 2050. This review is an opportunity for the UK to demonstrate that effective climate leadership can be compatible with maintaining a strong economy and robust energy security.



► **To ensure that licensing continues to be compatible with our climate change ambitions over the coming decades, we are considering formalising aspects of our existing process.**

As we develop our policy options, we believe that a sensible step for the UK may be to develop the existing checkpoints in our processes before proceeding with future licensing rounds. Such a step could involve regularly seeking independent advice on how proceeding with future licensing would impact our climate and energy goals.

This could serve to further formalise existing processes and provide an extra layer of assurance that oil and gas licensing remains consistent with our future policy objectives. We will assess what added benefit such a move would bring as part of our review.

In addition to this measure, we are considering a spectrum of options to ensure that the regime continues to be consistent with our wider aims. We will assess all options against a range of factors, including our energy transition goals; emissions reductions; and impacts on the supply chain and jobs. We expect to publish our conclusions in early 2021.

A NEW PARTNERSHIP BETWEEN GOVERNMENT AND INDUSTRY

In our Manifesto, the government committed to agreeing a Sector Deal with the offshore oil and gas industry which secures the sector's long-term future consistent with net zero.

- **We will agree a transformational North Sea Transition Deal with the industry during the first half of 2021, focused on the economic opportunities of net zero and providing support for the people and communities most affected by the move away from oil and gas production.**

The proposed North Sea Transition Deal represents a quid pro quo partnership between the government and industry for taking long-term action which transforms the sector and delivers the energy transition. We are negotiating the substance of the deal with the sector and aim to reach agreement by the first half of 2021. We will use the deal as a vehicle to create new jobs as well as trade and investment opportunities. The deal will also set out how we can retain existing skills and capabilities in the sector, many of which are of vital regional and national significance and which could give the UK first mover advantage in emerging low-carbon sectors.

The Prime Minister's Ten Point Plan included ambitious commitments on supporting the delivery of clean energy technologies such as hydrogen and CCUS. Given the proximity of UK oil and gas hubs – particularly Scotland and the North East of England, this presents a great opportunity for the sector to unlock additional funding through the North Sea Transition Deal. The sector can contribute meaningfully to the Green Industrial Revolution by providing essential skills across key regions of the UK economy.

NORTH SEA TRANSITION SECTOR DEAL

Key deliverables



Cleaner energy production through rigorous emissions reductions;



Supporting the **delivery of CCUS**;



Diversification of the oil and gas supply chain into new energies;



Supporting the **development of hydrogen production**; and



Safeguarding existing jobs and establishing tens of thousands of new high-quality jobs across the sector in diversified energy technologies.

SECURING NEW TRADE AND INVESTMENT OPPORTUNITIES

Through the UK's international leadership on climate change action, we will seek new opportunities in overseas markets to export our expertise in subsea engineering, decommissioning and other supply chain capabilities.

- **We will use our North Sea Transition Deal to support the UK-based oil and gas supply chain to secure new low-carbon export opportunities in overseas markets, capitalising on the global reach of the UK's world-class trade promotion and diplomatic resources.**

The UK's offshore oil and gas supply chain sells a range of products, services and expertise to domestic and world markets. With innovative providers of oil field services and capability across all sub-sectors, including marine and sub-sea operations, it had an estimated turnover in 2018 of £27 billion and employs around 116,000 people.²¹⁴ Many of these capabilities are readily exportable to new markets, as the world decarbonises.

The UK is forecast to become the largest decommissioning market globally over the next decade, with decommissioning expenditure forecast to be around £1.5 billion per year for the next ten years.²¹⁵ This will enable the UK supply chain to develop a world-leading decommissioning industry. If the sector can decommission our offshore infrastructure in a safe, efficient and environmentally responsible manner, while also meeting the OGA's ambitious cost reduction targets, it will be well-positioned to service the global market, by one estimate worth around £80 billion in the next decade²¹⁶ and near £270 billion from 2022 onwards.²¹⁷



£27bn

estimated turnover of the UK's offshore oil and gas supply chain in 2018



£8bn

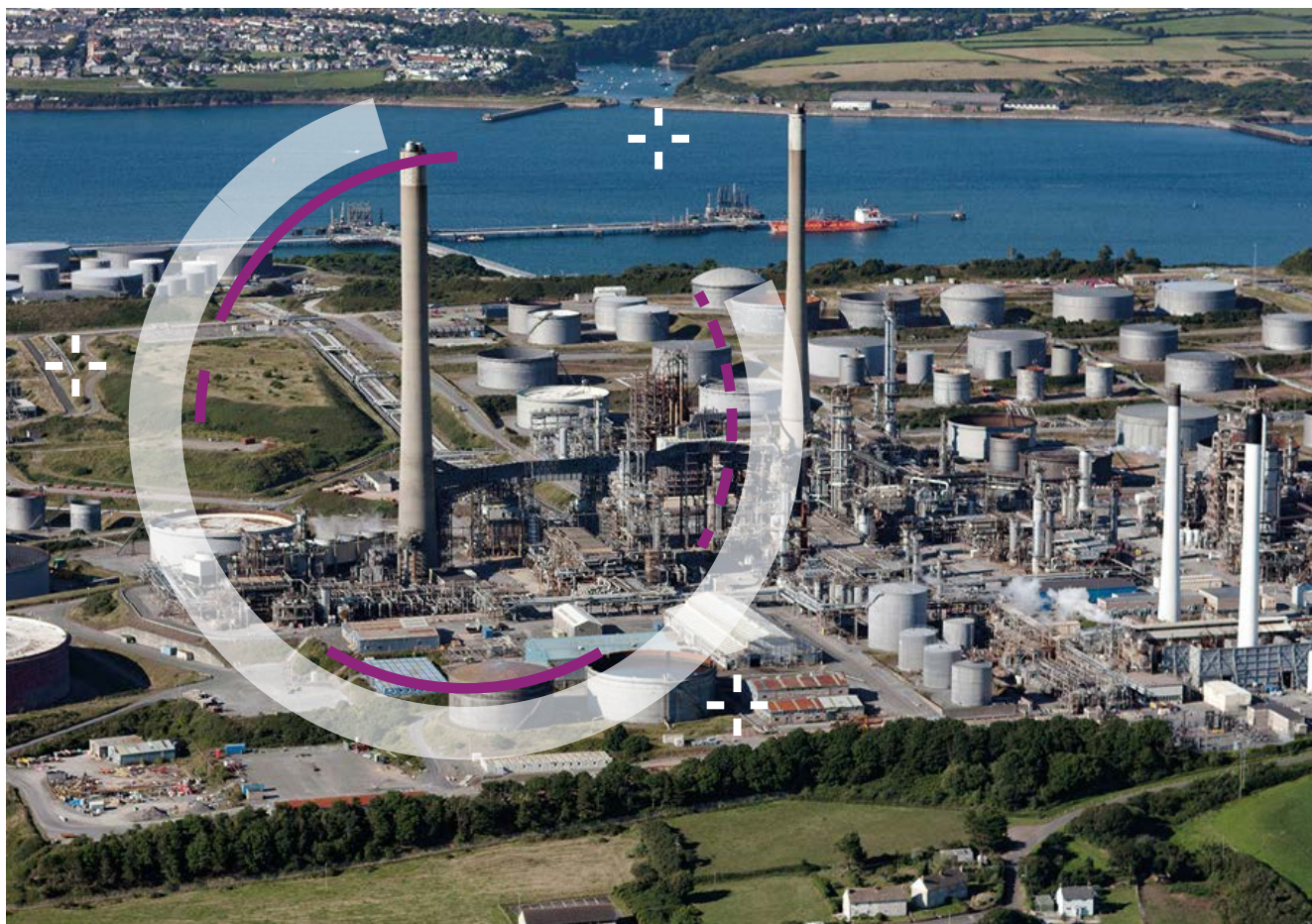
total value of UK subsea output in 2018/19



<1%

UK contribution to **overall global greenhouse gas emissions**

As announced in the 2020 Spending Review, we will commit funding towards the Global Underwater Hub in Aberdeen with satellites in North East England And Southern England. This new economic development hub will take a strategic approach to growing our world-leading subsea engineering, technology and services sector as the global subsea market diversifies away from oil and gas and shifts towards supporting new marine growth sectors such as renewables.



In parallel with this white paper, we will publish proposals for helping develop decommissioning opportunities, both domestically and in overseas markets.

The UK's world-leading subsea engineering industry is already positioned for global growth across a range of diversified sectors which make up the so-called 'Blue Economy', economic activities relating to the world's oceans and coastlines. The total value of UK subsea output in 2018/19 stood at around £8 billion, with over 45,000 people employed in the sector.²¹⁸

The UK contributes less than one per cent to overall global greenhouse gas emissions²¹⁹ so we must leverage our role as a world leader on climate change and ensure we use all available levers to support global clean growth opportunities.

This is why in January 2020 the Prime Minister announced that the UK government will no longer provide any new direct support for thermal coal mining or coal power plants. To bolster our commitment to supporting a clean energy transition, The Prime Minister has now announced that the UK government will no longer provide direct financial or promotional support for the fossil fuel energy sector overseas. Both announcements extend to any new official development assistance, investment, export credit and trade promotion activity. For oil and gas activities there will be a few - tightly bound - exemptions allowed for activities that support health and safety improvements, form part of wider clean energy transitions, support decommissioning, or are associated with a humanitarian response.

A public consultation process will take place on the implementation date for this policy and to help align government's support for clean technologies. The consultation will close in February 2021 and its findings will help form the North Sea Transition Deal. Our ambition is to lead by example, working towards establishing the UK at the forefront of the global supply chain and capitalising on the skills of the UK sector while working in close partnership with those seeking to transition to a cleaner future.

We will identify the international clean growth projects and emerging clean technology sectors in the UK which can benefit from our export finance mechanisms, from innovation to export, with a particular focus on technologies where the UK has first mover advantage. We will also help UK based companies to diversify and take advantage of the opportunities in emerging energy technologies.

DOWNSTREAM OIL RESILIENCE

The downstream oil sector provided 96 per cent of the energy used in the transport sector in 2019.²²⁰ It will continue to play a vital role in the transition to a net zero economy, delivering fuels to consumers.

The sector is already actively exploring the potential for low-carbon liquid fuels, particularly in aviation, shipping and heavy goods vehicles, which are more challenging to decarbonise.

We will work with industry to promote innovation and remove regulatory barriers which hinder the switch from fossil fuels. The Department for Transport will shortly publish a consultation over the use of fuels produced from non-biogenic waste, which is currently incinerated. It offers the potential to convert non-recyclable plastic and industrial waste gases to jet fuel or substitute for diesel and petrol in cars and vans.

As we make the transition away from fossil fuels, we must maintain secure supplies of fuel to the people and businesses whose livelihoods depend upon it.

► **We will take powers to ensure we maintain a secure and resilient supply of fossil fuels during the transition to net zero emissions.**

Our net zero future undoubtedly represents a challenge to the downstream oil sector, which has already been hit hard by falling demand and reduced refining margins resulting from the COVID-19 pandemic. We believe that it is necessary for government to have powers to monitor the resilience of the fuel supply market and, should it be necessary, to intervene to ensure there is an orderly transition to clean energy supplies. We will explore options for delivery and look to publish a draft Downstream Oil Resilience bill while we seek an opportunity to introduce these measures to Parliament.

Our key commitments



Working with the regulators, we will make **the UK continental shelf a net zero basin** by 2050.



We will **commit the UK to the World Bank's 'Zero Routine Flaring by 2030'**.



We will **support the UK oil and gas sector to repurpose its existing infrastructure** in support of clean energy technologies.



We will **undertake a review of the Offshore Petroleum Regulator for Environment and Decommissioning** to drive up environmental standards in its regulatory role, and support the sector's progress towards net zero emissions.



We aim to **lay a new strategy for the Oil & Gas Authority before the end of 2020** to bolster the regulator's ability to focus the sector on helping deliver net zero emissions.



To **ensure that licensing continues to be compatible with our climate change ambitions** over the coming decades, we are considering **formalising aspects of our existing process**.



We will **agree a transformational North Sea Transition Deal** with the industry during the first half of 2021.



We will use our North Sea Transition Deal to **support the UK-based oil and gas supply chain to secure new low-carbon export opportunities** in overseas markets.



We will take powers to **ensure we maintain a secure and resilient supply of fossil fuels during the transition** to net zero emissions.

Glossary

| Phrase | Meaning |
|--|---|
| Advanced Nuclear | Includes Small Modular and Advanced Modular Reactors. |
| Advanced Nuclear Reactors | Reactors which use novel cooling systems or fuels and may offer new functionalities (such as industrial process heat). |
| Balancing | Matching supply with demand, which is important to keep the gas and electricity systems within safe operating limits. For electricity this needs to be done on a second-by-second basis. |
| Balancing services / balancing market | The tools and markets that are used to make sure it is possible to match supply with demand. |
| Bioenergy with Carbon Capture and Storage | Refers to bioenergy processes (such as burning it for electricity) during which carbon is captured and stored. If carefully managed, using sustainable biomass, BECCS can generate 'negative emissions' because while providing energy it also captures and stores the atmospheric CO ₂ that is absorbed by plants as they grow. |
| Bioenergy | Refers to heat or electricity produced using biomass or gaseous and liquid fuels with a biological origin such as biomethane produced from biomass. |
| Biomass | Refers to any material of biological origin used as a feedstock for products (e.g. wood in construction to make chemicals and materials, like bio-based plastics), or as a fuel for bioenergy (heat, electricity and gaseous fuels such as biomethane and hydrogen) or biofuels (transport fuels). |
| Biomethane | A form of gas that is produced by processing biomass. It can be used for the same purposes as natural gas, like producing electricity or heat, and can use the same infrastructure for transmission and end-user equipment. |
| Capacity market | Is our primary policy mechanism for delivering security of electricity supply. It provides generators and flexibility providers with a payment for firm (reliable) capacity to ensure they deliver electricity generation or demand reduction, when required. |
| Carbon intensity | The amount of CO ₂ emitted when generating a unit of electricity, measured in gram of CO ₂ per kWh of electricity produced. |

| Phrase | Meaning |
|--|---|
| Carbon capture readiness | Is a requirement imposed on thermal plants (such as coal and gas plants) to enable future capturing and storing of carbon following a plant upgrade. Such plants currently emit CO ₂ directly into the atmosphere. |
| Carbon Capture Utilisation and Storage (CCUS) | The process of capturing carbon dioxide from industrial processes, power generation, certain hydrogen production methods and greenhouse gas removal technologies such as bioenergy with carbon capture and storage and direct air capture. The captured carbon dioxide is then either used, for example in chemical processes, or stored permanently in disused oil and gas fields or naturally occurring geological storage sites. |
| Carbon Leakage | Refers to the situation that may occur if, for reasons of costs related to climate pricing policies, businesses were to transfer production or reallocate future investments to other countries with laxer emission constraints or carbon pricing. This could lead to an increase in total global carbon emissions. |
| Carbon Price | A cost applied to carbon pollution to encourage polluters to reduce the amount of greenhouse gases they emit into the atmosphere. |
| Clean Electricity | Types of electricity generating technologies that emit little or no fossil fuel derived greenhouse gas from generation. |
| Competitive tendering | A process inviting eligible organisations to compete to carry out work or supply services, with the winner decided by who can offer the best price and quality. |
| Contracts for Difference Scheme (CfD) | The main support mechanism for large scale low-carbon electricity generation projects. Successful projects are awarded a long-term contract which secures a price to which they will either be topped up if electricity prices are low, or pay back to if electricity prices are high. |
| Contract for Difference allocation round | The competitive allocation process of CfD contracts. Participants bid the strike price they require to build their project with the cheapest ones winning on a pay-as-clear system. |
| Data triage | A logical step by step process to ensure energy data can be made openly available when it is secure and safe to do so. |
| Decarbonisation | A process of reducing the amount of carbon dioxide we release into the atmosphere. |

| Phrase | Meaning |
|--|--|
| Demand Side Response (Solutions) | Is when consumers adjust their energy usage in response to an external signal. Examples include either reducing it, delaying it, or using on-site generation or storage. DSR was historically provided by large industrial and commercial consumers, but technology development is making it easier for smaller consumers to provide these services for example by charging their electric car with a smart charger. |
| Digitalisation | Is the integration of digital technologies into a process, organisation, or system. For example, smart meters which automatically send meter readings to energy suppliers, meaning more accurate bills for customers. |
| Direct Air Carbon Capture and Storage | Use of engineered processes to capture carbon dioxide (CO ₂) directly from the atmosphere, for storage or use. |
| Dispatchable generation | Is electricity generation that can be turned on, off, up or down as needed. |
| Dispatch signals | A pricing mechanism designed to encourage power stations to produce and send electricity to the grid when it is needed |
| Distribution networks | Regional networks that transport gas or electricity into homes and businesses and import electricity from small-scale generation. |
| Distributed flexibility | Technologies that can deliver flexibility (see flexibility) that are connected to the distribution network across the country. |
| Domestic Load Connection Allowance | The duty that network owners have to provide the first 10 metres of a gas connection free of charge to customers. |
| Downstream Oil and Gas | The industries and processes in which oil and gas are converted into finished products |
| Electricity Capacity | The amount of electrical power a generator can produce when it is running at maximum output. |
| Electricity Generation | Is the total electrical energy created over a period of time. |
| Electricity System | A system consisting of generators, interconnectors, transmission and distribution networks, and storage that deliver electricity to the final consumer (businesses, industry, public sector and homes). As well as the markets and control infrastructure such as smart and digital technologies, that play a key role in making sure the system balances supply and demand. |
| Electrification | Switching from using fuels such as gas or petroleum, to using electricity. For example, switching from a petrol car to an electric car. |

| Phrase | Meaning |
|---------------------------------------|--|
| Emissions Trading System (ETS) | A method of putting a price on emissions. A cap is set on the total amount of certain greenhouse gases that can be emitted by participants. The cap is reduced over time so that total emissions fall. Within the cap, companies receive or buy emission allowances, which they can trade with one another as needed. |
| Energy codes | The detailed technical and commercial rules of the energy system. |
| Energy data | Historical, current, and future information covering things such as how, where and when energy is generated, transported, used, and stored. |
| Energy efficiency | When something performs better using the same amount of energy, or delivers the same performance for less. The principle of energy efficiency can be applied to many things: buildings, products, appliances, manufacturing processes, to name a few. |
| Energy Performance Certificate | Energy Performance Certificates (EPCs) are required in the UK to provide a prospective owner or tenant with information on the energy performance of a building and recommendations for improvement. EPCs use an A-G rating scale based on the modelled energy bill costs of running the building. |
| Engineering standards | The specifications to which the energy system is designed and operated. |
| Flaring | The controlled burning of unwanted or excess natural gases. |
| Flexibility | The ability to change generation and/or demand in response to an external signal (e.g. price or contract terms). Flexibility enabling technologies include batteries, demand side response, interconnectors and fossil fuel generators. |
| Fossil fuels | Oil (and fuels derived from oil), coal and natural gas |
| Fuel poverty | The government definition of fuel poverty is where a household has fuel costs that are above average and, were they to pay that amount, would be left with a residual income below the official poverty line. |
| Gas quality standards | Are rules to ensure that the gases we use, including natural gas, biogas and hydrogen, meet all of the specifications needed to be safe and effective as an energy source. |
| Gas system | A system consisting of gas producers, refineries, interconnectors, transmission and distribution networks that delivers gas from its original sources to the final consumer (businesses, industry, public sector and homes). As well as the physical infrastructure, markets play a key role in making sure the system balances supply and demand. |

| Phrase | Meaning |
|--|--|
| Generation mix | A mix of technologies designed to meet electricity demand. |
| Greenhouse Gas Emissions | Addition to the atmosphere of gases that are a cause of global warming, including carbon dioxide, methane and others. |
| Greenhouse Gas Removal Technologies (or negative emissions) | Methods that actively remove greenhouse gases from the atmosphere, ranging from engineered to nature-based solutions. |
| Gross value added (GVA) | Gross value added is the value generated by any unit engaged in the production of goods and services. |
| Heat network | A heat network, sometimes called district heating, is a system of insulated pipes that takes heat or cooling generated from a central source and distributes it to a number of domestic and non-domestic buildings. |
| Heat pump | A device that extracts heat from the air, ground or water and concentrates it to a higher temperature and delivers it elsewhere, for example to a central heating system. It can replace traditional fossil fuel heating, such as a gas or oil boiler. Heat pump systems are designed to extract a greater amount of heat energy from the surrounding environment than the energy they consume in doing so, therefore they can act as a more efficient source of heat than a conventional electric heater, producing two to three times (or more for very efficient systems) as much heat output as they consume in electricity input. |
| Hybrid interconnector projects | Projects that combine electricity generation with the ability to feed electricity to two (or more) different markets. For example, an offshore wind project that has multiple connections and is able to provide electricity to both the UK market and to European markets. |
| Hydrogen for heat | The combustion of hydrogen produces no long-lived greenhouse gas emissions at point of use, making it a possible low-carbon replacement for natural gas as a fuel source for heating homes and other buildings. |
| Clean hydrogen | Hydrogen that is produced with significantly lower greenhouse gas emissions compared to current methods of production – methods include reacting methane with steam to form hydrogen and then capturing the carbon dioxide by-product (steam methane reformation with CCUS) or using renewable electricity to split water into hydrogen and oxygen (electrolysis). |
| Industrial Sector | Businesses and organisations involved in manufacturing, refining, coke production and mining. |

| Phrase | Meaning |
|---|---|
| Interconnection | Interconnectors are cables or pipes, that transport electricity or gas between different markets internationally. As Great Britain is an island our interconnectors tend to run underneath the sea. |
| Low-carbon electricity generating technologies | Types of electricity generating technologies that emit little or no carbon, which include renewables, nuclear, CCUS. |
| Long-duration storage | Storage technologies capable of storing energy for days, weeks or even seasons. |
| Negative Emission | Achieved by removing greenhouse gases from the atmosphere, for example, through direct air capture or bio-energy production with carbon capture. |
| Net zero | Refers to a point at which the amount of greenhouse gas being put into the atmosphere by human activity in the UK equals the amount of greenhouse gas that is being taken out of the atmosphere. |
| Nuclear fusion | Is the process that powers the sun: the fusing of hydrogen atoms into helium, which releases large amounts of energy. Scientists are developing technology to use this process to provide fusion energy, which could be clean, safe and inexhaustible with no long-lived radioactive waste. |
| Ofgem | The Office for Gas and Electricity Markets (Ofgem) is the independent GB energy regulator for gas and electricity. Its role is to protect consumers now and in the future by working to deliver a greener, fairer energy system. |
| Peaking Capacity | Electricity generators that don't normally operate but are ready to do so when needed at times of peak demand or low generation. |
| Policy costs | Cost on energy bills of programmes to save energy, reduce emissions, and provide financial support to the fuel poor. |
| Price signals | Changes in market price that send messages to consumers and producers about whether to enter or leave a market. For example, rising prices give a signal to consumers to reduce demand, and at the same time they give a signal to potential producers to increase supply. |
| Real-time markets | In the context of energy this is a market which has no, or very little, time between the finalisation of all trading activity and the physical delivery of energy to the customer. This is very difficult to achieve so the phrase "closer-to-real-time" is often used to indicate a direction of travel. |

| Phrase | Meaning |
|--|---|
| Refineries | Industrial facilities which converts crude oil and gas into specific products such as jet fuel or diesel. |
| Renewable Energy | Energy that is collected from resources which are naturally replaced in human timescales such as sunlight, wind, rain, tides and waves. |
| R&D | Research and development: thinking up new ideas and applying them. |
| Regulated Asset Base (RAB) | A type of economic regulation typically used in the UK for monopoly infrastructure assets such as water, gas and electricity networks. The return on a RAB is regulated by an economic regulator. |
| Small Modular Reactors (SMRs) | SMRs are usually based on proven water-cooled reactors similar to current Nuclear Power station reactors, but on a smaller scale. They use nuclear fission to generate low-carbon electricity. SMRs are called modular reactors as their components can be manufactured in factories using innovative techniques and then transported to site to be assembled. |
| Smart charging | Connecting an electric vehicle to the electricity grid using a charging device which includes a data connection. This allows electric vehicles that are plugged in using smart chargers to be charged when it is the most efficient, in terms of cost for the consumer and/or from the point of view of balancing supply and demand across the electricity system. |
| Smart meters | The next generation of gas and electricity meters, which use a secure smart data network to automatically and wirelessly send meter readings to energy suppliers, enable remote topping up of balances for pre-payment customers and near real time energy consumption and expenditure to be visible to domestic energy consumers via an In-Home Display. Smart meters also enable innovations such as time of use tariffs which will help support delivery of our net zero objectives. |
| Strike price | The price a generator bids into a CfD allocation process. The strike price of the last successful project becomes the clearing price, which all successful generators are awarded in their contracts. |
| Suppliers (retail energy suppliers) | Licensed companies that buy gas and electricity primarily in the wholesale market and sell it to energy users including domestic and non-domestic consumers. |
| System constraint | A limit or restriction, which the current system does not have the ability to go beyond. For example, when electricity from a particular location is unable to be transported to the location of demand, due to restrictions on the network. |

| Phrase | Meaning |
|----------------------------------|---|
| System cost | The annualised costs of building and operating the energy system, including generation, transmission and distribution, balancing and carbon costs. |
| System operators | Manage the whole energy system and keep it in balance so that gas and electricity are available when needed. |
| Transmission networks | National networks that transport gas and electricity long distances across Great Britain; the motorways of our energy network. |
| Unabated (gas) generation | Electricity generation where carbon from burning natural gas is not captured and stored. |
| Upstream Oil and Gas | The industries and processes involved in exploration and extraction of oil and gas |
| Vehicle-to-grid | Technologies that allow electric vehicles (and their charging equipment) to export energy back to the electricity grid in response to communications to and from the electricity network. |
| Wholesale costs | The amount energy companies pay to buy gas and electricity |

References

- 1 Slater, T., Hogg, A.E. & Mottram, R. (2020), 'Ice-sheet losses track high-end sea-level rise projections'. *Nat. Clim. Chang.* 10, 879–881. <https://doi.org/10.1038/s41558-020-0893-y>
- 2 Kendon, M., McCarthy, M., Jevrejeva, S., Matthews, A., Sparks, T. and Garforth, J. (2020), State of the UK Climate 2019. *Int J Climatol*, 40: 1-69. <https://doi.org/10.1002/joc.6726>
- 3 CCC (2017), 'UK Climate Change Risk Assessment 2017: Synthesis Report: priorities for the next five years' <https://www.theccc.org.uk/uk-climate-change-risk-assessment-2017/synthesis-report/>
- 4 Robine et al. (2008), 'Death toll exceeded 70,000 in Europe during the summer of 2003', *Comptes Rendus Biologies*: <https://www.sciencedirect.com/science/article/pii/S1631069107003770?via%3Dihub>
- 5 CCC (2017), 'UK Climate Change Risk Assessment 2017: Synthesis Report: priorities for the next five years' <https://www.theccc.org.uk/uk-climate-change-risk-assessment-2017/synthesis-report/>
- 6 Paris Agreement (2015), <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>
- 7 UN Environment Programme (2019), 'Emissions Gap Report 2019', <https://www.unenvironment.org/resources/emissions-gap-report-2019>
- 8 HM Treasury (2006), 'Stern Review: The Economics of Climate Change', https://webarchive.nationalarchives.gov.uk/20100407172811/http://www.hm-treasury.gov.uk/stern_review_report.htm
- 9 Arnell, N.W., Lowe, J.A., Challinor, A.J. et al. Global and regional impacts of climate change at different levels of global temperature increase. *Climatic Change* 155, 377–391 (2019). <https://doi.org/10.1007/s10584-019-02464-z>
- 10 Naumann, G., Alfieri, L., Wyser, K., Mentaschi, L., Betts, R. A., Carrao, H., et al. (2018). Global changes in drought conditions under different levels of warming. *Geophysical Research Letters*, 45, 3285–3296. <https://doi.org/10.1002/2017GL076521>
- 11 Figure based on RCP4.5 projection for London from the UKCP18 Marine Projections. Projections for RCP6.0 (a 3°C scenario) are very similar and not reported for this reason in UKCP18 (see UKCP18 Overview Report, and Chapter 13, IPCC Fifth Assessment Report, Working Group 1). <https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Overview-report.pdf>
- 12 Alfieri, L.; Dottori, F.; Betts, R.; Salamon, P.; Feyen, L. Multi-Model Projections of River Flood Risk in Europe under Global Warming. *Climate* 2018, 6, 6., <https://www.mdpi.com/2225-1154/6/1/6#cite>
- 13 ASC (2016) UK Climate Change Risk Assessment 2017 Synthesis Report: priorities for the next five years. Adaptation Sub-Committee of the Committee on Climate Change, London.
- 14 IPCC, 2014. Section TS 5.5.1. Technical Summary. *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the IPCC*.
- 15 European Commission, 'Final Report Summary - HELIX (High-End cLimate Impacts and eXtremes)', <https://cordis.europa.eu/project/id/603864/reporting>, accessed 07/12/2020
- 16 IPCC, 2019. Chapter 4- Executive Summary. Special Report on the Ocean and Cryosphere in a Changing Climate.
- 17 CCC (2017), 'UK Climate Change Risk Assessment 2017 Evidence Report', <https://www.theccc.org.uk/uk-climate-change-risk-assessment-2017/synthesis-report/>
- 18 Data. World Bank, UNFCCC National Inventory Submissions, ONS, BEIS Greenhouse Gas Inventory. Note: Data are provided for 1990-2018.
- 19 The 2019 figures are provisional estimates. BEIS (2020), 'Provisional UK greenhouse gas emissions national statistics 2019', <https://www.gov.uk/government/statistics/provisional-uk-greenhouse-gas-emissions-national-statistics-2019>
- 20 Elexon Portal, <https://www.elexonportal.co.uk/article/view/7324?cachebust=0hmjyrt3qx>, accessed 26/08/2020
- 21 BEIS (2020), Energy Trends table 6.1, <https://www.gov.uk/government/statistics/energy-trends-section-6-renewables>
- 22 BEIS (2020), Energy Trends table 5.1, <https://www.gov.uk/government/statistics/electricity-section-5-energy-trends>
- 23 BEIS (2020), 'Contracts for Difference (CfD) Allocation Round 3: results', <https://www.gov.uk/government/publications/contracts-for-difference-cfd-allocation-round-3-results>. Reduction of clearing prices calculated using AR1 and AR3 clearing prices.
- 24 EnergieKontor (2018), 'Energiekontor realises Witherwick II – the first wind project without state

- subsidies in the UK', <https://www.energiekontor.de/en/news/energiekontor-realises-withernwick-ii-the-first-wind-project-without-state-subsidies-in-the-uk.html> accessed 01/12/2020
- 25 CCC (2018), 'UK Housing: fit for the future?', <https://www.theccc.org.uk/publication/uk-housing-fit-for-the-future/>
 - 26 HM Treasury (2020), 'National Infrastructure Strategy', <https://www.gov.uk/government/publications/national-infrastructure-strategy>
 - 27 ONS (2020), 'Low Carbon and Renewable Energy Economy (LCREE) Survey direct and indirect estimates of employment, UK, 2014 to 2018', <https://www.ons.gov.uk/economy/environmentalaccounts/adhocs/11120lowcarbonandrenewableenergyeconomy/lcreeesurveydirectandindirectestimatesofemploymentuk2014to2018>
 - 28 Climate Watch, Historical GHG Emissions, <https://www.climatewatchdata.org/ghg-emissions?regions=WORLD%2CGBR> accessed 14/10/20
 - 29 COP25, Climate Ambition Alliance Press Release, <https://cop25.mma.gob.cl/en/climate-ambition-alliance/>, accessed 14/10/2020
 - 30 The Ten Point Plan additionally covers jobs created in public transport, aviation, shipping and natural environment sectors. We have not included these in our estimates, instead focusing on jobs created directly or indirectly within energy.
 - 31 Quoted savings based on a medium consumption as defined by Ofgem (3,100 kWh of electricity, 12,000 kWh of gas). Consumption savings based on shifting 75 per cent of electricity consumption to off peak times. <https://octopus.energy/agile/>
 - 32 Ofgem, 'Typical Domestic Consumption Values', <https://www.ofgem.gov.uk/gas/retail-market/monitoring-data-and-statistics/typical-domestic-consumption-values>, accessed 13/10/2020.
 - 33 Figure 2.1 – Average domestic dual fuel bills. Additional costs from the White Paper include: CfD uplift costs from increased renewables ambition; network reinforcement costs; Energy Company Obligation 4; Green Gas Levy; Warm Home Discount extension; Green Home Grants; Home Upgrade Grants; Social Housing Decarbonisation Fund; and changes to regulations in the housing lending and rented sectors. The impact of additional heat pump deployment has not been included as policy detail is still being developed; the bills impact of financing new nuclear beyond Hinkley Point C has not been included while our approach is in development. This also assumes that ECO support costs continue beyond 2026 despite the policy landscape still under development and additional efficiency benefits beyond ECO 4 have not been quantified. This is a central scenario based on an electrified system as the costs of hydrogen are considered too uncertain at present to include in future estimates of household bills. Figures will differ depending on several variables including wholesale gas prices, behavioural changes, outcomes of future Capacity Market and CfD auctions and additional policy decisions. This is based on an average bill for a dual fuel household – actual bills will vary depending on household characteristics and energy behaviour.
 - 34 BEIS (2020), 'Annual Domestic Energy bills', tables 2.2.5 and 2.3.5, <https://www.gov.uk/government/statistical-data-sets/annual-domestic-energy-price-statistics>.
 - 35 The Energy Company Obligation is an energy efficiency scheme under which obligated suppliers must mainly promote measures which improve the ability of low income, fuel poor and vulnerable households to heat their homes.
 - 36 The Warm Home Discount is an obligation on energy suppliers with at least 150,000 customer accounts to provide £150 energy bill rebates to eligible low income and vulnerable households each winter.
 - 37 BEIS Analysis, based on an average domestic dual fuel bill in 2030
 - 38 Climate Assembly UK (2020), 'The path to net zero: Underpinning Principles', <https://www.climateassembly.uk/report/read/underpinning-principles.html>
 - 39 Ofgem (2020), 'Electricity Retail Market-wide Half-hourly Settlement: Draft Impact Assessment Consultation', <https://www.ofgem.gov.uk/publications-and-updates/electricity-retail-market-wide-half-hourly-settlement-draft-impact-assessment-consultation>
 - 40 Ofgem, 'Number of domestic gas customer accounts by supplier', <https://www.ofgem.gov.uk/data-portal/number-domestic-gas-customer-accounts-supplier-excluding-pre-payment-customers-standard-variable-fixed-and-other-tariffs-gb>
 - 41 It should be noted that there are some consumers on default tariffs who actively choose to stay on these tariffs with their current supplier.
 - 42 A summary of these findings and links to the individuals trials is available here: <https://www.ofgem.gov.uk/publications-and-updates/what-works-icreasing-engagement-energy-tariff-choices>
 - 43 <https://www.ofgem.gov.uk/publications-and-updates/ofgems-collective-switch-trials> The (DECC run) Government's 2013 Cheaper Energy Together fund also showed the success of Collective Switching schemes: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/253862/Helping_Customers_Switch_Collective_Switching_and_Beyond_final__2_.pdf
 - 44 Ofgem and BEIS (2019), 'Flexible and responsive energy retail markets', <https://www.>

- gov.uk/government/consultations/flexible-and-responsive-energy-retail-markets
- 45 <https://www.ofgem.gov.uk/publications-and-updates/what-works-increasing-engagement-energy-tariff-choices>
- 46 BEIS analysis of BEIS (2020), Final UK greenhouse gas emissions national statistics: 1990 to 2018, <https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2018>
- 47 BEIS (2020), DUKES, table 5.1.3, <https://www.gov.uk/government/statistics/electricity-chapter-5-digest-of-united-kingdom-energy-statistics-dukes>
- 48 BEIS (2020), Energy Trends, table 5.1, <https://www.gov.uk/government/statistics/electricity-section-5-energy-trends>
- 49 BEIS (2020), Energy Trends, table 6.1, <https://www.gov.uk/government/statistics/energy-trends-section-6-renewables>
- 50 BEIS (2020), BEIS Electricity Generation Costs, <https://www.gov.uk/government/publications/beis-electricity-generation-costs-2020>
- 51 BEIS (2020), 'Early phase out of unabated coal generation in Great Britain', <https://gov.uk/government/consultations/early-phase-out-of-unabated-coal-generation-in-great-britain>
- 52 BEIS (2020), Energy Trends, table 1.3, <https://www.gov.uk/government/statistics/total-energy-section-1-energy-trends>
- 53 BEIS (2020), 'Final UK greenhouse gas emissions national statistics: 1990 to 2018', <https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2018>
- 54 BEIS (2020), 'Modelling 2050: Electricity System Analysis', <https://gov.uk/government/publications/modelling-2050-electricity-system-analysis>
- 55 BEIS (2019), 'Contracts for Difference (CfD) Allocation Round 3: results', <https://www.gov.uk/government/publications/contracts-for-difference-cfd-allocation-round-3-results>
- 56 DECC (2013), 'Record investments of £40 billion in renewable electricity to bring green jobs and growth to the UK' <https://www.gov.uk/government/news/record-investments-of-40-billion-in-renewable-electricity-to-bring-green-jobs-and-growth-to-the-uk>
- 57 BEIS (2020), Call for Evidence on Renewable Support, <https://www.gov.uk/government/consultations/enabling-a-high-renewable-net-zero-electricity-system-call-for-evidence>
- 58 BEIS (2020), 'Business models for carbon capture, usage and storage: government response', <https://www.gov.uk/government/consultations/carbon-capture-usage-and-storage-ccus-business-models>
- 59 BEIS (2020), Energy Trends, table 5.1, <https://www.gov.uk/government/statistics/electricity-section-5-energy-trends>
- 60 BEIS (2018), 'Hinkley Point C wider benefits realisation plan' <https://www.gov.uk/government/publications/hinkley-point-c-wider-benefits-realisation-plan>
- 61 BEIS (2020), Ten point plan for a green industrial revolution, <https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution>
- 62 BEIS (2018), Nuclear Sector Deal, <https://www.gov.uk/government/publications/nuclear-sector-deal>
- 63 BEIS (2019), 'Regulated Asset Base (RAB) model for nuclear', <https://www.gov.uk/government/consultations/regulated-asset-base-rab-model-for-nuclear>
- 64 BEIS (2020), Government response to RAB model consultation on nuclear <https://www.gov.uk/government/consultations/regulated-asset-base-rab-model-for-nuclear>
- 65 National Nuclear Laboratory (2014), 'Small Modular Reactors (SMR) Feasibility Study', <https://namrc.co.uk/wp-content/uploads/2015/01/smr-feasibility-study-december-2014.pdf>
- 66 UK Atomic Energy Authority (2020), STEP, <https://step.ukaea.uk/>
- 67 Estimate updated to 2020 prices. Vivid Economics (2019), 'Energy Innovation Needs Assessment: overview', <https://www.gov.uk/government/publications/energy-innovation-needs-assessments>
- 68 CCC (2019), 'Net Zero – Technical Report', <https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/>
- 69 Prime Minister's Office, 10 Downing Street (2020), 'PM: A new deal for Britain', <https://www.gov.uk/government/news/pm-a-new-deal-for-britain>
- 70 BEIS (2020), Greenhouse gas removals: call for evidence, <https://www.gov.uk/government/consultations/greenhouse-gas-removals-call-for-evidence>
- 71 BEIS (2020), Offshore wind manufacturing investment support scheme, <https://www.gov.uk/government/publications/offshore-wind-manufacturing-investment-support-scheme>
- 72 BEIS (2020), Offshore Wind Sector Deal, <https://www.gov.uk/government/publications/offshore-wind-sector-deal/offshore-wind-sector-deal>
- 73 BEIS analysis of Vivid Economics (2019), 'Offshore

- 100 <https://www.gov.uk/government/publications/storage-cost-and-technical-assumptions-for-electricity-storage-technologies>
- 101 Kaluza, 'Kaluza Intelligently Controls Home Batteries to Support Local WPD Network in UK First', <https://www.kaluza.com/kaluza-intelligently-controls-home-batteries-to-support-local-wpd-network-in-uk-first/> The Association for Decentralised Energy, 'Kiwi Power and Social Energy join UK Power Networks' Flexibility portfolio', <https://www.theade.co.uk/news/market-news/kiwi-power-and-social-energy-join-uk-power-networks-flexibility-portfolio>
- 102 National Grid ESO, Capacity Market Registers, <https://www.emrdeliverybody.com/CM/Registers.aspx>, accessed 04/10/2020
- 103 BEIS (2019), 'Capacity Market: Five-year Review (2014 to 2019)', <https://www.gov.uk/government/publications/capacity-market-5-year-review-2014-to-2019>
- 104 Figures published by the Energy Networks Association as part of their Gas Goes Green programme (2020), <https://www.energynetworks.org/newsroom/gas-networks-set-to-slash-grid-emissions-as-new-figures-show-equivalent-of-500-000-cars-to-be-taken-off-the-road>
- 105 BEIS (2019), 'Sub-national estimates of properties not connected to the gas network', <https://www.gov.uk/government/statistics/sub-national-estimates-of-households-not-connected-to-the-gas-network>
- 106 Ofgem (2018), 'Network Price Controls and you: Fast facts', <https://www.ofgem.gov.uk/publications-and-updates/network-price-controls-and-you-fast-facts>
- 107 <https://www.gov.uk/government/publications/climate-change-adaptation-reporting-third-round>
- 108 Based on the lower range of savings from counterfactual #3, with values updated to 2020 prices from 2014/15 prices. Ofgem (2016), 'Evaluation of OFTO Tender Round 2 and 3 Benefits', <https://www.ofgem.gov.uk/publications-and-updates/evaluation-of-to-tender-round-2-and-3-benefits>
- 109 Highways England (2017), 'Strategic Road Network Initial Report', <https://www.gov.uk/government/publications/highways-englands-strategic-road-network-initial-report>
- 110 OLEV (2020). 'Government Visions for the rapid chargepoint network in England'. <https://www.gov.uk/government/publications/government-vision-for-the-rapid-chargepoint-network-in-england/government-vision-for-the-rapid-chargepoint-network-in-england>
- 111 BEIS (2020), 'Letter to Ofgem on RII0 Ed 2 related energy policies', <https://gov.uk/government/publications/letter-to-ofgem-on-rii0-ed2-related-energy-policies>
- 112 Aurora as commissioned by BEIS, (2020), 'The impact of interconnectors on decarbonisation', <https://www.gov.uk/government/publications/the-impact-of-interconnectors-on-decarbonisation>
- 113 BEIS (2020), 'Offshore transmission network review', <https://www.gov.uk/government/publications/offshore-transmission-network-review>
- 114 National Grid ESO (2020) 'Offshore Coordination Consultation: <https://www.nationalgrideso.com/document/177296/download>
- 115 Energy Data Taskforce (2019), 'A strategy for a Modern Digitalised Energy System', <https://es.catapult.org.uk/reports/energy-data-taskforce-report/>
- 116 DCMS (2020), 'UK National Data Strategy', <https://www.gov.uk/government/publications/uk-national-data-strategy>
- 117 Modernising energy data access (MEDA): <https://innovateuk.blog.gov.uk/2020/05/29/modernising-energy-data-access-and-the-winners-are>, and Modernising energy data applications (MEDApps) <https://innovateuk.blog.gov.uk/2020/10/05/modernising-energy-data-applications>
- 118 Final energy use: BEIS (2020), Energy Trends, Table 1.3, <https://www.gov.uk/government/statistics/total-energy-section-1-energy-trends> Electricity generation: BEIS (2020), Energy Trends, Table 5.1, <https://www.gov.uk/government/statistics/electricity-section-5-energy-trends>
- 119 2019 Consultation on Reforming Energy Codes, <https://www.gov.uk/government/consultations/reforming-the-energy-industry-codes>. This consultation was published as part of the joint BEIS and Ofgem Energy Codes Review, <https://www.ofgem.gov.uk/publications-and-updates/energy-codes-review>
- 120 BEIS (2020), 'Electrical engineering standards: Independent review', <https://www.gov.uk/government/publications/electrical-engineering-standards-independent-review>
- 121 BEIS (2020), '2018 UK greenhouse gas emissions: final figures - data tables', <https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2018>
- 122 DfT (2020), 'Decarbonising Transport: Setting the Challenge', <https://www.gov.uk/government/publications/creating-the-transport-decarbonisation-plan>
- 123 ACEA (2020), <https://www.acea.be/press-releases/article/fuel-types-of-new-cars-petrol-47.5-hybrids-12.4-electric-9.9-market-share-t> - accessed 23/11/2020
- 124 EAFO (2020), <https://www.eafo.eu/vehicles-and-fleet/m1> - accessed 23/11/2020 To access


- the data, please select 'Electricity' for the fuel filter, 'EU+UK+EFTA+Turkey' for the region/countries filter, and '2019' for the Date filter. Then, scroll down to the pie chart titled 'TOP 10 MODELS NEW REGISTRATIONS Electricity (2019)' and select 'BEV' in the categories filter
- 125 DfT (2020), 'Ultra-low emissions vehicles (ULEVs) - VEH0130', <https://www.gov.uk/government/statistical-data-sets/all-vehicles-veh01>
 - 126 SSE Enterprise (2020), 'Bus2Grid', <https://www.sseutilitiesolutions.co.uk/products/bus2grid-2/> - accessed on 02/12/2020
 - 127 DfT (2020), 'Union connectivity review: call for evidence', <https://www.gov.uk/government/consultations/union-connectivity-review-call-for-evidence/union-connectivity-review-call-for-evidence#about-the-call-for-evidence>
 - 128 BEIS analysis of BEIS (2020), 'Final UK greenhouse gas emissions national statistics: 1990 to 2018', <https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2018>
 - 129 BEIS analysis of BEIS (2020), 'Final UK greenhouse gas emissions national statistics: 1990 to 2018', <https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2018>
 - 130 MHCLG (2020), 'English Housing Survey 2018: energy report' <https://www.gov.uk/government/statistics/english-housing-survey-2018-energy-report>
 - 131 BEIS (2019), 'Sub-national estimates of properties not connected to the gas network', <https://www.gov.uk/government/statistics/sub-national-estimates-of-households-not-connected-to-the-gas-network>
 - 132 BEIS (2019), 'Sub-national electricity and gas consumption summary report 2018', <https://www.gov.uk/government/statistics/sub-national-electricity-and-gas-consumption-summary-report-2018>
 - 133 BEIS analysis
 - 134 BEIS (2020), Final UK greenhouse gas emissions national statistics: 1990 to 2018, <https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2018>
 - 135 MHCLG (2020), English Housing Survey 2018: stock condition, <https://www.gov.uk/government/statistics/english-housing-survey-2018-stock-condition>
 - 136 MHCLG (2020), 'English Housing Survey 2018: energy report, table AT1.5', <https://www.gov.uk/government/statistics/english-housing-survey-2018-energy-report>
 - 137 BEIS (2016), 'Building Energy Efficiency Survey (BEES)', <https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees>
 - 138 BEIS (2018), Digest of UK Energy Statistics, Table 1.1, <https://www.gov.uk/government/statistics/energy-chapter-1-digest-of-united-kingdom-energy-statistics-dukes:Commercial+public+administration+miscellaneous+sectors,as+a+share+of+Other+final+energy+consumption>
 - 139 BEIS (2016), 'BEES Overarching Tables', tables C.1 and B.4, <https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees>
 - 140 BEIS (2020), Transforming heat: public attitudes research, <https://www.gov.uk/government/publications/transforming-heat-public-attitudes-research>
 - 141 MHCLG (2019), 'The Future Homes Standards: changes to Part L and Part F of the Building Regulations for new dwellings', <https://www.gov.uk/government/consultations/the-future-homes-standard-changes-to-part-l-and-part-f-of-the-building-regulations-for-new-dwellings>
 - 142 DfT (2019), 'Electric vehicle chargepoints in residential and non-residential buildings' <https://www.gov.uk/government/consultations/electric-vehicle-chargepoints-in-residential-and-non-residential-buildings>
 - 143 BEIS (2020), 'Green Homes Grant Local Authority Delivery scheme, Phase 1B: entering a bid', <https://www.gov.uk/government/publications/green-homes-grant-local-authority-delivery-scheme-entering-a-bid>
 - 144 BEIS (2020), 'Greener homes, jobs and cheaper bills on the way as government launches biggest upgrade of nation's buildings in a generation', <https://www.gov.uk/government/news/greener-homes-jobs-and-cheaper-bills-on-the-way-as-government-launches-biggest-upgrade-of-nations-buildings-in-a-generation>
 - 145 BEIS (2020), 'Improving the energy performance of privately rented homes', <https://www.gov.uk/government/consultations/improving-the-energy-performance-of-privately-rented-homes>
 - 146 Updated to 2020 prices from 2018 prices. BEIS (2020), 'Improving the energy performance of privately rented homes in England and Wales: Consultation Stage Impact Assessment', <https://www.gov.uk/government/consultations/improving-the-energy-performance-of-privately-rented-homes>
 - 147 MHCLG (2020), English Housing Survey 2018: energy report, table AT2.7, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/859758/2018-19_Section_2_Housing_Stock_Annex_Tables.xlsx
 - 148 HM Treasury (2020), 'A Plan for Jobs 2020', <https://www.gov.uk/government/publications/a-plan-for-jobs-documents/a-plan-for-jobs-2020>
 - 149 BEIS analysis

- 150 BEIS analysis
- 151 BEIS estimates – savings in relation to having no products policy measures
- 152 BEIS (2016), 'Building Energy Efficiency Survey (BEES)', table 3.9, <https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees>
- 153 BEIS (2016), 'Building Energy Efficiency Survey (BEES)', table 3.11, <https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees>
- 154 BEIS (2020), 'Final UK greenhouse gas emissions national statistics: 1990 to 2018', <https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2018>
- 155 BEIS (2020), 'Public Sector Decarbonisation Scheme (PSDS)', <https://www.gov.uk/government/publications/public-sector-decarbonisation-scheme-psds>
- BEIS (2020), 'Household Energy Efficiency Statistics, headline release November 2020', <https://www.gov.uk/government/statistics/household-energy-efficiency-statistics-headline-release-november-2020>
- 156 BEIS (2020), 'Household Energy Efficiency Statistics, headline release November 2020', <https://www.gov.uk/government/statistics/household-energy-efficiency-statistics-headline-release-november-2020>
- 157 BEIS (2018), 'ECO3: 2018-2022 - final stage Impact Assessment', <https://www.gov.uk/government/consultations/energy-company-obligation-eco3-2018-to-2022>
- 158 The scheme will be worth £475 million in 2020 prices, rising with inflation.
- 159 BSRIA (2020). 'UK Domestic boilers market analysis', https://www.bsria.com/uk/product/nEjGED/domestic_boilers_world_market_for_heating_boilers_2020r2019_8a707622/
- 160 MHCLG (2020), Table AT2.1, 'English Housing Survey 2018: energy report' <https://www.gov.uk/government/statistics/english-housing-survey-2018-energy-report>
- 161 Assuming replacement rate of once every 15-20 years with a total stock of 1.1m households in England using fossil fuel heating off the gas grid
- 162 BEIS (2020), 'Heat Pump Manufacturing Supply Chain Research Project', <https://gov.uk/government/publications/heat-pump-manufacturing-supply-chain-research-project>
- 163 BEIS (2020), 'Consultation Stage IA: Future Support for Low Carbon Heat', <https://www.gov.uk/government/consultations/future-support-for-low-carbon-heat>
- 164 Ofgem, 'Typical Domestic Consumption Values', <https://www.ofgem.gov.uk/gas/retail-market/monitoring-data-and-statistics/typical-domestic-consumption-values>, accessed 21/10/2020
- 165 BEIS (2018), 'Energy Trends: March 2018, special feature article - Experimental statistics on heat networks', <https://www.gov.uk/government/publications/energy-trends-march-2018-special-feature-article-experimental-statistics-on-heat-networks>
- 166 Energy Efficiency EEIG (2020), 'Rebuilding for resilience: Energy efficiency's offer for a net zero compatible stimulus and recovery', <https://www.theeeig.co.uk/news/starstarnew-reportstarstar-rebuilding-for-resilience-energy-efficiency-s-offer-for-a-net-zero-compatible-stimulus-and-recovery/>
- 167 HM Treasury (2020), 'Chancellor's Plan for Jobs to help the UK's recovery', <https://www.gov.uk/government/news/rishis-plan-for-jobs-will-help-britain-bounce-back>
- 168 Grantham Research Institute on Climate Change and the Environment (2019), 'Policy brief: Investing in a just transition in the UK', https://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2019/02/Investing-in-a-just-transition-in-the-UK_policy-brief_8pp-1.pdf
- 169 ONS (2020), 'EMP14: Employees and self-employed by industry', <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/employeesandselfemployedbyindustryemp14>
- 170 BEIS (2020), 'Green Homes Grant skills training competition', <https://www.gov.uk/government/publications/green-homes-grant-skills-training-competition>
- 171 CCC (2019), Net Zero - Technical Report, <https://www.theccc.org.uk/publication/net-zero-technical-report/>. Reduction based on the 'Further Ambition' scenario for industry.
- 172 GVA and employment statistics: ONS (2020), 'Non-financial business economy, UK: Sections A to S', <https://www.ons.gov.uk/businessindustryandtrade/business/businessservices/datasets/uknonfinancialbusinesseconomyannualbusinesssurveysections> as Export statistics: ONS (2020), 'UK trade: goods and services publication tables', tables 1 and 3, <https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/datasets/uktradegoodsandservicepublicationtables>. Industry is defined as SITC 5-8.
- 173 ONS (2019), 'Business Register and Employment Survey', <https://www.nomisweb.co.uk/query/construct/summary.asp?mode=construct&version=0&dataset=189>
- 174 BEIS analysis of BEIS (2020), 'Supplementary tables: 2018 UK greenhouse gas emissions by Standard Industrial Classification (alternative format)', <https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2018> 'Manufacturing and Refining' are defined as group c; refining; coke; and mining and quarrying.

- 175 BEIS (2018), 'Energy Consumption in the UK' table 4.08 <https://www.gov.uk/government/statistics/energy-consumption-in-the-uk>
- 176 National Atmospheric Emissions Inventory, <https://naei.beis.gov.uk/data/map-large-source>, accessed 16/10/2020 Vivid Economics (2019), 'Industry (EINA sub-theme)', <https://www.gov.uk/government/publications/energy-innovation-needs-assessments>
- 177 TCE (2019), 'News Release: Tata Chemicals Europe to Build UK's Largest Carbon Capture & Use Plant', <https://www.tatachemicalseurope.com/news-release-tata-chemicals-europe-build-uks-largest-carbon-capture-use-plant>
- 178 BEIS analysis comparing potential CCUS salaries with ONS stats on salaries for 'energy plant operatives', and 'chemical and related process operatives'. Vivid Economics (2019), 'Carbon capture, usage and storage (EINA sub-theme)', <https://www.gov.uk/government/publications/energy-innovation-needs-assessments>. ONS (2020), 'Employee earnings in the UK: 2020', Figure 6, <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/bulletins/annualsurveyofhoursandearnings/2020>
- 179 Energy Technologies Institute (2017), 'Taking stock of UK CO₂ Storage', [https://www.eti.co.uk/insights/taking-stock-of-uk-CO₂-storage](https://www.eti.co.uk/insights/taking-stock-of-uk-CO2-storage)
- 180 BEIS analysis based on EINA methodology Vivid Economics (2019), 'Energy Innovation Needs Assessments', <https://www.gov.uk/government/publications/energy-innovation-needs-assessments>
- 181 TCE (2019), 'News Release: Tata Chemicals Europe to Build UK's Largest Carbon Capture & Use Plant', <https://www.tatachemicalseurope.com/news-release-tata-chemicals-europe-build-uks-largest-carbon-capture-use-plant>
- 182 HM Treasury (2020), 'Budget 2020', <https://www.gov.uk/government/publications/budget-2020-documents>
- 183 BEIS analysis based on EINA methodology. Vivid Economics (2019), 'Carbon capture, usage and storage (EINA sub-theme)', <https://www.gov.uk/government/publications/energy-innovation-needs-assessments>
- 184 CCC (2018), 'Hydrogen in a low-carbon economy', <https://www.theccc.org.uk/publication/hydrogen-in-a-low-carbon-economy/>
- 185 Energy Research Partnership (2016), Role of hydrogen in the UK Energy System, <http://erpuk.org/wp-content/uploads/2016/10/ERP-Hydrogen-report-Oct-2016.pdf>; CCC (2018), Hydrogen in a low-carbon economy, <https://www.theccc.org.uk/wp-content/uploads/2018/11/Hydrogen-in-a-low-carbon-economy.pdf>
- 186 CCC (2019), 'Net Zero – Technical Report', <https://www.theccc.org.uk/publication/net-zero-technical-report/>
- 187 BEIS analysis based on EINA methodology. Vivid Economics (2019), 'Hydrogen and fuel cells (EINA sub-theme)', <https://www.gov.uk/government/publications/energy-innovation-needs-assessments>
- 188 World Bank, Carbon Pricing Dashboard, https://carbonpricingdashboard.worldbank.org/map_data, accessed 02/11/2020
- 189 HMRC (2020), 'Non Structural Tax Reliefs', <https://www.gov.uk/government/statistics/main-tax-expenditures-and-structural-reliefs>
- 190 BEIS (2019) Energy Trends Table 4.1, <https://www.gov.uk/government/statistics/gas-section-4-energy-trends>
- 191 GVA: ONS (2020), 'GDP output approach – low-level aggregates', tab CVM £million, <https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/ukgdpolowlevelaggregates> Taxes: OGA (2020), Government revenues from UK oil and gas production in 2019-2020 prices <https://www.ogauthority.co.uk/exploration-production/taxation/government-revenues-from-uk-oil-and-gas-production/>
- 192 OGUK (2019), Workforce report, <https://oilandgasuk.co.uk/wp-content/uploads/2019/08/Workforce-Report-2019.pdf>
- 193 OGA (2020), UK Oil and Gas Reserves and Resources 2018, <https://www.ogauthority.co.uk/data-centre/data-downloads-and-publications/reserves-and-resources/>
- 194 OGA (2020), OGA oil and gas production projections, table 4Others, <https://www.ogauthority.co.uk/media/6407/oga-production-and-beis-demand-projections-february-2020.xlsx>
- 195 CCC (2019), Net Zero – The UK's contribution to stopping global warming, <https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/>
- 196 Bloomberg tracker for Brent Crude
- 197 OGUK (2020), Business Outlook Report: Activity and Supply chain, <https://oilandgasuk.co.uk/wp-content/uploads/2020/05/OGUK-Business-Outlook-2020-Report-Activity-and-Supply-Chain.pdf>
- 198 OGUK (2020), Workforce insight <https://oilandgasuk.cld.bz/Workforce-Insight-2020/4/>
- 199 Multiple sources <https://www.ft.com/content/83b4ba6b-bef9-45d3-a6fb-087ef3143a43>; <https://www.dw.com/en/oil-giants-face-shareholder-pressure-on-climate-emissions-greenhouse-gas-targets/a-48802418>; <https://www.theguardian.com/environment/2020/jan/09/blackrock-joins-pressure-group-taking-on-biggest-polluters>

- <https://www.reuters.com/article/us-climate-change-oil-shareholders-idUSKBN1YJ0OR>
- 200 bp, Shell and Equinor strategies [last accessed 06/11/2020] <https://www.bp.com/en/global/corporate/who-we-are/our-ambition.html> ; <https://www.shell.com/energy-and-innovation/new-energies.html> ; <https://www.equinor.com/en/what-we-do/renewables.html>
- 201 BEIS (2020), 'The Ten Point Plan for a green industrial revolution', <https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution>
- 202 Woodplc (2014) Annual report, https://www.woodplc.com/__data/assets/pdf_file/0023/36266/John-Wood-Group-Plc-Annual-Report-and-Accounts-2014.pdf Woodplc (2020) Half year report, https://www.woodplc.com/__data/assets/pdf_file/0018/130068/Half-Year-Report-2020.pdf
- 203 OGUK (2019), 'Business Outlook Report 2019', <https://oilandgasuk.co.uk/wp-content/uploads/2019/03/OGUK-Business-Outlook-Report-2019.pdf>
- 204 UKPIA (2020) Transition, Transformation, and Innovation: Our role in the Net-Zero Challenge, <https://online.flippingbook.com/view/111037/Woodplc> (2014) Annual report, https://www.woodplc.com/__data/assets/pdf_file/0023/36266/John-Wood-Group-Plc-Annual-Report-and-Accounts-2014.pdf Woodplc (2020) Half year report, https://www.woodplc.com/__data/assets/pdf_file/0018/130068/Half-Year-Report-2020.pdf
- 205 NAEI, <https://naei.beis.gov.uk/data/>, accessed 03/11/2020. Estimate based off of all activities from Upstream Oil & Upstream Gas.
- 206 OGUK (2019), 'Economic Report 2019', <https://oilandgasuk.co.uk/product/economic-report/>
- 207 OGUK, 'Roadmap 2035', <https://roadmap2035.co.uk/>
- 208 OGUK (2020), Pathway to a Net-Zero Basin: Production Emissions Targets, <https://oilandgasuk.cld.bz/OGUK-Pathway-to-a-Net-Zero-Basin-Production-Emissions-Targets-Report-2020>
- 209 World Bank and NOAA (2020), 'Global Gas Flaring Tracker Report', <http://pubdocs.worldbank.org/en/503141595343850009/WB-GGFR-Report-July2020.pdf>
- 210 OGA (2020), UKCS Flaring and Venting 2020 report, <https://ogauthorityreports.wixsite.com/ukcs-f-v-report-2020>
- 211 Acorn Project (2019), Infrastructure Reuse and Decommissioning, https://actacorn.eu/sites/default/files/Infrastructure_Poster2.pdf
- 212 BEIS (2020), Re-use of oil and gas assets for carbon capture, usage and storage projects – government response <https://www.gov.uk/government/consultations/carbon-capture-usage-and-storage-ccus-projects-re-use-of-oil-and-gas-assets>
- 213 OGA (2020), 'Consultation on new OGA Strategy', <https://www.ogauthority.co.uk/news-publications/consultations/2020/consultation-on-new-oga-strategy/>
- 214 Turnover: Adjusted to 2020 prices. EY (2020), Review of the UK oilfield services industry, https://assets.ey.com/content/dam/ey-sites/ey-com/en_uk/news/2020/02/ey-review-of-the-uk-oilfield-services-industry.pdf Employment: OGUK (2019), Workforce report, Figure 1 <https://oilandgasuk.co.uk/wp-content/uploads/2019/08/Workforce-Report-2019.pdf>
- 215 OGUK (2018), Decommissioning Insight, <https://oilandgasuk.co.uk/wp-content/uploads/2019/11/OGUK-Decommissioning-Insight-2019.pdf>
- 216 Wood Mackenzie (2018), Upstream decommissioning – where's next and who pays? <https://www.woodmac.com/reports/upstream-oil-and-gas-upstream-decommissioning-wheres-next-and-who-pays-22918>
- 217 Wood Mackenzie (2017), US\$32 billion of decommissioning worldwide over the next five years: is the industry ready? <https://www.woodmac.com/reports/upstream-oil-and-gas-us32-billion-of-decommissioning-worldwide-over-the-next-five-years-is-the-industry-ready-9599>
- 218 Subsea UK (2019), Into the Blue – UK Subsea Business Activity Review, <https://www.subseauk.com/documents/documents2019/uk%20subsea%20business%20activity%20review%202019%20-%20full%20report.pdf>
- 219 Climate watch (2020), Global historic emissions up to 2016, <https://www.climatewatchdata.org/ghg-emissions?regions=WORLD%20GBR>
- 220 BEIS (2020), Digest of UK Energy Statistics, Chapter 3 <https://www.gov.uk/government/statistics/petroleum-chapter-3-digest-of-united-kingdom-energy-statistics-dukes>





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