



POWERING THE FUTURE

RenewableUK's Vision of the Transition

SUMMARY REPORT 2020

CONTENTS

00 INTRO **01 BUILDING OUR ENERGY SUPPLY AROUND RENEWABLE SOURCES** **02 DECARBONISING OUR POWER DEMAND** **03 OVERCOMING FUTURE CHALLENGES AND FINDING OPPORTUNITIES** **04 ENABLING TECHNOLOGIES AND INNOVATION** **05 CREATING NEW BUSINESS MODELS** **06 CONCLUSION**

INTRODUCTION

A renewables-led net zero revolution

Energy policy is now being reshaped around the new realities of large-scale, low-cost clean power and, globally, renewables are set to grow faster than any energy source in modern history. The UK is the leading industrialised nation when it comes to decarbonising the electricity system. We have increased the proportion of UK generation from wind from just 3% in 2010 to 20% in 2019. Last year, there were two fortnight periods without coal generation. Renewable generation represented an average of 37% of the UK electricity supply mix in 2019.¹

RenewableUK members are delivering innovative solutions to climate change

RenewableUK member companies are building our new energy system and working to solve one of the greatest challenges of our time. Our members have the expertise and experience to achieve this, and the technologies to do so are widely available and affordable globally. In the decades ahead, renewable energy sources will penetrate the global energy markets faster than anyone predicted, completely changing the way the energy system operates. And they are here to stay.²

RenewableUK is optimistic, but we need to go further, faster. This is our vision of the energy transition

Renewables will shortly become the backbone of our energy system. This market disruption is undercutting old business models and creating opportunities for new ones to emerge. Recent net zero commitments from councils, UK Government and other EU countries suggest that this must now happen even faster than we anticipated. In terms of how we both generate and consume energy, changes, such as digitalisation, are happening which will bring greater flexibility and transparency. We are confident that with the right markets and policies, we can secure low cost energy, decarbonisation and energy security through a renewables-led system.

This report explores our vision of changes in the energy system over the next 30 years to meet our net zero target. From the rapid, total decarbonisation of our power sector to greening our energy consumption, RenewableUK members are leading the fastest energy transition of any major economy.

This decade will be the most important in the fight against climate change ■



¹ BEIS 2019 provisional GHG emissions stats https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/875485/2019_UK_greenhouse_gas_emissions_provisional_figures_statistical_release.pdf

² BP Energy outlook 2019



Building our energy supply around renewable sources



For the first time in history, renewables surpassed fossil fuel generation during the last quarter of 2019.

The UK is already making strong progress in decarbonising our electricity system. Last year, renewable generation represented more than a third of total electricity generation, making it one of the top countries in Europe in terms of total renewable power output. For the first time in history, renewables surpassed fossil fuel generation during the last quarter of 2019.

How did this happen? Over the last decade the UK has pressed forward with building a low carbon future and has delivered a step change in the way we generate our power. The clear direction of travel set by the Climate Change Act has resulted in a world-leading renewables industry, delivered by the private sector in

partnership with successive governments. Throughout the 2000's, the UK Government backed support schemes which allowed these then emerging technologies to come forward and incentivised their deployment at scale.

In June 2019, the UK Government committed to a new legally binding target of “net zero” by 2050, following an increased desire from the public for action to tackle climate change, and the huge success of renewable deployment. The Scottish Government and the Welsh Government adopted targets of net zero by 2045 and 2050 respectively. These targets mean that the progress we have seen so far, and the technology delivered to date, will now have to go further and faster. RenewableUK members are at the centre of delivering this ambition. They are already investing, building and supplying the clean electricity that the system will rely on for decades to come.



1. OFFSHORE WIND

The cost of new offshore wind fell by 66% between 2015 and 2019. This cost reduction has been achieved as project developers have gained confidence and experience, building trust in their supply chain and investors. This has in turn allowed innovation and incredible technology advancements to come forward. Most importantly, the cost of borrowing capital through long term contracts has fallen thanks to the certainty provided by the Contracts for Difference (CfD).

RenewableUK's offshore wind model shows that with the right incentives, operational wind capacity could reach 40GW by 2030, in line with the UK Government's offshore wind target. As turbines get bigger, we then see offshore wind potentially ramping up to almost 70GW by 2040 and over 90 GW by 2050 in our high ambition scenario. In any of these scenarios, offshore wind becomes the main source of electricity supply for UK homes.

Deploying offshore wind at the scale and pace required to meet the UK's increased ambition and our net-zero target is not without its challenges. First and foremost is the need for a strong partnership between industry and Government, and accelerated cooperation between Government departments. Some of the key assumptions behind this ambitious scenario include faster and more regular timeframes for leasing and allocation rounds, a full repowering or life extension of all wind farms built from 2025, investment in our UK supply chain and partnerships with other industries sharing the sea – such as shipping, fishing, aviation, etc.

Ramping up deployment of offshore wind to the levels required by the UK Government and the CCC in 2019, will also mean enabling innovative technologies such as floating offshore wind which can access deeper waters, thereby increasing geographic diversity of our energy supply. It is also necessary to ensure a coordinated strategy in connecting all these future wind farms to the high voltage offshore transmission network. Timely connection agreements will be vital to meet the deployment schedules.

SHARING THE SEA



PROJECT 1

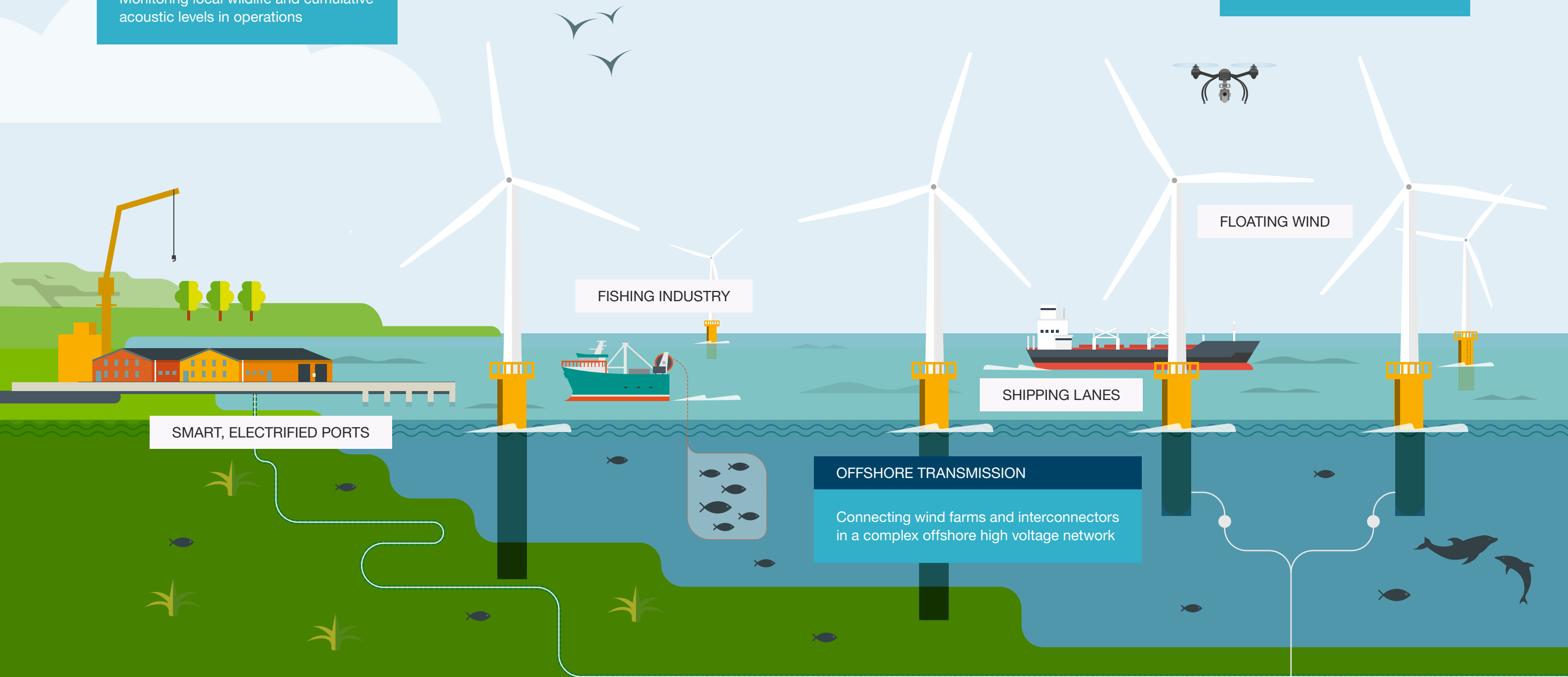
Monitoring local wildlife and cumulative acoustic levels in operations

PROJECT 2

Minimising cumulative acoustic levels during construction

PROJECT 3

Coordination with aviation strategy, radars, drones



FISHING INDUSTRY

FLOATING WIND

SHIPPING LANES

SMART, ELECTRIFIED PORTS

OFFSHORE TRANSMISSION
Connecting wind farms and interconnectors in a complex offshore high voltage network



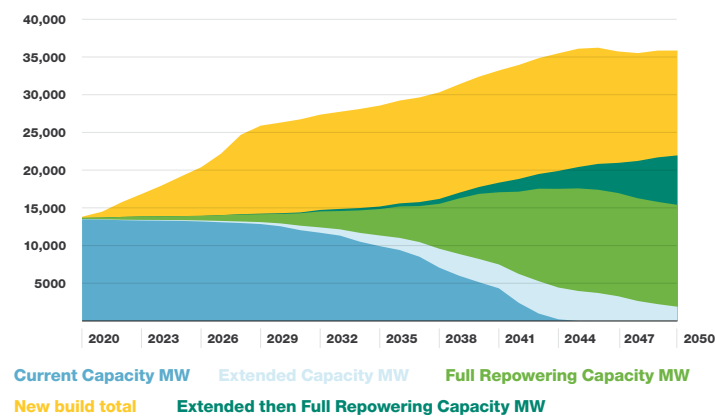
2. ONSHORE WIND

From small distribution-connected wind farms to utility-scale sites, the onshore wind industry provides the diverse, clean and cheap generation that the grid needs. The Committee on Climate Change net zero report recommends a much greater level of deployment by 2030 to ensure we keep on track with our net zero ambitions. Government's announcement of the return of Pot 1 auctions for onshore wind and solar in March 2020 is therefore extremely welcomed and follows years of targeted and strategic advocacy from RenewableUK.

RenewableUK has considered three main scenarios of onshore build out. In our high scenario, we model significant growth in onshore wind capacity growing to 26GW by 2030, 32GW by 2040 and 36GW by 2050 compliant with the CCC's indications. This includes a great level of full repowering and life extensions. The model indicates that the majority of projects will be located in Scotland (over 20GW by 2050) however it still forecasts over 5GW of capacity coming from repowered projects in England by 2050 which will be crucial to meet the net zero levels mentioned above. Reaching this goal requires a set of supportive policies from Government, such as the Pot 1 auction, and improved timescales for grid connection.

The important assumptions behind these modelled, high levels of deployment are an effective planning environment with improved connection timescales and the ability to stack revenues. Regardless of which financing route developers pursue, it is clear that much more capacity will be needed to achieve the levels of ambition necessitated by net zero.

ONSHORE FORECAST IN A HIGH SCENARIO



Source: RenewableUK Project Intelligence Onshore model

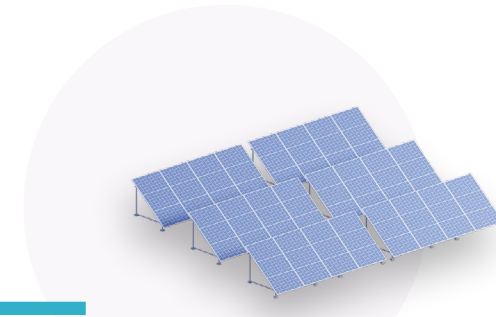


3. SOLAR TECHNOLOGY

The CCC projects that 40GW of installed solar capacity will be needed by 2030 to keep on track to achieve net zero by 2050. As of January 2020, the total installed capacity of solar PV in the UK is 13.4GW.

The Solar Trade Association's (STA) high ambition scenario forecasts a total operational capacity of 27GW by 2030, assuming the reinstatement of Pot 1 technologies in CfDs, which the Government has already announced, alongside a strong Power Purchase Agreement (PPA) market, and reforms to business rates for solar. The Government will need to go even further with enabling measures if it wants to accelerate deployment in the medium to long term such as public sector PPAs and support for solar and storage within the Home Upgrades Grant Scheme to finance domestic retrofits.

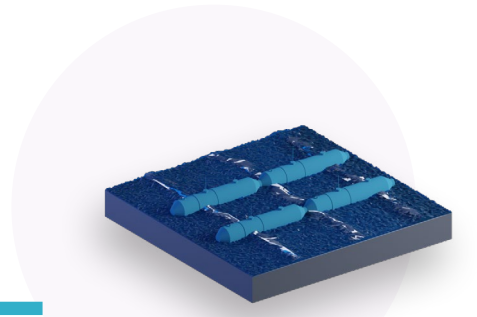
Distribution grid upgrades will also be essential to allow continued growth of distributed solar generation throughout the 2020s. It will be crucial for Ofgem and Distribution Network Operators to work collaboratively with industry to create a favourable policy environment and target grid upgrades strategically to enable the greatest possible penetration of distributed generation assets.

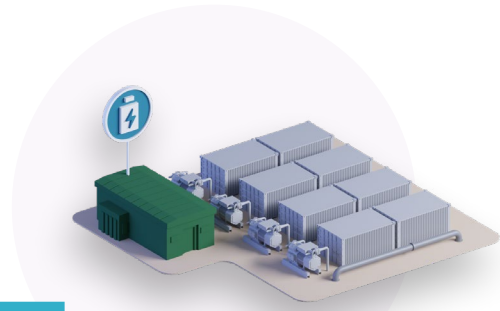


4. MARINE TECHNOLOGIES

The UK's tidal stream and wave energy industries are at a critical time in their development. While innovation and demonstration projects gained significant public support at the beginning of the last decade, the lack of a mechanism allowing the technology to be deployed beyond a handful of devices per project has now had a knock-on impact on private sector investor confidence. Currently there are 22 tidal and 23 wave energy developers in the UK and a potential 13GW in the pipeline. The majority of projects are located on the coasts of Orkney and Caithness in Scotland, west coast of Scotland, Northern Ireland and Anglesey, South Wales and in the south west of England.

Within a competitive auction process, innovative technologies like these are at a disadvantage when compared to more established renewables. There is a need for a dedicated support for the commercialisation of wave and tidal technologies to deliver a world leading sector in the UK, which will create local economic benefits and a strong export sector.





5. ENERGY STORAGE

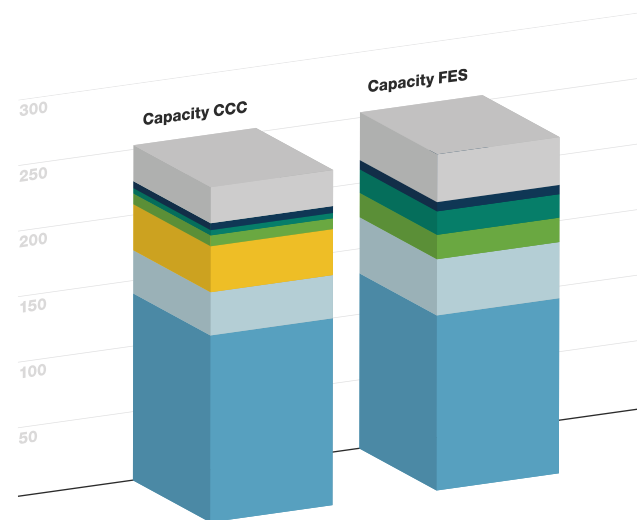
Energy Storage represents a wide range of technologies, from different types of batteries (including Electric Vehicles) to compressed air, liquid air, and at the very large scale, pumped hydro. These technologies will be heavily represented in our future mix and our members are actively trying to deploy and integrate them into their portfolios.

As the deployment of renewable generation increases, storing cheap renewable power, and discharging it when demand is higher, will become vital to the future functioning of the grid.

The majority of storage projects in the UK pipeline is batteries. The UK saw a step-change increase in planning applications for batteries in 2017, when these projects were first able to participate in the capacity market, indicating a clear interest from developers in accessing this market and the new revenue streams it can provide. For the same reasons, we are also seeing a growing appetite for co-located projects combining renewable power generation and a battery.

Different profiles of storage are needed to meet different system needs and batteries are not the only form of storage that will work well with our increased renewable generation. While batteries provide near instantaneous frequency response to help manage short-term fluctuations, long duration storage such as pumped hydro or ammonia and renewable hydrogen will be crucial to accompany high levels of renewables and achieve low carbon intensity.

INDICATIVE SUPPLY MIX IN A NET ZERO 2050 SCENARIO FROM FES AND CCC

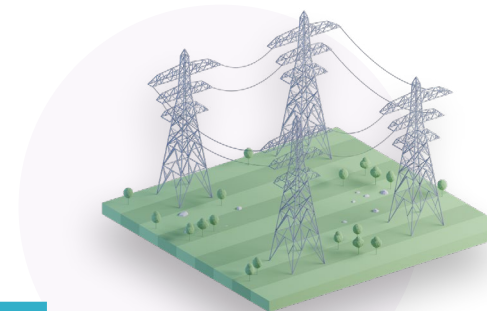


Solar, Wind, Marine Gas CCS Peaking plants
Nuclear Other bio and hydro Bioenergy with CCS
Potential added wind capacity from RUK model

Source: CCC, FES, RUK



Adding RenewableUK's own optimum scenario for onshore and offshore wind, the capacity and generation from RES increases to become 76% of the UK generation mix by 2050.



6. INTERCONNECTORS

In a similar manner to long duration storage, interconnectors will be an important source of balancing and seasonal flexibility.

The 2020s will see an increase in the interconnection capacity of the UK, from 4GW today to 12GW in 2025. As we depart the EU, it is essential that the flows from and to the continent maintain optimum responsiveness and flexibility. We believe that by 2050, the total net flows through interconnectors should be close to zero. This means that on average the amount of electricity imported should equal the amount of electricity exported. The increased interconnector capacity has an important role to play in stabilising price fluctuations.

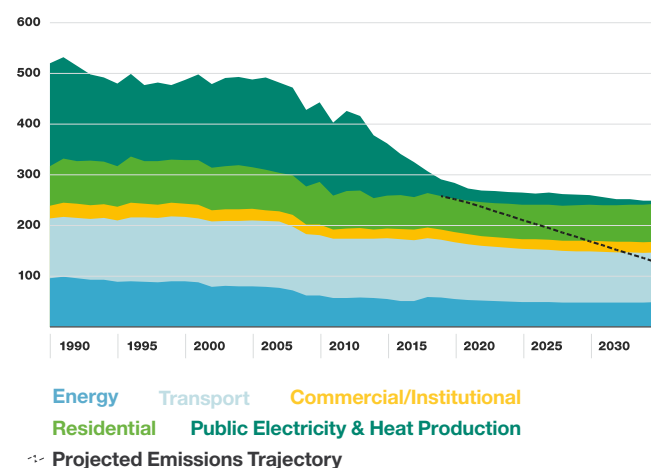
In their indicative net zero generation mix, the CCC assumes 175GW of variable renewable generation capacity such as wind, solar and marine energy. In addition, there would be further renewable power from Bioenergy with carbon capture storage (BECCS) and hydro (~10GW). In this scenario, renewables would account for 66% of the UK generation mix.

Adding RenewableUK's own optimum scenario for onshore and offshore wind, we are confident that renewable energy sources can provide 76% of the UK generation mix by 2050 ■



Decarbonising our power demand

CO2 EMISSIONS BY CATEGORY



Source: Updated Energy and Emissions Projections 2018, BEIS

Total energy demand is made up of every part of our economy, from the residential sector through to agriculture, commercial services and transport.

Some processes within these sectors (heating buildings or the production of steel for example) are inherently energy-intensive and are, therefore, very dependent on changes to the supply side of our energy system in order to decarbonise. Moreover, the capital-intensive investment in the new energy infrastructure we need for net zero relies on future demand growth which, as yet, is not evident. Supply and demand are closely linked and investment in each needs to acknowledge changes in the other. The decarbonisation of our electricity supply is at an advanced stage. Power supply has gone from being the most polluting sector, emitting over 200 MtCO₂e annually in 1990, to below 60MtCO₂e in 2019. Indeed, over 60% of the UK's total emissions reductions are accounted for by the power sector.⁵

THE DECARBONISATION OF OUR ELECTRICITY SUPPLY IS AT AN ADVANCED STAGE.

Power supply has gone from being the most polluting sector, emitting over 200 MtCO₂e annually in 1990, to below 60MtCO₂e in 2019.



The way electricity is dispatched through the system will change and that will require new dynamics in terms of network management. Increased renewable generation, storage, interconnection and new dynamics in managing networks will ensure that security of supply standards are met. National Grid ESO's net zero sensitivity analysis sees peak demand growing from 60GW today to 115GW by 2050. Alongside managing periods of peak demand, ESO will increasingly have to manage periods of excess supply.

The decarbonisation of our energy system will require important investment in electrification, energy efficiencies and technology enabling flexibility, such as storage and hydrogen, to ensure that the energy supplying our industry and homes is clean – even at peak times.

- ◆ Transport
- ◆ Aviation and Shipping
- ◆ Heating
- ◆ Industrial processes

Credits:

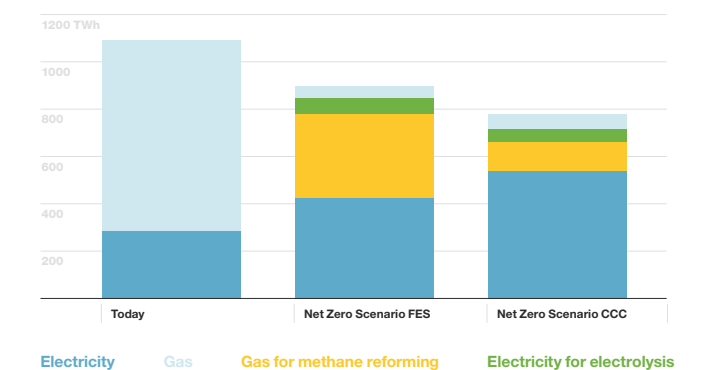
Shutterstock.com (Left Top), Shutterstock.com (Left Bottom)
Shutterstock.com (Right Top), Shutterstock.com (Right Bottom)

Each of these sectors of energy demand will require different types of efficiency improvement measures, levels of electrification and pace to fully decarbonise. They are detailed in our main report.

By 2050, demand for gas from various sectors of our economy will be less than 50TWh per year, while the rest of our demand will be met by low carbon electricity or renewable hydrogen. Power demand will more than double compared to today's levels. More than half of it will come from building electricity demand such as heat, appliances and computing (360TWh from the total 645TWh according to the CCC's further ambition scenario).

Shifting our energy demand for carbon intensive fuels to demand for green electricity and low carbon gas like green hydrogen is essential to reduce our CO₂ emissions. The technology and the appetite for it are there but will require the right policy framework and incentives to meet our net zero targets on time ■

THE ESO AND THE CCC NET ZERO SCENARIOS SEE A RISE IN DEMAND FOR ELECTRICITY AND HYDROGEN



Source: National Grid ESO, Future Energy Scenarios 2019 and Committee on Climate Change, Net zero technical report 2019, calculations from RUK



Overcoming future challenges and finding opportunities

Decarbonising our power supply and electrifying our energy consumption does not come without its challenges.

While industry and the CCC recommend stronger actions and shorter timescales from Government to ensure that the UK keeps on track for our net zero targets, we are already observing some of the impacts of these changes on the energy system: periods of high electricity supply and negative prices, technologies pushed down the merit-order and more volatile wholesale power prices. This is not unique to the UK; similar changes are clear in many markets globally, and innovative technological and business solutions are ready to be implemented to take advantage of the challenges and benefit consumers.

The downward impact on market prices from periods of high renewable energy output and low demand is known as price cannibalisation. Ultimately, RenewableUK believes lower energy prices should be an advantage to electricity consumers and more needs to be done to ensure that they reap its benefits. For project



The benefits of a smart system and flexibility are also borne out by the National Infrastructure Commission, which concluded that a smart, flexible system will save consumers as much as £8 billion per year by 2030.

developers, however, it can highly impact their ability to recover their investment overall when selling their electricity to the market.

This subject has been much discussed over the recent years and there is still a lot of uncertainty about the magnitude of the challenge as it depends on a variety of external factors and assumptions such as infrastructure investment, electrification and demand and supply flexibility levels. However, it is one that needs to be addressed when discussing the viability of our future energy system in a renewables dominated world. The current electricity market is designed around the marginal cost of generation which will get closer to zero as we successfully manage the decarbonisation of our grid.

This challenge is likely to decrease already as we ramp up electrification of demand and reduce the instances of excess supply in our power markets. But we need to go further. Making contracts and market access more flexible for renewable generators will allow them to make the best use of their asset and be able to be more responsive when negative price situations happen in the future.

The benefits of a smart system and flexibility are also borne out by the National Infrastructure Commission, which concluded that a smart, flexible system will save consumers as much as £8 billion per year by 2030.⁶ RenewableUK members are building the UK's future energy system. We believe that the deployment of renewables should not be seen in isolation, but as a wider part of a whole system reform and of the transition to a low carbon economy. Reform as we explain in this report, will include everything from building more interconnectors, enabling vehicle to grid technologies to the optimisation of renewable assets such as wind farms, all of which will respond to market signals when needed to minimise costs to the system and, ultimately, to the consumers ■





Enabling technologies and innovation



Creating new business models



The success story of wind and solar all over the world have shown that this is a technology-led transition.

Technological innovation has been key in making markets believe a new energy system with clean energy sources was possible, and technological innovation will be key to ensuring that system is stable and sustainable. Our members are disrupting the energy system and bringing new solutions with them. The energy transition is global and there is great potential for the UK to be seen as a leader in innovation and new technology markets for smart flexible energy systems.

As the volume of renewable generation increases on the system, there is a wide range of disruptive technologies that will be able to support their integration at low cost such as storage technology like batteries, pumped hydro and renewable hydrogen and demand side technologies such as vehicle to grid and smart meters ■

The current system landscape, which was built around the model of centralised generation and passive consumers, does not send clear signals to customers about the actions they can take.

As the energy system becomes more flexible and variable, there will be more active participants in the market. Many of these players will be smaller, with less resources to manage complex contracts and rules. Simplicity will therefore be an essential principle to enable the widest, and most liquid market for the benefit of consumers. Transparency of data will also play a vital role in enabling a more decentralised market, where innovative solutions can come forward.

We are seeing some renewable energy suppliers offering tariffs to their customers that incentivise their energy consumptions at times of high renewable generation and low electricity prices. Time of use tariffs will help unlock decarbonisation of our economy, by incentivising consumers to use more energy at times when the wind is blowing. This will help the system operator balance demand, flatten it and ultimately reduce balancing costs for everybody. At the

same time, consumers would benefit from lower prices if they can shift their electricity use.

As should be apparent, in the future there are going to be many more players in the energy market – from households with EVs and demand responsive fridges to industrial demand response, and generators of all sizes. But the energy market is complex, and households and smaller businesses may not want to actively participate. Aggregators exist to pull together many small players to provide a large offering to the system, such as demand response.

We are at an incredibly exciting time for the power system. RenewableUK members are solving the transition challenges and creating opportunities for new business models to emerge. New technologies, data management, digitalisation and communication are opening up new markets and business models that will help manage the future energy system. This will enable us to increase the volume of renewable resources on the system, while continuing to reduce costs for the consumer. Increasing flexibility and digitalisation will see smart meters capturing and sharing data, with aggregators and innovative new services to match supply and demand ■

Credits:

Shutterstock.com (Left Top), Sonnen (Left Bottom)
Shutterstock.com (Right)

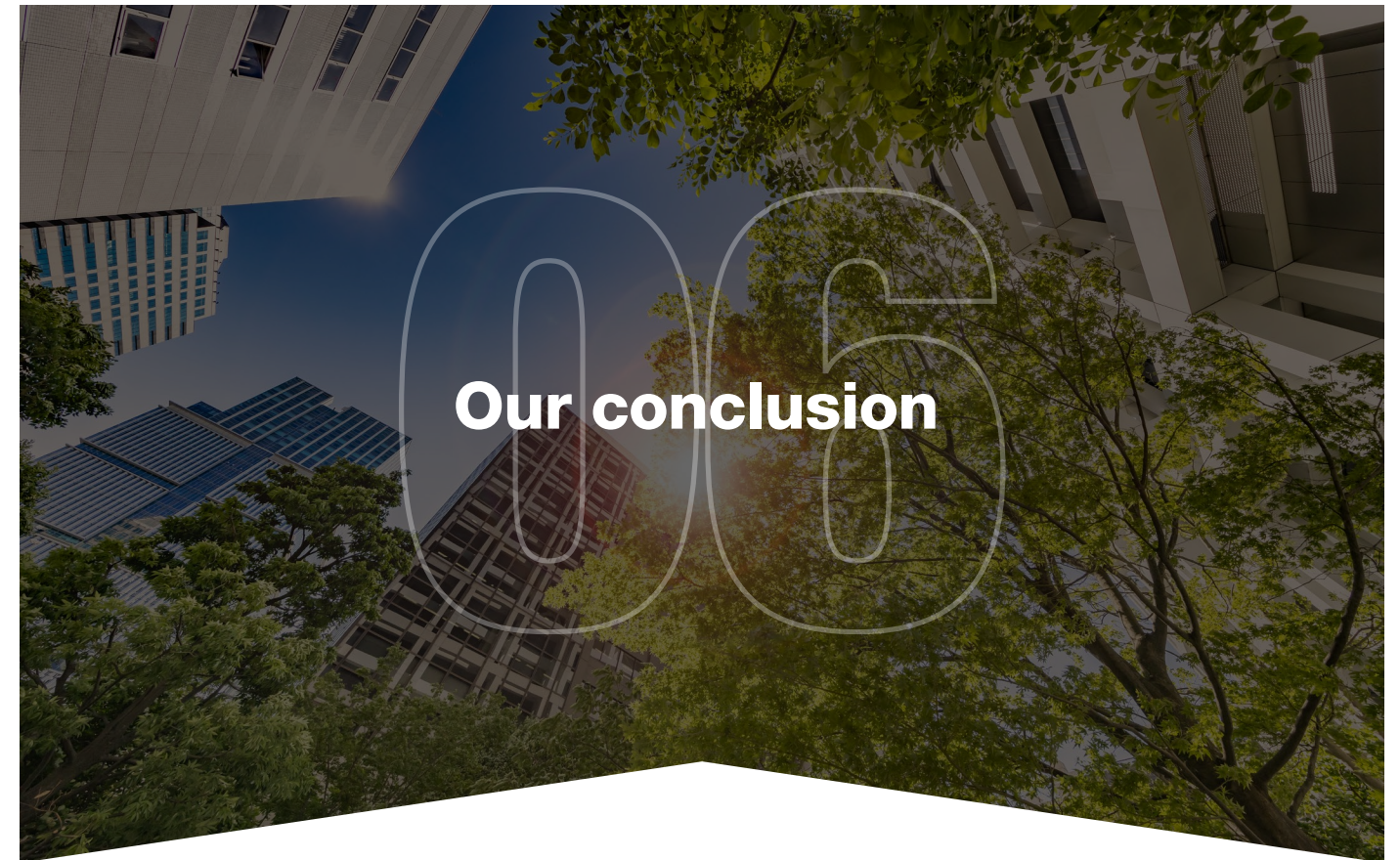
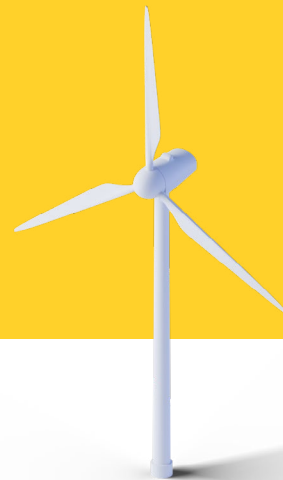
OUR RECOMMENDATIONS

Transforming our energy system to deliver net zero can only happen under a certain set of conditions, and this report presents recommendations on what should happen in this decade.

Recommendations are discussed throughout the online report.



- ◆ **Enabling actions from Government and new governance structures** to support deployment of offshore wind and floating wind
- ◆ Maintain **routes to market** and certainty to support investment in cheap decentralised renewables, such as onshore wind
- ◆ Build markets for innovative technologies, such as marine renewables and green hydrogen, to allow **deployment and cost reduction**
- ◆ Ensure that energy market **regulation accelerates the transition** to a smart, flexible, low carbon energy system
- ◆ Create a **fair, cost reflective approach to network charging** and connection queue regime that delivers net zero at the least costs
- ◆ **Renewable hydrogen** to fuel emission-intensive industries
- ◆ Put in place the right framework to enable to adapt consumption and receive pass through benefits of abundant cheap power
- ◆ Implement and build on the Smart Systems and Flexibility plan to **accelerate the development of flexibility markets** at national and local level
- ◆ **Encourage greater flexibility** through increasing interconnection, vehicle-to-grid (V2G) technologies and industrial demand response to maximise variable renewable generation



CONCLUSION

Whether it is investing in new generation technologies where the UK has a competitive advantage, developing batteries to ensure a secure clean power grid, partnering with the automobile sector to build the EV charging network, installing low cost heat pumps in UK homes or producing home-grown renewable hydrogen, our members are using their expertise to build the energy system of tomorrow.

Our unparalleled success in decarbonising the power sector was kickstarted by ambitious public policies that supported innovation at scale, allowing companies to learn, build supply chains and reduce costs. While targets become more ambitious, the importance of this support for market signals and investment in all sectors of the energy system only becomes greater.

The UK's net zero energy system will be renewables-led and will provide cheap, clean power to a wider range of consumers with specific needs. Renewable electricity, both directly and indirectly through the production of renewable hydrogen, will meet the vast majority of our energy needs. We are confident that this vision can be realised but it will require the development of stable markets with the right incentives in place to support the companies and investors who will deliver it. The investments needed in all aspects of the energy system are long-term and capital intensive.

Putting in place clear, long-term market signals will allow our technologies and companies to do what they do best: innovate and problem-solve ■

To read the full version of this report visit: vision.renewableuk.com



ABOUT RENEWABLEUK

RenewableUK is the only trade association to encompass both the transmission and distribution aspects of the changing energy system. Across the organisation, work is being done to support the energy transition. RenewableUK's members are building our future energy system, powered by clean electricity. We bring them together to deliver that future faster; a future which is better for industry, billpayers, and the environment. We support over 400 member companies to ensure increasing amounts of renewable electricity are deployed across the UK and to access export markets all over the world. Our members are business leaders, technology innovators, and expert thinkers from right across industry.

www.renewableuk.com