A connected future

Why electricity interconnection between Europe and the UK matters

April 2023

nationalgrid

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Co-operation on energy between Europe and the UK is vital to deliver our respective net zero targets

To achieve a cleaner energy future, the UK and the EU need to work closely together on the energy transition. We have so much in common already. We share similar strategic and ambitious climate and energy targets, including a legally binding approach to net zero by 2050, and cumulative offshore wind targets of over 350GW by 2050.

Our markets have been built together for decades, with the UK being instrumental in designing the EU Emissions Trading System, while the EU model shaping the new UK Emissions Trading System.

The EU-UK Trade and Cooperation Agreement recognises the critical role of efficient cross-border trading arrangements to facilitate the growth and integration of renewables. National Grid is committed to continued cooperation with our EU neighbours to develop arrangements that ensure the best outcome for consumers across Europe and the UK.

The North Sea has the potential to be a clean energy 'powerhouse' for Europe.

Implementing a North Sea powerhouse demands a new approach to the way we plan and build our energy system. We need to cooperate and innovate, to mobilise the supply chain, to simplify the regulatory regime and to reform the planning framework to make it a reality for all European consumers.



By 2030

the GB power sector could reach net carbon negative emissions and is expected to become a **net electricity exporter to Europe by 2050.**

A connected future

Who we are National Grid Ventures plays a leading role in the energy transition

Part of the National Grid Group, National Grid Ventures (NGV) develops, operates and invests in energy projects, technologies, and partnerships to accelerate the development of a clean energy future.

We have a strong track record of delivering electricity interconnector projects. By 2024, we will have a total of six subsea electricity interconnectors with a capacity of 7.8 GW connecting the UK with four EU Member States (France, the Netherlands, Belgium and Denmark), as well as Norway.

This will be enough electricity to power a total of 8 million British homes and 8.5 million homes in the partner countries.

Over the last 10 years, National Grid has invested more than €2.5 billion in new interconnector capacity to connect the UK with its neighbours. Our interconnector experience dates to 1986, with the commissioning of IFA (Interconnexion France-Angleterre). The ground-breaking 2 GW subsea electricity link between Great Britain and France was the first to bring together the technical and commercial expertise of RTE and National Grid.

Our newest interconnector North Sea Link (which started commercial operations in 2021) and Viking Link, (which will be completed by the end of 2023) will be the two longest electricity interconnectors of their kind in the world. We are also driving change through engineering innovation in High Voltage Direct Current (HVDC) technology to increase performance and develop new applications such as Black Start technology for IFA2.

150%

We need a **150 per cent** increase of installed capacity in order to meet the EU and UK offshore wind target by 2030





Shared benefits Interconnectors bring value to the EU and the UK

Sustainability

1. More sustainable energy and compatibility with European climate policy

Interconnectors are helping both the EU and the UK to realise the full potential of renewable energy sources. A greater role for renewables means more intermittent generation and volatility of the system. When the sun shines and the wind blows, there could be excess generation available, but when the weather is cloudy and calm, interconnectors can transfer this excess power from regions to where it is needed and in line with market prices, helping to meet consumer demand and reduce costs at both ends of the cable.

The UK currently has 13.6GW of operational offshore capacity, second only to China. The share of offshore wind in the UK power mix should be increasing by over 250 per cent by 2030 in order to meet the government's offshore targets.

With a growth in intermittent renewables, interconnectors become more important, providing system operators access to huge volumes of electricity at the flick of a switch. Accessing European electricity markets for wholesale electricity with a broadly similar mechanism will enable Britain to become a net exporter of electricity to the EU by 2050. Together with our European partners, we are committed to helping the EU and the UK reach net zero by 2050 by building a well-integrated and resilient energy transmission system that integrates offshore wind. Interconnectors are the product of great cooperation with our neighbours, they provide real benefits to consumers and help us all to meet our net zero targets. A win-win.

The ability to export excess generation to where it is needed most, prevents the curtailment of renewables. Renewables curtailment is when output from a renewable resource is reduced below what it could have otherwise produced. This can be when there is excess wind generation in a low demand period, or operator to protect the stability of the grid. In either case, low cost, zero carbon energy is wasted, which is disadvantageous for consumers and generators.

Looking forward to 2030, we expect that during the periods when Great Britain is exporting, renewable generation will exceed total demand for a significant portion of time. Wind and renewables in general, will supply more than three quarters of demand during export periods. Without the ability to export this excess power via interconnectors, we estimate the curtailment of renewables could be up to six times higher.

Viking Link:

Up to 1.4 GW of the UK's wind generation can be exported and, in return, Denmark can export green power to ensure security of supply.

Preventing the curtailment of renewables is also an issue for our neighbours across Europe. When wind generation is high and electricity Taking Viking Link as an example, our forecast predicts that, by 2030, Britain will mainly be importing low carbon electricity from Denmark.

For more than 75 per cent of those export periods, we expect Danish wind energy to exceed domestic demand. Without Viking Link, that wind generation would likely be curtailed. The interconnector fleet will also help to avoid curtailment of GB renewable generation, contributing to lower prices for consumers.

Viking Link

demand is low in the UK, Viking Link will allow up to 1.4 GW of power to flow from the UK to Denmark. When demand is high in the UK and there is low wind generation, up to 1.4 GW can flow from Denmark, providing the UK with clean imported electricity supplies.



Curtailment rates against penetration





With EU renewable generation expected to double from **32 per cent up to 65 per cent by 2030** of the total electricity mix, interconnectors can provide flexibility and cost-efficiency

Security of supply

2. Delivering improved security of supply and flexibility with more renewable energy sources (RES). By connecting Europe's energy markets, interconnectors enable countries to tap into a more diverse and sustainable mix of generation, increasing security of supply and flexibility in connected markets.

The EU has the ambitious goal of a 55 per cent reduction in greenhouse gas emissions by 2030. This means at least doubling the EU RES target in the energy mix from 32 per cent to up to 65 per cent.

Renewable generation is, by nature, more variable, which is why interconnectors can provide valuable flexibility to meet market supply and demand.

Offshore grids will play a key role in supporting a European integrated energy system. Close regional cooperation in the North Sea region is vital in achieving this ambition. This collaboration will enable countries to unlock the potential of hundreds of GW of offshore wind in the North Sea.

Nemo Link

Nemo Link is one example of the value of interconnection between mainland Europe and Great Britain.

The 1GW interconnector links the electricity systems of Belgium and Britain, and has achieved three years of outstanding operational performance:

- 100 per cent availability between September 2021 and September 2022, making it one of the most efficient assets of its kind
- 13 TWh of electricity imported and exported between the two countries
- More opportunities for balancing grids and limiting price spikes
- Greater energy independency and system resilience for both Belgium and Great Britain

13 TWh

Nemo Link is one of the most reliable interconnectors in the world, with over 13 TWh of electricity imported and exported

Case study 1: Overcoming power shortage issues



The importance of co-operation between the EU and the UK to support system stability was brought into sharp focus on 8 January 2021.

The electricity network in continental Europe faced significant system stability issues following a series of trips on the transmission network affecting the continental Europe Synchronous Area, which threatened security of supply.

By exceeding the 200 MHz frequency limit, a large number of generation units changed their control mode by either activating additional reserves in the North-West area or decreasing their generation further in the South-East area. Some 1.7 GW of automatic interruptible load in France and Italy was disconnected and frequency support was provided over HVDC links. The North-West area received 535 MW of automatic supportive power from the Nordic synchronous area. A further 60 MW from Great Britain contributed to system stability and security of supply. The incident underlined the critical importance of continued co-operation to maintain the integrity of the network and system stability.

60 MW

Case study 2: Meeting electricity demand in France



On 2 December 2020, capacity from the IFA interconnector played a crucial role in meeting demand from France at a point when power prices in mainland Europe were high, wind generation was scarce and there was unexpectedly high electricity demand.

On that date, intraday power prices in France traded near EUR 840/MWh, and German prices hit EUR 800/MWh, largely due to a combination of very low wind output in northwest Europe and high electricity demand. Within-day prices rose eight-fold compared with the equivalent day-ahead results in several Central-Western European countries. With French power consumption 1.5 GW higher than forecasted, there was also 'zero wind' in the tightest hours. Meanwhile, the Netherlands and Belgium were unable to export at that point meaning that IFA capacity was crucial in maintaining security of supply in France and mitigating a further increase in wholesale prices.



During the early winter months, this saw the National Grid interconnectors primarily exporting, driven by reduced nuclear output in France. This enabled the UK to share its excess wind generation, at a lower cost to them, while avoiding any curtailment costs in the UK. Since mid-December, the UK has been primarily importing despite high wind output, reflecting the market prices in Europe and therefore providing GB customers with lower priced electricity.



quality jobs, Viking Link, **3,000 roles** and Nemo Link **a further 1,400**¹

NGV interconnector

projects boost employment. NSL has created **2,700 high**

> Interconnectors enable intraday commercial flow mechanisms

Along with EU Member States, phasing out nuclear and coal, NGV interconnectors help to **ensure electricity is available when and where needed**



¹ Jobs referred cover roles such as client-side, consultants (environmental, technical, design assessment, civils etc), but also ground works development such as converter contractors/sub-contractors/specialists, cables contractors/sub-contractors.

Economic value 3. More flexible, competitive markets

and lower prices

NGV interconnectors can play an important role in enhancing the European energy market and enable the efficient integration of new renewable energy sources via market products like intraday commercial flow mechanisms.

The European energy landscape is changing rapidly. Belgium is planning to phase out nuclear power by 2025, while France aims to close 14 of its nuclear generators by 2035, and the Netherlands is set to end coal-fired power production by 2030. Against that backdrop, NGV interconnectors will deliver clean energy across borders to ensure security of supply and best value for consumers.



Reaching the full renewable energy potential in the North Sea via offshore hybrid projects

The North Sea has the potential to be a clean energy 'powerhouse' for Europe. As experienced developers and operators of sub-sea transmission projects in Europe, as well as wind power in the US, we want to ensure the North Sea's potential delivers maximum benefit to all Europeans. Offshore arid development will also support the European offshore wind industry leadership and energy innovation globally.

Offshore wind is a reliable source of energy with high load factors. In the coming years. the North Sea could be home to up to 220 GW of offshore wind, making a significant contribution to meeting Northwest Europe's electricity demand.

We are working with European partners to develop a vision for multi-purpose interconnectors. Instead of individual wind farms connecting to one land point. multi-purpose interconnectors would allow clusters of offshore wind farms to connect all in one go, plugging into the energy systems of neighbouring countries.

Multi-Purpose Interconnectors, also called offshore hybrid projects, can deliver:

- Support UK and EU efforts to meet 2030 and 2050 offshore wind targets
- Reduce the impact on the environment and coastal communities with fewer individual connections
- Speed up the displacement of fossil fuelled power stations
- Deliver more affordable energy by allowing more clean energy to flow between countries, in line with market prices

NGV currently has connection agreements in place for 6.4 GW of interconnector capacity, which could connect up to 12.8 GW of offshore wind

NGV sees potential for 6.4 GW of The proposed Nautilus interconnector project interconnector capacity in the North Sea to connect up to 12.8GW of offshore wind with Belgium, the Netherlands, and Norway,

delivering significant benefits: 1. By 2050, we estimate a circa 60%

- reduction in GB CO2 emissions in the power sector compared to 2022 levels
- 2. More than 50 per cent reduction in landfalls
- 3. More than 50 per cent reduction in DC converters
- 4. Net socio-economic welfare benefits up to EUR3.5bn for EU and UK consumers.

connecting up to 2.4GW of offshore wind in Great Britain and Belgium would result in £300m net benefits for GB consumers and £1.000m for EU consumers over the period from 2030 to 2050.

An integrated approach means saving up to EUR3.5bn for EU & UK consumers

2050 - under current radial connections*



2050 - with an integrated approach*



*Figures from ESO Offshore Coordination Phase 1 Final Report, December 2020



The UK & EU have set ambitious targets for offshore wind and interconnectors to generate and share huge amounts of clean energy. Today, wind farms and interconnectors connect individually to electricity networks. This approach is inefficient and unstainable given the huge scale of development required.

Multi-Purpose Interconnectors

Multi-purpose interconnectors combine the enormous benefits of offshore wind and interconnectors. They connect clusters of offshore wind farms to multiple countries via interconnectors, accelerating the connection of offshore wind and reducing the impact of infrastructure on coastal communities.

Energy Islands

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Energy Islands are state-of-the-art offshore clean energy hubs that will enable the connection of offshore wind to multiple countries and serve as a platform for the production and delivery of green hydrogen.

Green hydrogen

Carbon-free hydrogen can be created through a process called electrolysis. Electrolysis are a system that use electricity to split hydrogen from water molecules, producing green hydrogen with oxygen as a by-product. Green hydrogen will play a critical role in Europe's evolution to a Net Zero energy system.



Commitment to communities

The delivery of new clean energy infrastructure cannot be at the expense of the environment and coastal communities. A coordinated approach to network design is needed to maximise the benefits of clean energy, while mitigating the impact of new infrastructure on communities.

Job Increase

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The growth of offshore wind will deliver significant economic benefits across the UK & EU. By 2030, wind energy will produce 450,000 jobs in Europe, with around 200,000 in just offshore wind.

Marine Environment

The marine environment must be protected as offshore networks and wind farms are developed. TSOs, wind developers, environmental NGOs, and energy associations must work together to develop a holistic approach for offshore wind grid infrastructure development that balances the protection of the marine environment with climate objectives.

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