

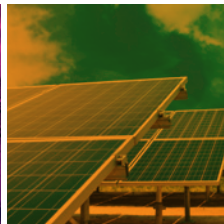


national**grid**
Interconnectors



Connecting for a smarter future

How interconnectors are making energy better for consumers



Benefiting customers today and tomorrow

Interconnectors are making energy more secure, affordable and sustainable for consumers across Great Britain (GB) and Europe. And they are set to deliver much more.



£3 billion investment

Since 2014, over £3 billion has been invested in 4.4 GW of new interconnector capacity, which will more than double the existing capacity between GB and continental Europe by the early 2020s.



Power for 11 million homes

4.4 GW of capacity provides access to enough electricity to power 11 million homes.



9.5 GW more

There is potential to increase the benefits to consumers through a further 9.5 GW of interconnectors that will help deliver a smarter, more flexible future energy system.



£11 billion for consumers

The 9.5 GW pipeline is worth at least £11 billion to GB consumers. We're now working together with governments, regulators and industry partners to ensure consumers benefit from the full potential of interconnectors.

Stronger links for a smarter future

Interconnectors are transmission cables that allow electricity to flow freely between markets. They are at the heart of the transition to a smarter energy system.

Tomorrow's energy will be cleaner, more flexible and more responsive to the individual needs of consumers. To efficiently deliver the energy system of tomorrow, European countries are working together to maximise the potential of technologies like battery storage, wind and solar power. Interconnectors enable smarter energy systems to react quickly to changes in supply and demand, ensuring renewable energy flows from where it is being generated in large quantities, to where it is needed most. Consumers benefit from interconnectors because they open the door to cheaper energy sources and help GB build a smarter energy system.

While the future relationship between GB and the EU remains unclear, we are confident that we will continue to trade electricity across interconnectors. It is in the best interests of all consumers for GB to keep working closely with the EU to build an energy system that makes the best use of all our energy resources.

Doubling capacity

Today, GB has four interconnectors linking to France, Ireland and the Netherlands. These interconnectors deliver 4 GW of capacity. Thanks to the positive benefits these projects have brought to consumers, the GB government is now encouraging the market to develop more interconnectors.

A key element of this is the Cap and Floor regulatory regime. This provides confidence to investors while ensuring consumers have access to cheaper electricity and the potential to directly share in the financial benefits of interconnector projects. The design of the regime means that consumers are highly unlikely to ever pay a penny for these benefits.

National Grid recognises the challenges that Brexit poses. However, we remain confident that trade in electricity will continue to benefit consumers in GB and Europe now and in the future.



As a result, three new interconnectors – North Sea Link to Norway, Nemo Link to Belgium, and IFA2 to France – secured regulatory approval and private sector investment, and are now under construction. The improved investment climate was also behind the development of the ElecLink interconnector, which is moving forward without Cap and Floor regulation.

These pioneering new projects, funded by more than £3 billion of private sector investment, will create 4.4 GW of extra capacity. As a result, GB will have 8.4 GW of interconnector capacity by the early 2020s – more than double the amount we have today.

Consumers benefit from interconnection because it opens the door to different energy markets and cheaper energy sources. This helps to keep energy supplies secure, safe and affordable.

£11 billion opportunity

The GB government, through its Clean Growth Strategy, has identified new opportunities to build interconnectors that would deliver a further 9.5 GW of capacity. Our analysis shows that these projects can deliver at least £11 billion of benefits to consumers, compared to a scenario where additional power stations are built to provide GB with the same level of flexibility and security of supply.

GB will need to maintain a clear and stable policy and regulatory landscape to make this next generation of interconnectors a reality. We are ready to work with government and Ofgem, the GB energy regulator, to make sure consumers experience these important benefits. Collaboration is particularly important because of the huge investment – in both time and money – that's required to make these projects happen. A typical interconnector takes around 10 years to develop and build.

For potential investors, clarity and stability is vital. With clear regulatory frameworks and policies in place, they'll have greater confidence in backing this new era in energy.

Maximising benefits

Interconnectors are integral to today's energy system and will continue to be in future. Across Europe and GB, leaders agree that building more interconnectors will only benefit consumers and industries.

At a GB level, we welcome the government's ongoing commitment to interconnectors, as well as its support for policies that give confidence to investors and consumers in the short and long term. As these are long-term projects, with 25-year regulatory deals, it is important that policies support the investment throughout the lifetime of the interconnector.

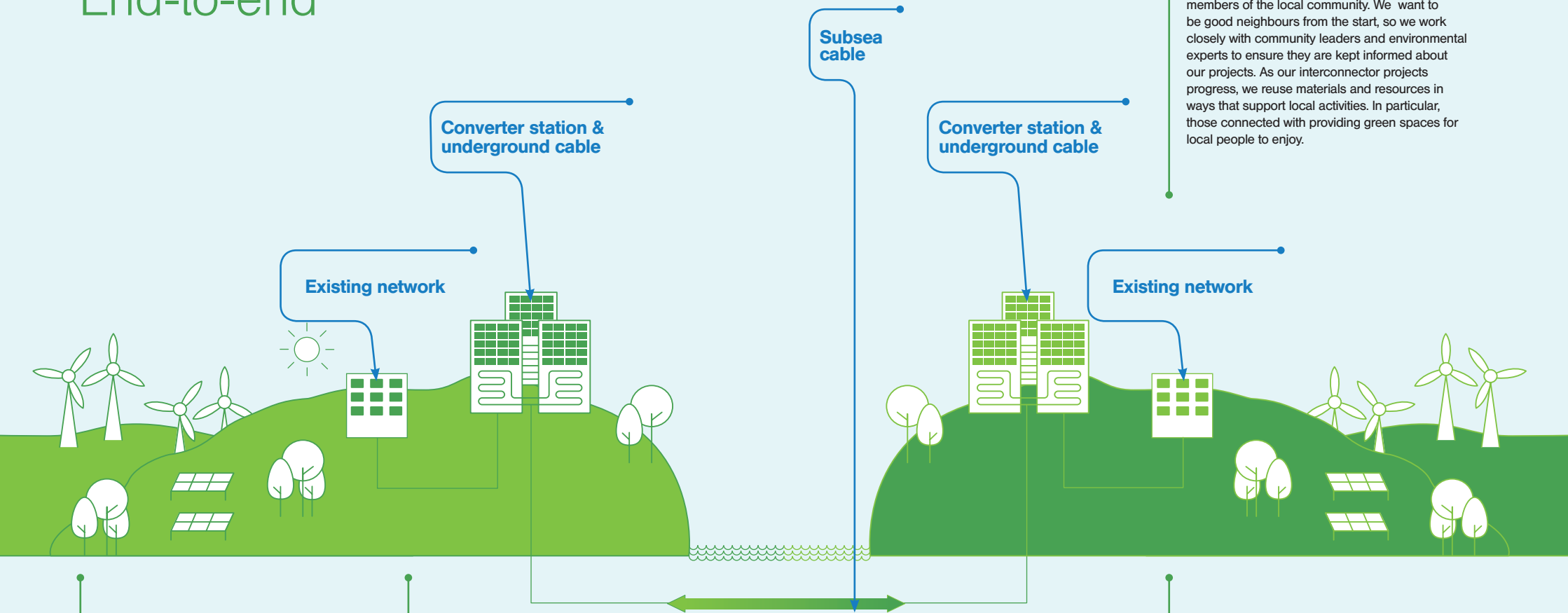
Ofgem has announced that it will carry out a strategic review of the Cap and Floor regime to ensure that it is meeting the needs of consumers. We welcome this well-timed review. With three Cap and Floor projects under construction, and six more in the development phase, there is plenty to learn about the regime.

We look forward to working closely and transparently with Ofgem and others to ensure that the Cap and Floor regime continues to achieve the best outcome for consumers by prioritising the best projects when they become available.

With clear regulatory structures and policies in place, potential investors will have greater confidence in backing this exciting new era in energy.



Interconnectors: End-to-end



Local communities

How we work with local communities is really important to us. We see ourselves as long-term members of the local community. We want to be good neighbours from the start, so we work closely with community leaders and environmental experts to ensure they are kept informed about our projects. As our interconnector projects progress, we reuse materials and resources in ways that support local activities. In particular, those connected with providing green spaces for local people to enjoy.

Pioneering hi-tech innovation

Renewable generation, such as wind and solar, creates challenges for GB's electricity System Operator. We're continually exploring how we can use interconnector technology to help deliver the smart and flexible services we need to manage the system more efficiently. These include frequency response and reactive power reserve.

Re-thinking the supply chain

We've been working with new suppliers to increase competition, reduce costs and overcome manufacturing challenges on these large and complex projects. Our efforts have already had a positive impact; on our North Sea Link project, our work with the supply chain enabled us to reduce costs by 30% from initial estimates. This directly benefits consumers.

Connecting renewable generation across borders

Interconnectors allow countries to look beyond their borders and use renewable energy more efficiently. When it is sunny and windy in GB, for example, where lots of power is generated, generation can be moved quickly to a country where it's needed. When GB conditions are less favourable, power can be imported from Europe.

Building strong partnerships

We are at the heart of the energy system, so building the right relationships is really important to us. We have forged strong relationships with partners across Europe which help us to build businesses that focus on driving greater benefits for consumers. By working with our neighbours in Europe, we can maximise the benefits of cleaner energy in our own energy mix – for example, wind power from Denmark, hydro energy from Norway, and wind and carbon-free nuclear from Belgium and France.

Why interconnectors are the smart choice

Stakeholders from across the British government, Ofgem, consumer organisations, environmental groups, think tanks and EU institutions all agree that more interconnectors are integral to delivering a smart and more flexible energy system for consumers.

Security

Interconnectors strengthen security of energy supplies. They provide reliable and flexible access to electricity which dynamic, growing economies need. Importantly, they give system operators the critical tools they need to balance rapid changes in supply and demand.

By linking national energy systems, interconnectors help to smooth hourly variations in production from wind and solar farms. Time and cultural differences between countries, where for example the average dinner time is later than in Britain, also ensures that peak times do not completely overlap.

In recent years, GB has imported electricity from France, due to its comparatively low prices. During a few weeks of 2017 and 2018, we exported more frequently to France. At these times, the market protects our security of supply by dictating a change in flow if GB experiences a shortage of available generation.

We know that both the cost and complexity of managing the electricity system will rise in the next few years as renewable sources of generation make it more difficult to balance supply and demand. Interconnectors will help us overcome this by putting large volumes of dynamically available power at the flick of a switch.

Interconnectors make the market more economically efficient, by ensuring everyone has access to the lowest priced electricity available.

Sustainability

The GB energy sector is going through a radical transformation. Renewable generation, including solar, onshore and offshore wind, biomass, and potentially tidal, is bringing an era of low-carbon energy ever closer.

The government has set ambitious goals decarbonising the energy sector, using the Carbon Price Floor to turn GB into a global leader in the fight against climate change. However, the challenge remains that renewable sources are difficult to forecast and control.

Interconnectors can help by providing the flexibility for multiple sources of low-carbon energy to be used efficiently. For example, Norwegian hydropower can fill the gap when the sun isn't shining and there is little or no wind in the UK. While on very sunny and windy days in Britain, excess power production can be stored in Norwegian lakes using hydro storage. In years with little rainfall, Norway can top up with power from the UK.

Affordability

By the early 2020s, GB consumers will see significant benefits from the interconnector projects that have secured investment and regulatory approval in the past few years.

Interconnectors make the market more economically efficient, by ensuring everyone has access to the lowest priced electricity available. When the market is tight in an individual country, interconnectors make it possible to import power from countries with less expensive generation resources, for example a surplus of electricity generated by wind turbines on a windy day. As more interconnectors help to bring down wholesale prices, consumers will benefit from lower bills.

Benefits in brief



More interconnectors reduce energy prices for consumers.



Interconnectors enable the best and most efficient use of renewable energy across Europe.



Interconnectors provide system operators with large volumes of extra power to efficiently and economically balance the system.



Case study

GB's first coal-free day since the Industrial Revolution

On Friday 21 April 2017, GB went 24 hours without using coal to generate electricity – for the first time since 1882. This historic achievement was made possible by GB's bold environmental policies and initiatives to decarbonise the country's energy production. Interconnectors played a key role in achieving that coal-free day.

21 April
2017

First coal-free day



Consensus for more interconnectors

Ministers, the regulator and other people at the heart of our industry agree that more interconnectors are good for energy security, GB consumers and a greener grid.

“Interconnectors offer a number of benefits to the UK and are a key source of flexibility to the electricity system. They are one of the few existing technologies that can shift large volumes of electricity from where it isn't needed to where it is. By doing this they have the potential to lower prices for consumers, improve the investment case for power stations, help us meet our carbon targets at a lower cost and improve security of supply.”

UK National Infrastructure Commission

“Greater interconnection is good for security of supply as we can import from a wider, deeper and cheaper pool of electricity available in neighbouring countries... More interconnection is also good for competition.”

Dermot Nolan, Ofgem CEO

“We will work to ensure significant private investment in new electricity interconnectors, which will help keep prices low for consumers, ensure a more secure grid and help integrate clean generation.”

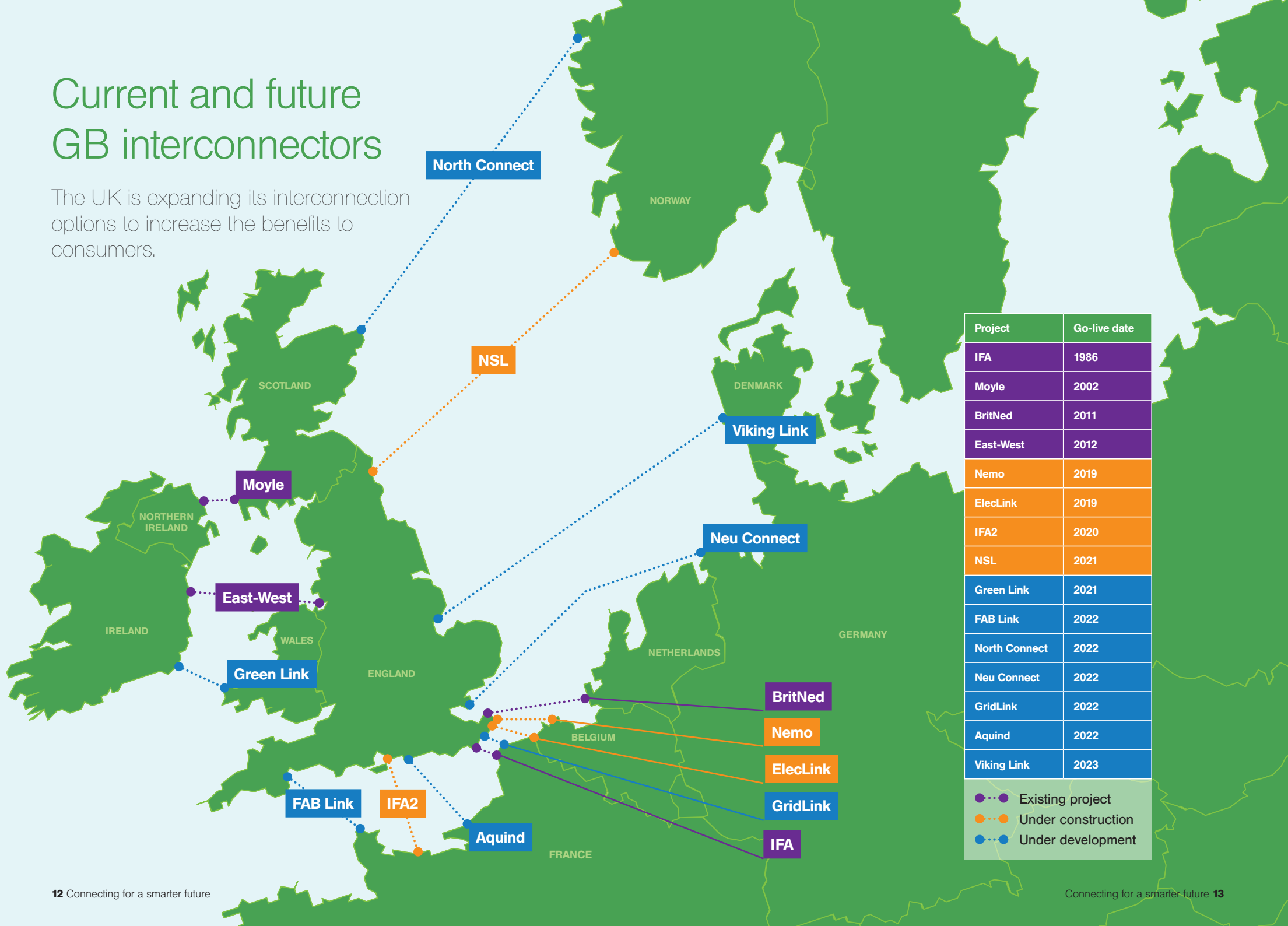
The UK government's Clean Growth Strategy

“We remain strongly supportive of new interconnectors. Brexit does not change the advantages of linking our electricity market with those of Europe. This trade is mutually beneficial for British business and consumers, and for our European counterparts.”

Greg Clark, Secretary of State for the Department of Business, Energy and Industrial Strategy

Current and future GB interconnectors

The UK is expanding its interconnection options to increase the benefits to consumers.



Project	Go-live date
IFA	1986
Moyle	2002
BritNed	2011
East-West	2012
Nemo	2019
ElecLink	2019
IFA2	2020
NSL	2021
Green Link	2021
FAB Link	2022
North Connect	2022
Neu Connect	2022
GridLink	2022
Aquind	2022
Viking Link	2023

● Existing project
● Under construction
● Under development

The power of cooperation

Working together, the public and private sectors have dramatically, and positively, changed the landscape for interconnectors.

Strong commitment from the GB government, and its European counterparts, has been integral to the rapid increase in interconnector capacity. Helpful regulatory frameworks have been developed that strike a balance between risk and reward for developers and consumers.

Thanks to this regulatory clarity and supportive policy environment, we're building robust and wide-ranging projects – and more are in the pipeline. There are several notable successes in this area.



4.4 GW
of interconnector projects – with a combined investment of over £3 billion – are currently being built.

Cap and Floor: The GB government introduced the innovative Cap and Floor regime for interconnectors in 2014. It gives some security to investors, while making sure consumers also enjoy the benefits of interconnectors.

Ofgem sets the level of the Cap and the Floor based on its assessment of the costs of developing and building the interconnector. Investors are guaranteed a revenue 'floor', which ensures a minimum return. 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 back to consumers – this is different from merchant interconnectors and generators, where the developer retains windfall profits. Ofgem only approves projects where independent analysis has established that the project benefits consumers – i.e. that floor payments are highly unlikely.

As well as giving some certainty to investors, Cap and Floor has been vital in providing confidence to European Transmission System Operator Joint Venture partners and the National Regulatory Authorities in other jurisdictions.



Case study

NSL – flexible access to clean energy

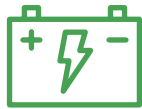
To meet environmental targets, GB and Norway will continue to generate more power from renewable sources, including offshore and onshore wind, and large and small-scale hydropower.

Thanks to North Sea Link (NSL), this renewable energy – wind power from GB and hydropower from Norway – will be quickly and reliably available for other countries to use.

The project is an incredible feat of engineering. Not only will NSL be the longest subsea interconnector in the world at 720km, but by the time it is completed, engineers will have drilled a 2.5km tunnel through granite, installed avalanche protection and laid cable through lakes 100m above sea level.

720km

NSL will be the longest subsea interconnector in the world.



9.5 GW

has been identified, which could amount to a consumer welfare value of £11 billion over 25 years.

These successes have had a ripple effect, encouraging more interest from investors, enabling more projects to get off the ground, and enhancing the benefit to consumers.

Supply chain: At National Grid, we have a strong track record of developing interconnector projects. Always looking for a better way to do things, we've invested in expanding the supply chain. This activity has a direct benefit for consumers.

Broadening the supply chain beyond traditional European manufacturers has helped overcome supply limitations with cable manufacturers – this means projects can benefit consumers faster.

By increasing competition we not only deliver faster, but also reduce project costs. The Cap and Floor is set in direct reference to project costs, so when these are lower, the threshold for giving money back to consumers is lower.

These successes have had a ripple effect, encouraging more interest from investors, enabling more projects to get off the ground, and increasing benefits to consumers.

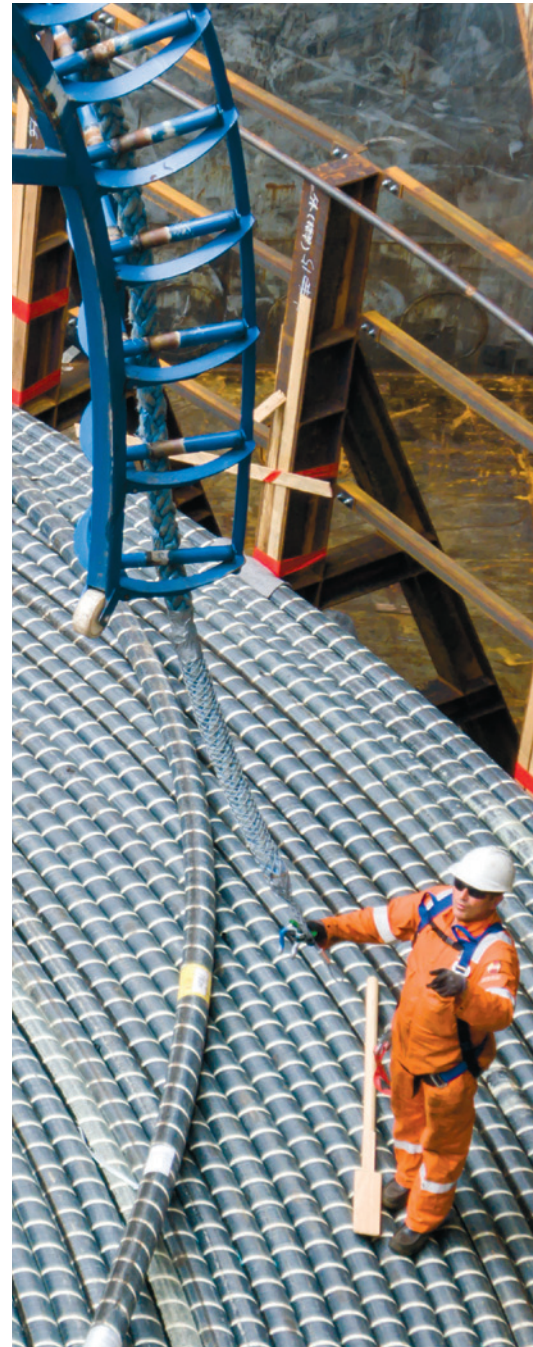
What's more, the government's recent Clean Growth Strategy shows a clear path towards an extra 9.5 GW, in addition to the 4.4 GW under construction.

Saving GB consumers £11 billion

We estimate an additional 9.5 GW would be worth at least £11 billion in consumer welfare value over 25 years.

The consumer welfare value is the predicted reduction in the total spend on electricity in GB as a result of interconnector imports. In other words, imported electricity is cheaper than electricity generated by carbon-intensive GB generators, especially fossil fuels such as gas.

We based our analysis on the independent report commissioned by Ofgem and produced by Pöyry, to assess the second phase of Cap and Floor applicants. Our estimate is a conservative one and we believe the consumer welfare benefit from a further 9.5 GW will ultimately be higher than £11 billion.



Case study

Nemo – bringing innovation to the HVDC supply chain

Most European High-Voltage Direct Current (HVDC) interconnector projects use European suppliers and manufacturers. While there's no lack of a global supply chain, businesses from outside Europe face barriers to entry including European technical standards, supply chain support, and high shipping costs.

National Grid has spent substantial time and effort working with suppliers from other markets to bring more competition into Europe. A key success is the Nemo interconnector, where Japanese manufacturer Sumitomo will provide the HVDC cable.

Along with bringing in a new supplier, the cable itself will be a world-first deployment of an innovative new technology. This 400kV XLPE cable is cheaper and more efficient than traditional alternatives.

Bringing new suppliers into the European market, along with pioneering new technology, is great news for consumers. It helps overcome existing issues in the supply chain and makes sure developers get the most cost-effective solution.

Delivering investment in the next generation of projects

Our analysis shows that there is significant consumer benefit from at least a further 9.5 GW of interconnectors, in addition to the 8.4 GW in operation or under construction.



We believe that continued cooperation between the EU and the UK post-Brexit will be beneficial... and crucial for maintaining Europe's unique level of security of supply.



Peder Andreasen,
ENTSO-E President,
March 2017

It is in the interest of all parties to deliver the next generation of interconnectors as fast as possible, building on the successes so far and learning lessons where appropriate. The work done together to this point will be vital to delivering the £11 billion consumer benefit from even more interconnectors.

While there is uncertainty over the exact nature of the future relationship, both the EU and GB continue to support interconnectors and recognise the benefits to consumers through lower prices, enhanced security of supply, and decarbonisation.

Having a clear and reliable framework of policies and regulations gives investors confidence to support these vital projects. Given the scale and complexity of interconnector projects, we encourage Ofgem and the government to develop a plan to minimise the risk of projects falling short of expectations.



Interconnector investors develop projects in response to market signals. Given the fundamental differences between the GB and European markets, we expect that, in any scenario, electricity will continue to flow between markets. It is also important that the government continues the policies that have prompted investment:

Continue to allow interconnectors non-discriminatory access to the Capacity Market

Without interconnectors, there is less competition in the Capacity Market, and GB generators are under less pressure to bring down costs for consumers. It is crucial that government policy continues to recognise this and allows interconnectors to be rewarded on an equal basis to other capacity. Interconnectors add to the diversity of capacity resources and reduce reliance on importing potentially volatile commodities such as gas and coal.

Treating interconnectors as an integral part of the transmission system

Current law recognises that applying transmission charges to interconnectors would amount to double taxation, as



Above all, that means offshore wind and nuclear have a big role to play, alongside greater interconnection with grids in neighbouring countries. We remain strongly supportive of new interconnectors.



Greg Clark,
Secretary of State for
the Department of
Business, Energy and
Industrial Strategy,
November 2016

charges for the electricity are already paid in the country of origin. Applying transmission charges to interconnectors simply adds an import tariff to cross-border trades, increasing costs to end consumers through higher electricity bills.

A stable regulatory environment that supports investment is also vital. That means working to ensure European and GB regulatory frameworks stay aligned. We will support Ofgem in playing a significant role to make this happen.

While Ofgem's Cap and Floor regime has encouraged a lot of investment in its current format, we see ways to deliver more investment faster in the future. We look forward to Ofgem's review of the Cap and Floor regime; based on our experience, we have identified some changes that could make an immediate and substantial difference.

It is our belief that the consumer benefit of interconnectors will be greater if more projects are allowed to sign up for a regulatory deal.

We recommend that Ofgem:

- Ensures the best projects are delivered as fast as possible.
- Allows developers to put forward new projects for a Cap and Floor deal in an open-ended way – with each one being assessed on its own merits.

One solution is further expansion of the number of interconnector projects. If the government committed to this, we could control the risk of existing projects hitting delays or not measuring up to expectations.

We believe that the consumer benefit of interconnectors will be greater if more projects are allowed to sign up for a regulatory deal, and developers are allowed to compete on delivering these important projects.



Background

Working with strategic partners, we are developing further interconnection and supporting market integration initiatives between GB and Europe.

This paper has been prepared by National Grid Interconnector Holdings Limited (NGIH Limited), which pursues business development opportunities alongside National Grid's RIIIO regulated businesses. NGIH Limited is a wholly-owned subsidiary of National Grid plc. Our interconnectors deliver secure and affordable electricity, and will play a critical role in tomorrow's cleaner and smarter energy systems. We sell capacity products to energy traders and provide services for transmission system operators in the UK and mainland Europe.

Our operational businesses are the Interconnexion France-Angleterre (IFA) interconnector between GB and France, and the BritNed interconnector which runs beneath the North Sea between the Isle of Grain in Kent and Maasvlakte, near Rotterdam. Interconnexion France-Angleterre has been operational since 1986 through our joint operation with Réseau de Transport d'Electricité (RTE). BritNed has been operational since 2011 through our joint operation with TenneT. Working with strategic partners, we are developing further interconnection and supporting market integration initiatives between GB and Europe.



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National Grid Interconnector Holdings Limited
1-3 The Strand, London WC2N 5EH
United Kingdom

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