



A connected future

Why electricity interconnection
between Europe and the UK matters

August 2021

nationalgrid

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 EU and the UK need to work closely together on the energy transition. We have so much in common already. We share similar strategic climate targets, including a legally binding approach to net zero by 2050, and our markets have been built together for decades.

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 co-operation with our EU neighbours to develop arrangements that ensure the best outcome for consumers across Europe.



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**





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 new 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.

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 2 GW subsea electricity link between Great Britain and France – a project that first brought together the technical and commercial expertise of RTE and National Grid.

Our newest interconnectors, North Sea Link (operational in 2021) and Viking Link (operational in 2024), will be the two longest electricity interconnectors of their kind in the world.

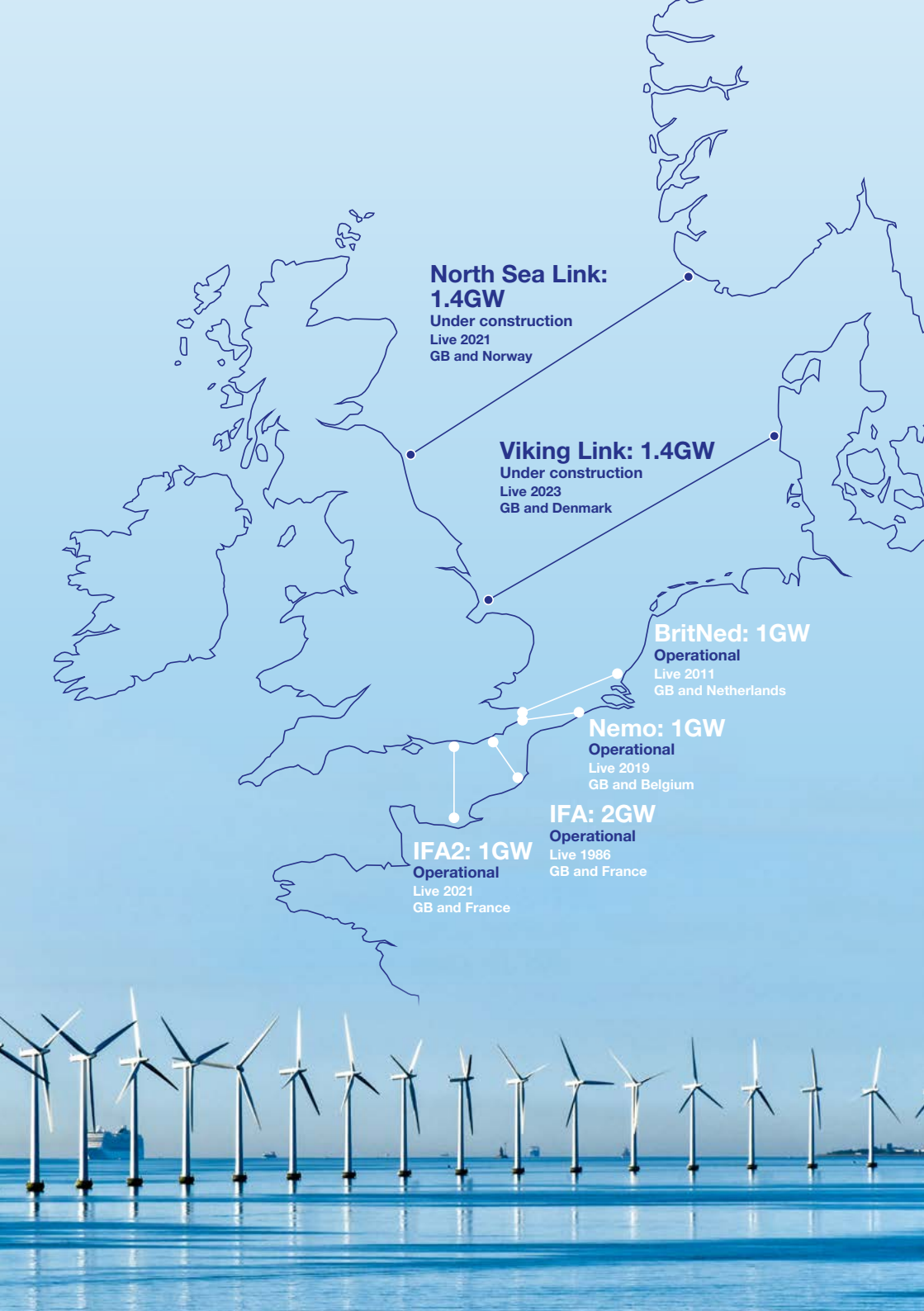
We are also driving change through engineering innovation in High Voltage Direct Current (HVDC) technology to increase performance and develop new applications such as Black Start technology for IFA2.

The overall capacity from NGV's interconnectors of nearly 8 GW will be enough to power 8.5 million homes in France, Belgium, the Netherlands, Norway and Denmark, as well as up to 8 million UK homes.



300%

We expect a **300 per cent** increase offshore wind's share of the UK power mix by 2030



North Sea Link: 1.4GW

Under construction
Live 2021
GB and Norway

Viking Link: 1.4GW

Under construction
Live 2023
GB and Denmark

BritNed: 1GW

Operational
Live 2011
GB and Netherlands

Nemo: 1GW

Operational
Live 2019
GB and Belgium

IFA: 2GW

Operational
Live 1986
GB and France

IFA2: 1GW

Operational
Live 2021
GB and France



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 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. Interconnectors are helping to enable this transition. They can provide the solution to transfer this excess power and have the capacity to meet consumers' demand on either side of the Channel.

The UK is the world leader in offshore wind with 10 GW capacity installed in 2020. Meanwhile, the share of offshore wind in the UK power mix is expected to increase by 300 per cent by 2030.

Having access to European electricity markets for wholesale electricity with a broadly similar mechanism, Britain will become a net exporter of electricity to the EU by 2050.

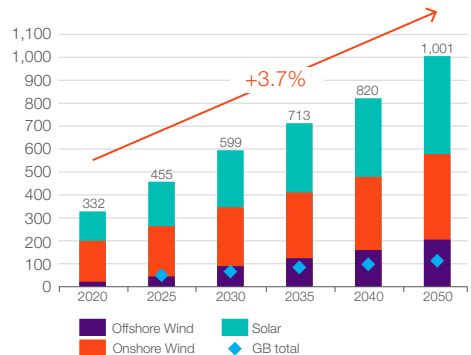
According to National Grid ESO's Future Energy Scenarios, the GB power sector may reach net carbon negative emissions as early as 2030.

Offshore wind will have to increase 20-fold to reach the 300 GW EU target by 2050. Together with our European partners, we are committed to help the EU and the UK reach net zero by 2050 by building a well-integrated and resilient energy transmission system to integrate offshore wind. More wind and solar generation across Europe will also contribute to significantly higher volatility which underlines the value of interconnectors.

EU renewables installed capacity (GW)

Source: National Grid Market Fundamentals BC21

Notes: 1) EU represents here EU17 (AT, BE, CH, DE, DK, ES, FI, FR, GB, IE, IT, LU, NL, NO, PL, PT, SE) covered under BC21. 2) Renewables (RES) include wind onshore, wind offshore, solar; 3) +3.7% is the growth rate from 2020 to 2050.



North Sea Link:

Up to 1.4GW of the UK's wind power generation can be exported and in return Norway can sell hydropower ensuring security of supplies

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 because of an instruction by the system 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.





Preventing the curtailment of renewables is also an issue for our neighbours across Europe. Taking Viking Link as an example, our view is that, by 2030, Britain will be importing electricity from Denmark up to 60 per cent of the time. 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.

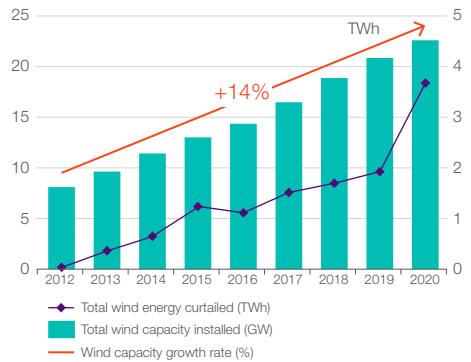
North Sea Link

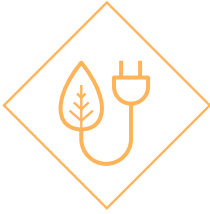
When wind generation is high and electricity demand is low in the UK, North Sea Link will allow up to 1.4 GW of power to flow from the UK to Norway, conserving water in Norway's reservoirs.

When demand is high in the UK and there is low wind generation, up to 1.4 GW can flow in the opposite direction from Norway, providing the UK with clean imported electricity supplies.

Curtailment rates against penetration levels for wind power in GB (GW)

Source: National Grid Market Fundamentals BC21





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 1 GW interconnector links the electricity systems of Belgium and Britain, providing affordable, clean, secure electricity.

Nemo Link has achieved two years of outstanding operational performance:

- Availability of over 98 per cent, making it one of the most reliable installations of its type in the world
- 12 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

98%

With **availability of over 98 per cent**, Nemo Link is one of the most reliable interconnectors in the world, with over 12 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.

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.

Case study 3: Belgian nuclear outage



When a 1 GW nuclear power plant in Belgium tripped on 4 December 2019, it led to a 37-hour outage. The Nemo Link interconnector was called on to provide a substantial amount of electricity capacity to balance the grid.

Nemo Link flows primarily in the direction of the UK, but the flexibility to change the direction of flow proved valuable on this occasion. With high demand in the evening, the peak imbalance price was **EUR 1,660/MWh** due to the system's shortage of over 600 MW in some periods.

Nemo Link's capacity of 1 GW coupled with the technical flexibility to export power at short notice was vital in resolving the situation. The incident also demonstrated the importance of intraday products in enabling the market to react in real time.



NGV interconnector projects boost employment. NSL has created **2,700 high quality jobs**, Viking Link, **3,000 roles** and Nemo Link **a further 1,400¹**

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.



Interconnectors enable
intraday commercial
flow mechanisms



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

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 'power station' 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 grid development will also support the European offshore wind industry leadership and energy innovation globally.

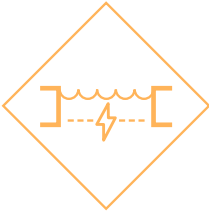
Offshore wind is a reliable source of energy with high load factors. In the coming years, the North Sea could be home to up to 220 GW of offshore wind, making a significant contribution to meeting Northwest Europe's electricity demand.

We are working with European partners to develop a vision for multi-purpose interconnectors. Instead of individual wind farms connecting one by one to the shore, 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/offshore hybrid projects can deliver:

- Better interconnectivity with energy from connected larger markets being delivered more flexibly
- Environmental and spatial planning benefits, with less infrastructure and landing points
- More efficient use of offshore wind infrastructure, driving down costs





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 interconnector capacity in the North Sea to connect up to 12.8 GW of offshore wind with Belgium, the Netherlands, and Norway, delivering significant benefits:

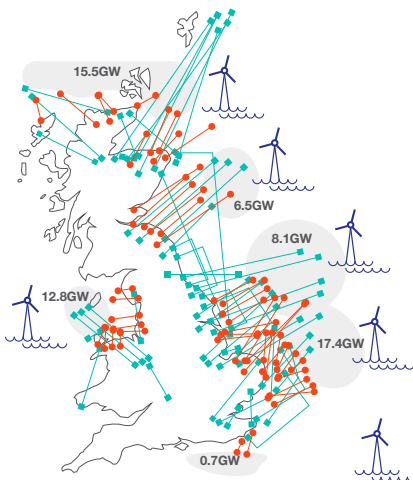
1. A 21mt reduction in Europe's CO₂ emissions of across different scenarios between 2030 and 2050
2. More than 50 per cent reduction in landfalls
3. More than 50 per cent reduction in DC converters
4. Net socio-economic welfare benefits – up to EUR3.5bn for EU and UK consumers

The new Eurolink interconnector project connecting 1.8 GW of offshore wind in Great Britain and another 1.8 GW in the Netherlands would result in net benefits for EU consumers of EUR 1,013m over the period from 2030 to 2050.²

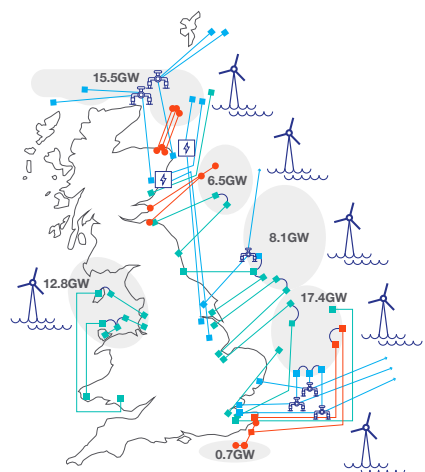
² Baringa report "Multi-Purpose Interconnectors: key benefits for European consumers of a coordinated approach to offshore wind and interconnectors", October 2020

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

2050 – under current radial connections



2050 – with an integrated approach



Source: National Grid ESO Offshore Coordination Proposals, 2020

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