Connecting to a net zero future

Exploring the role of interconnectors in the transition to net zero

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nationalgrid

Contents

The route to net zero

By 2024, National Grid's flexible interconnector capacity will provide enough energy to power **eight million homes.**

Electricity interconnectors have an important role to play in a radical shift to the way we produce and use energy. Acting like international clean energy super-highways, they can stretch for hundreds of miles and cross borders, helping power to flow back and forth between Great Britain and neighbouring countries. This flexibility will be vital as Britain's reliance on renewable sources of energy grows.

The UK Government has committed to achieve net zero carbon emissions by 2050. In December 2020, ministers pledged that in the next decade the UK will cut its carbon emissions by 68% of 1990 levels. Meanwhile, the proposed European Climate Law also includes a net zero target by 2050. So, how do we reach these ambitious targets?

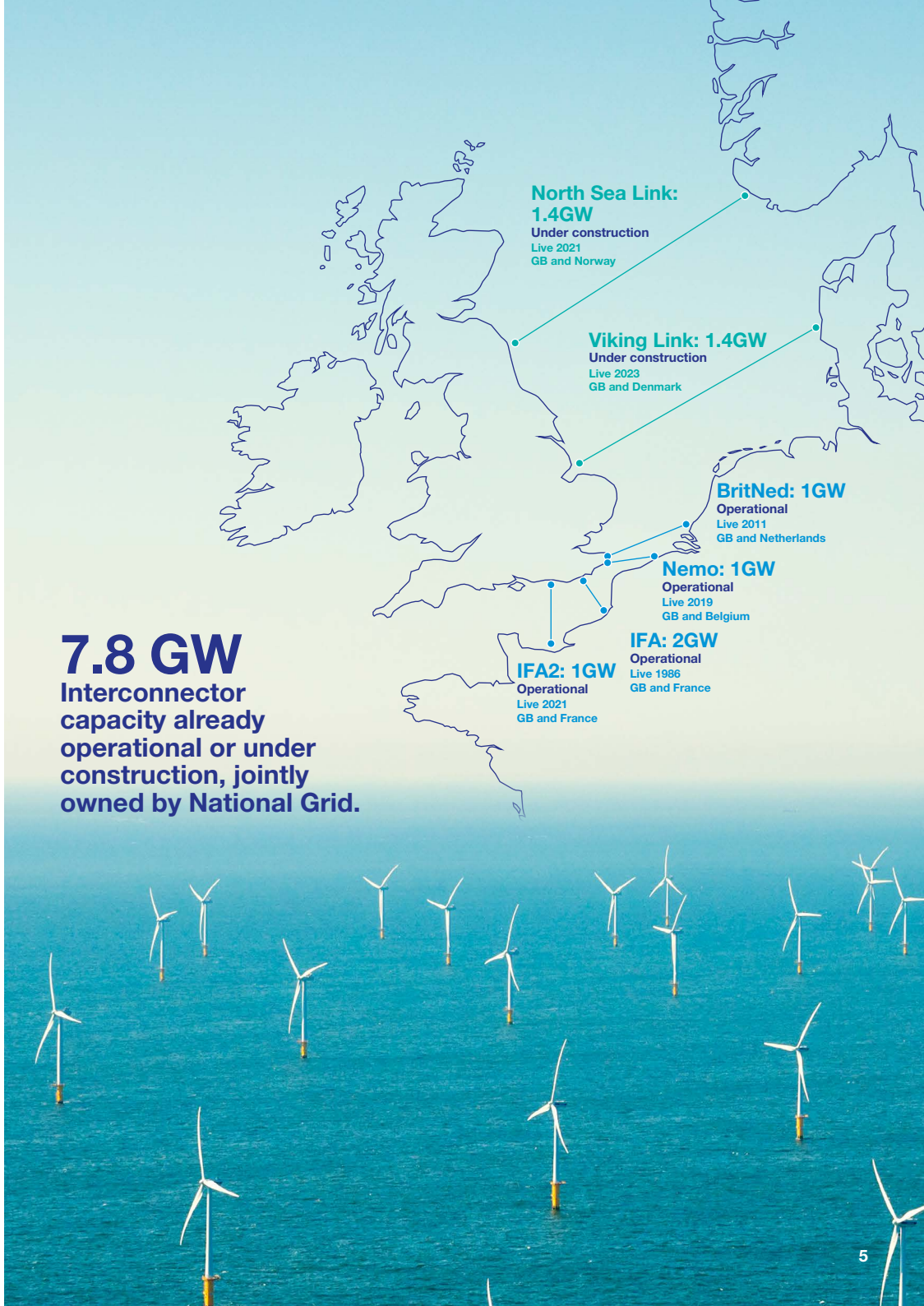
Interconnectors, high voltage transmission cables that move electricity between countries, are already making a significant contribution to the energy transition.

The technology is operating today and delivering real benefits for consumers across the UK and Europe. A total of six interconnectors currently link the Great Britain electricity grid to Northern Ireland, the Republic of Ireland, Belgium, France, and the Netherlands. A further three projects are under construction and many more are in development.

Interconnection is in many ways the perfect technology to integrate renewable energy and ensure a secure, affordable and sustainable transition to a cleaner energy system. By linking Britain to neighbouring countries, interconnectors can import cheaper clean energy when it is needed, while exporting excess power - so that both Britain and its neighbours have access to a broader and more flexible supply of electricity.

We know that increasingly large volumes of renewable energy – particularly offshore wind – will need to connect to the grid in the coming years to achieve net zero. Interconnectors can provide a way to achieve offshore wind connections at scale.

In this publication we look at the role of interconnectors now and in the future, explaining how the technology, the market and the regulation works. We also explore how interconnectors are already delivering significant benefits for consumers, and how this trend is set to continue with increased interconnector capacity planned between GB and Europe.



Who we are and what we do

About National Grid

National Grid lies at the heart of a transforming energy system, spanning the UK and the US. Our businesses supply gas and electricity, safely, reliably, and efficiently to millions of customers and communities. We drive change through engineering innovation and by incubating new ideas with the power to revolutionise our industry.

As the world changes to embrace cleaner energy and businesses shift to operate in a more responsible way, we are leading that charge.

We are focused on finding ways to decarbonise the energy system; from building interconnectors to allow the UK to share clean energy with our neighbours in Europe, to investing in renewable energy generation in the US. We connect people to the energy they need to live their lives. We continually strive to find a better way. We Bring Energy to Life.

About National Grid Ventures

National Grid Ventures develops, builds, operates, and invests in technologies that decarbonise our economy and society. We are the competitive division of National Grid, operating separately from the company's core regulated businesses.

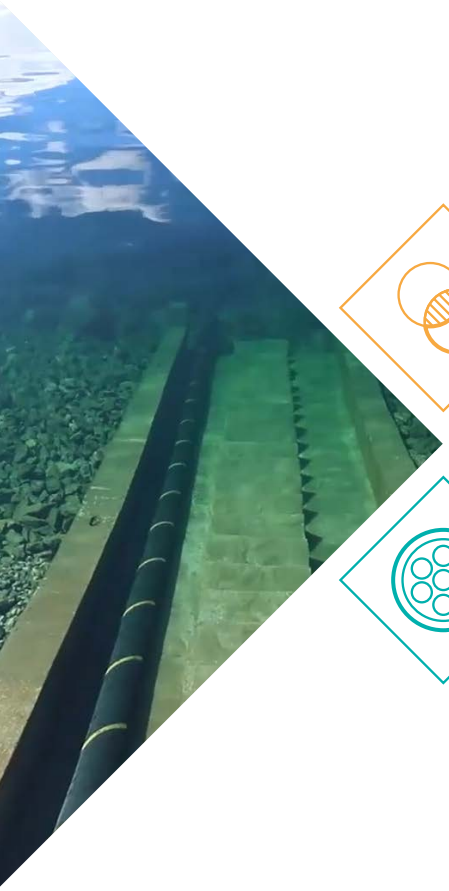
We have a diverse portfolio of low-carbon and renewable energy projects in the UK, Europe and US stretching from offshore transmission to battery storage, wind, and solar power. We also have significant experience in developing and operating sub-sea electricity interconnectors.

"National Grid has a critical role to play in helping to accelerate towards a cleaner future. Tackling climate change and reaching net zero are top of our agenda. Our interconnector projects are critical to this, enabling us to deliver a cleaner and smarter energy system for consumers both in the UK and in Europe."

John Pettigrew, Chief Executive, National Grid

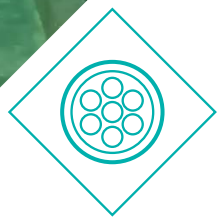
This publication in 60 seconds

Read our 60-second summary of the role that interconnectors play today and how they will support the journey to net zero.



Managing the energy transition

The UK is committed to net zero emissions by 2050. Meeting that target means transforming our energy system to one powered by zero-carbon generation. Interconnectors have an important part to play in this ambition by ensuring zero-carbon generation can be moved from where it is plentiful to where it is needed most.



Interconnectors today

Interconnectors give Great Britain access to clean energy from elsewhere in Europe and allow us to export excess clean power. They are helping to create a cleaner, more secure, and more affordable energy system that benefits consumers. Between 2020 and 2030, we estimate our interconnectors will help Britain to prevent 100 million tonnes of carbon emissions.*

**This is an internal calculation based on pan-European modelling of hourly flows through interconnectors, then assuming that these flows were replaced by CCGTs in the UK.*

A challenging decade ahead

Achieving net zero will require some dramatic shifts in how we produce and use energy. The UK Government targets building 40 GW of offshore wind capacity by 2030. Connecting large volumes of renewable generation to the grid is a challenge and requires us to think differently.

A connected future

Interconnectors can help to connect large volumes of offshore wind by acting as a hub for clean energy connections. National Grid Ventures is developing a new generation of multi-purpose interconnector. These innovative projects aim to connect offshore wind projects here in Great Britain and to mainland Europe. Multi-purpose interconnectors reduce the number of onshore connections needed and lessen the impact of infrastructure on coastal communities.

How the energy system is changing

The energy system is shifting ever further away from a reliance on fossil fuels towards renewables and a broader mix of zero-carbon generation, including wind and solar as well as nuclear power. Interconnectors are helping to enable this transition.

- The way we produce and consume energy is changing rapidly. In 2019, zero-carbon sources delivered 48.5% of Britain's electricity.
- In 2019, zero-carbon generation outstripped fossil fuels over a 12-month period for the first time.
- How did this happen? Via a combination of wind farms, solar, nuclear energy and clean power imported via interconnectors.
- To achieve the UK's net zero target, the 6th Carbon Budget Report by the Climate Change Committee published in December 2020 recommends growing offshore wind from a 40 GW ambition in 2030 to at least 100 GW by 2050.
- That's 10 times the offshore wind Britain has operational today.
- A greater role for renewables means more intermittent generation and volatility on the system. When the sun shines and the wind blows, there could be excess generation available. When the weather is cloudy and calm, the opposite could be true.

What are interconnectors and why are they needed?

Interconnectors act like super-highways for clean energy. They are high-voltage transmission cables that efficiently transmit electricity between countries, from where it is produced to where it is most needed. For Great Britain, sub-sea cables enable large volumes of zero-carbon generation to be imported or exported over long distances without significant energy loss along the way.

How interconnectors work

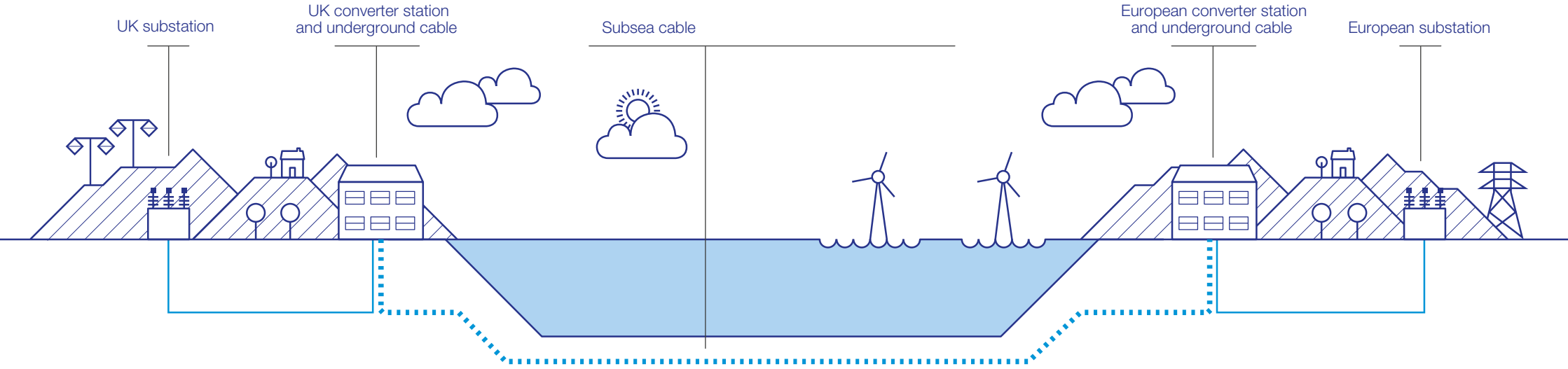
The technology

Interconnector technology has been operating successfully for decades, so it is well proven and reliable.

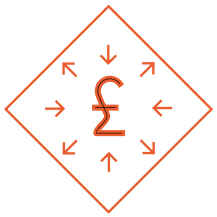
Sub-sea cables link the Great Britain transmission network to other countries in Europe via a point-to-point connection. Underground and sub-sea cables carry electricity as High Voltage Direct Current (HVDC). At either end, a converter station transforms this to and from the alternating current needed to run the grid that supplies our homes and businesses. This conversion is needed to make sure power can be transmitted over long distances via interconnectors without significant losses.

Cables can run for hundreds of miles. The Viking Link interconnector that will connect Great Britain to Denmark features a 765km cable – the longest of its type in the world. The project is due to be completed at the end of 2023.

Currently, all existing and planned sub-sea cables link the Great Britain transmission network to other countries in Europe via a point-to-point connection.



How interconnectors work



The market

Interconnectors allow power to flow between two countries or markets, in either direction, depending on the electricity price in the market at either end.

Interconnector capacity is made available to market parties via Capacity Auctions. The current auction schedules include long-term capacity auctions that offer annual, seasonal, and monthly capacity, as well as short-term capacity auctions that offer day ahead and intraday capacity. The auction bidding process allows our customers to bid to purchase capacity.

Once customers have won capacity, they have the option of nominating the capacity to physically flow energy across the link. If customers do not nominate their capacity it is automatically placed into the day ahead auction and, if cleared, they will receive the proceeds from the auction.

Short-term auctions at the day ahead and intra-day timescales enable customers to respond to movements in the market – for example driven by changes in the weather – to optimise the flow of renewable power.

The regulation

Interconnectors earn revenue by selling capacity to the market. Regulation determines whether the investor can keep all the revenues, give some to consumers or needs a top up from consumers. The UK Government introduced the Cap and Floor regulatory regime for interconnectors in 2014 to do this. It gives some security to investors, while making sure consumers benefit from interconnectors. Ofgem sets the level of the Cap and the Floor by assessing the efficient costs of developing, building and operating the interconnector.

Investors are guaranteed a revenue 'floor', which ensures a minimum return as long as availability targets are met. However, the floor is not intended as a reward for the developer, it only covers the basic costs of a project. Additionally, all revenue above the agreed 'cap' goes to consumers. This is different from merchant interconnectors and generators, where the developer retains the full revenue associated with the asset. Ofgem only approves projects for the Cap and Floor regime where its analysis has established that the project benefits consumers.

How interconnectors benefit consumers

Interconnectors are helping Great Britain to achieve a cleaner, more secure, and more affordable energy system that benefits consumers.

Making energy cleaner

Interconnectors enable Great Britain to import zero-carbon energy from other countries in Europe to supplement our own generation mix. This could be wind power from Denmark, Norwegian hydro, or nuclear power from France.

And when the sun is shining and the wind is blowing here at home, excess generation can be exported to neighbouring European countries.

By providing energy systems with access to renewable energy via interconnectors, countries can phase out coal-fired generation.

Improving energy security

The UK Government is planning to bring forward the date to end coal-fired generation by a year to 2024. Coupled with an ongoing programme of additional power station closures, having access to energy systems beyond Great Britain's borders is more important than ever.

Interconnectors provide this much-needed access. They are a direct link to a wider pool of generation that can flow across interconnectors to ensure demand is met.

Interconnectors can also give system operators a way to react quickly to rapid changes in supply and demand. This is particularly important as intermittent renewable generation increases. It allows a response in minutes rather than the many hours needed to fire up fossil fuel generation.

Interconnectors also support security of supply by participating in the Capacity Market – the mechanism introduced by Government which ensures that electricity supplies will continue to meet demand.

Making energy more affordable

Above all else, interconnectors bring flexibility. They ensure that Britain has access to the lowest-priced electricity from a wider pool of sources. This increased competition means better value overall for consumers.

If prices are high in UK, interconnection allows power to be imported immediately from countries where generation is less expensive.

The Power of Now

Quick link

Carbon dashboard

By transferring zero-carbon energy from where it is produced to where it's needed most, interconnectors help to reduce carbon compared with meeting energy demand via domestic power alone.

For the first time, these benefits can be measured in real time through an interactive carbon dashboard on the Power of Now site.

It is powered by live market and carbon data from Britain and connected countries.

The dashboard calculates the contribution of interconnectors towards net zero every five minutes. It also allows these savings to be viewed in equivalent terms – for example as cars taken off the road or trees planted.

How interconnectors help to decarbonise the energy sector

Interconnectors are already part of the European power mix. Many nations have more than one connection to their neighbouring countries, with more under way.

The European Commission has raised its climate ambitions: A plan was agreed in December 2020 to reduce greenhouse gas emissions by at least 55 per cent by 2030 (compared with 1990 levels). We analysed the role that interconnectors would have in the 2030 power generation mix and how they could help in integrating a higher share of renewable energy. The results show that interconnectors transfer energy from one country to another during hours when renewable generation is high.

For example, the study indicates that about three quarters of the time when Denmark is exporting to Great Britain, renewables supply well above Danish demand. Great Britain will benefit from this excess renewable power generation, through the interconnector flows.

Similarly, about one third of the time when Great Britain is exporting to Belgium, renewables supply is expected to be well above the British demand. If the interconnector didn't exist, this renewable power generation would have to be reduced because of the lower demand, resulting in a potential waste of zero-carbon energy.

"Interconnectors can play a crucial role in the UK's climate and energy policies, helping to ensure it takes the least-cost path to decarbonisation while meeting its climate change targets."
E3G

By 2030

around 90% of electricity imported to Great Britain will be from zero-carbon sources.

Unlocking the potential of clean energy

The UK Government recognises that interconnectors are vital to Britain's energy future. In its Energy White Paper, the Government has set an ambition of 18 GW of total interconnector capacity.

National Grid calculates that between 2020 and 2030, our interconnectors will help Britain to prevent 100 million tonnes of carbon emissions. There will be other benefits too, including better security of supply, access to cheaper clean energy from across Europe and the increased ability for Great Britain to export electricity.

National Grid Ventures is already at forefront of interconnector development. We have extensive experience building and operating interconnectors. As well our four operational links, we are creating new connections to Norway and Denmark as part of a £2bn investment programme.

And as the shift to zero-carbon generation accelerates across Europe, we are investigating opportunities for future interconnectors. Our priority is to focus on markets that we believe will offer the biggest benefits to British consumers.

National Grid calculates that if the UK Government hits its 18 GW ambition for interconnector capacity, this would bring £20bn of cost savings for consumers between 2020 and 2045.*

***Source:** *Pöyry assessment of Cap & Floor Window 2 projects published January 2017 and internal analysis.*

A partnership across Europe

To deliver a cleaner energy future, it makes sense for the UK to work closely with other European countries.

We have a common purpose in many energy challenges. We have similar climate change targets and our energy systems already operate in similar ways.

Now the Brexit transition period is over, there is a need to work together to deliver the substantial changes necessary to achieve net zero.

Energy is a key part of the Trade and Co-operation Agreement between the UK and the EU. The agreement recognises that interconnectors will become even more important in the integration of zero carbon energy in the coming years. Both parties have agreed to work together to maximise the benefit of connecting renewable generation in the North Sea. The agreement also prioritises more efficient electricity trading arrangements.

A framework has been agreed to ensure that interconnector trading is as efficient as possible. Owners of electricity interconnectors and onshore transmission networks are collaborating to ensure the best outcome for UK and EU consumers.

"Remaining connected and improving energy trading with neighbouring countries reduces the need to build new infrastructure and is a quick way to access affordable, low carbon electricity. It also provides a market to export excess renewable power generated in the UK."

Caterina Brandmayr, Head of Climate, Green Alliance

Looking to the future

In the Energy White Paper published in December 2020, the UK Government recognised the important role that interconnectors play today and their future role in the transition to net zero.

National Grid Ventures welcomes this recognition and we are fully committed to working with all stakeholders in the UK and across the EU to maximise the opportunities that interconnectors bring.

The Government also set out plans to achieve 40 GW of offshore wind by 2030 – a four-fold increase over the next decade. Connecting large volumes of offshore wind to the grid efficiently will be challenging and will require significant coordination with our European partners. Interconnectors could make a significant contribution by efficiently linking with neighbouring markets and helping to unlock the potential of renewable generation at scale.

A new generation of interconnector

Offshore wind and interconnector technologies currently operate side by side. Individual offshore wind farms connect directly to the shore. Existing interconnectors, meanwhile, provide point-to-point links between the electricity systems of different countries. But these adjacent technologies have the potential to work together in a way that could transform how offshore wind connects to Great Britain and our European neighbours.

Instead of dozens of individual wind farms connecting one by one to the shore, multi-purpose interconnectors (MPIs) would allow clusters of wind farms to connect all in one go, plugging in offshore.

Bringing offshore wind and interconnector assets together makes sense. As well as speeding up connections, using interconnectors in a smarter way would vastly reduce the amount of grid reinforcement needed and mean much less disruption for coastal communities in terms of construction work.

UK and EU governments, regulators, and industry stakeholders, including TSOs and offshore wind developers, now need to work together to develop a framework to enable the delivery of pathfinder projects by 2030. You can find out more about the potential of MPIs and the investment we're making here:

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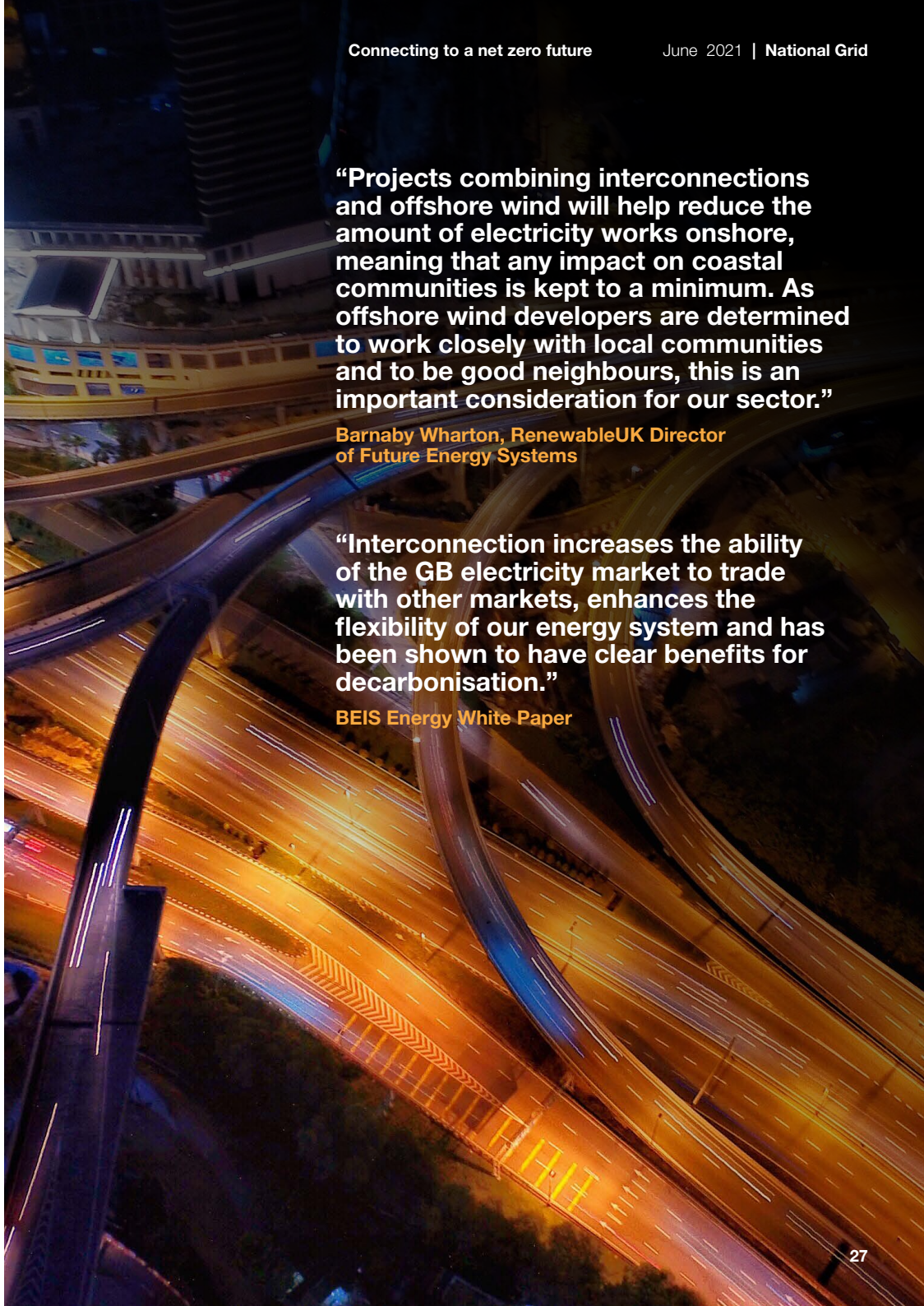

"Projects combining interconnections and offshore wind will help reduce the amount of electricity works onshore, meaning that any impact on coastal communities is kept to a minimum. As offshore wind developers are determined to work closely with local communities and to be good neighbours, this is an important consideration for our sector."

Barnaby Wharton, RenewableUK Director of Future Energy Systems

"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."

BEIS Energy White Paper

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