Vital connections

How interconnectors are helping
to secure our energy future

December 2023

nationalgrid

Contents

Energy security is a pressing challenge for governments worldwide. This publication explores how electricity interconnectors strengthen security of supply by keeping the power flowing to millions of homes and businesses across Great Britain. It also examines how a new generation of offshore hybrid assets will help to unlock the full potential of offshore wind, supporting the UK's net zero ambitions and speeding up the clean energy transition.

About us

National Grid Ventures plays a leading role in the energy transition.

National Grid Ventures (NGV) is at the forefront of the energy transition. We operate across the UK, Europe and US, developing, operating, and investing in large-scale clean energy infrastructure. We're helping to accelerate society's drive towards net zero while maintaining security of supply today.

NGV runs separately from National Grid plc's core regulated operations. We've built a broad portfolio of businesses that work together to keep the lights on, decarbonise the economy and power a clean, fair and affordable energy future for consumers.

NGV has a proven track record of developing electricity interconnectors. By the end of 2024, we will have six subsea interconnectors in operation, connecting Great Britain's electricity network to Belgium, Denmark, France, the Netherlands and Norway. Together these projects have a capacity of 7.8GW – that's enough electricity to power about 8 million homes in the UK.

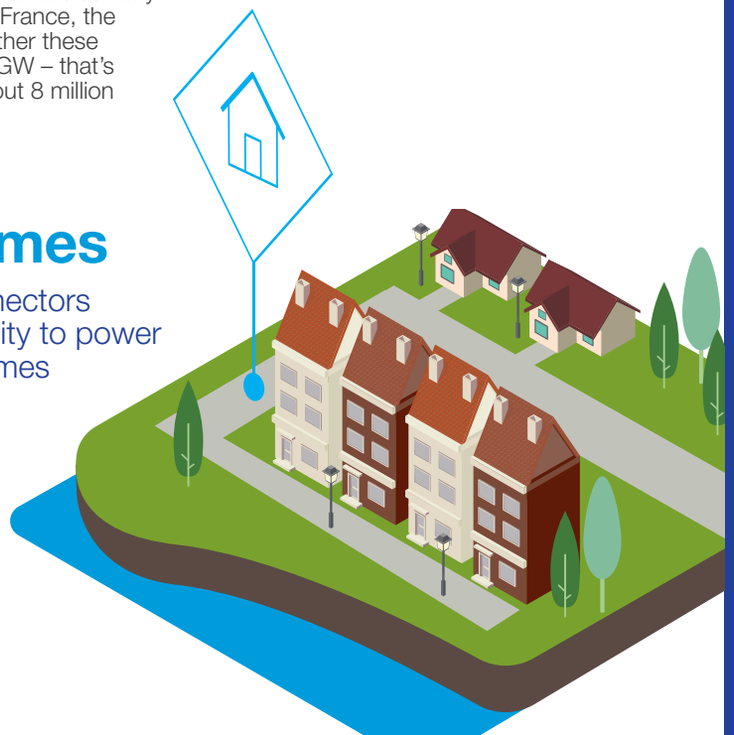
We have over 30 years' experience in delivering secure, affordable and sustainable energy via interconnection. The pioneering Interconnexion France-Angleterre (IFA) was the first subsea electricity link connecting Great Britain and France, commissioned in 1986.

Building on this experience, over the last decade National Grid Ventures has invested more than £2 billion in interconnector projects to connect the UK with its neighbours.

North Sea Link, one of our newest interconnectors, began operation in 2021 and connects Britain's grid to Norway. It was followed by Viking Link, commissioned December 2023. They are the two longest interconnectors of their kind anywhere in the world.

8 million homes

By 2024 NGV interconnectors will have enough capacity to power around 8 million UK homes



Interconnectors and energy security

Interconnectors strengthen security of supply by providing a proven, reliable way for electricity to flow between neighbouring countries. These point-to-point transmission cables are at the heart of the transition to a secure, clean, and affordable energy system for consumers in Great Britain and beyond. Interconnectors are doing what they were built to do – keeping the lights on today and helping to power the nation.

What are interconnectors and how do they work?

Interconnectors are high-voltage electricity cables that enable power to be transmitted efficiently between two countries.

- They carry electricity from where it's produced and in abundance (cheapest), to where it is needed most and where supplies are scarce (more expensive).
- Subsea cables can stretch for hundreds of kilometres and are connected at either end via converter stations and underground cables that link into the domestic power grids.
- Interconnectors enable power to flow in both directions. So, when generation is low in one market, electricity can be drawn from a neighbouring country to keep supplies secure.

765km

At 765km, Viking Link is the world's longest onshore and subsea interconnector, linking the UK and Denmark. This is even longer than the North Sea Link which began operation in 2021 and stretches for 720km across the North Sea between the UK and Norway, the world's longest subsea route.

90%

By 2030, we estimate that 90% of the electricity we import from mainland Europe via National Grid Ventures interconnectors will be from zero-carbon sources such as wind, solar and hydro.

Key benefits of interconnectors

Security of supply

Interconnectors strengthen security of energy supplies by providing flexible and reliable access to large volumes of electricity. Neighbouring countries can support each other when domestic energy production is not sufficient to meet demand.

Connecting lots more renewable energy

To meet its net zero ambitions, Great Britain needs to connect huge volumes of renewable energy resources in the next decade, particularly offshore wind. Interconnectors maximise the use of renewable energy by giving Britain an efficient way to both import and export clean power.

Balancing rapid changes in supply and demand

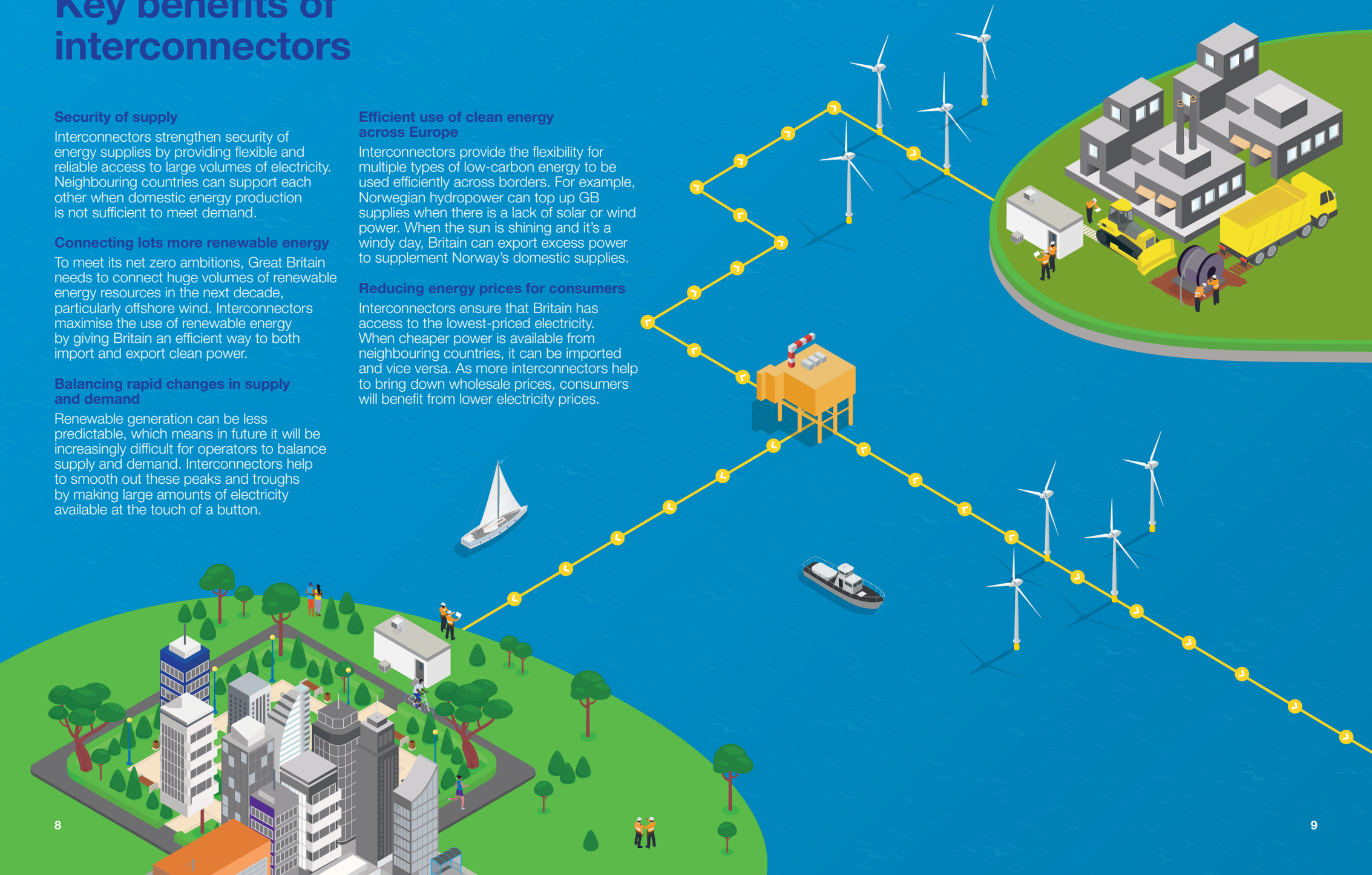
Renewable generation can be less predictable, which means in future it will be increasingly difficult for operators to balance supply and demand. Interconnectors help to smooth out these peaks and troughs by making large amounts of electricity available at the touch of a button.

Efficient use of clean energy across Europe

Interconnectors provide the flexibility for multiple types of low-carbon energy to be used efficiently across borders. For example, Norwegian hydropower can top up GB supplies when there is a lack of solar or wind power. When the sun is shining and it's a windy day, Britain can export excess power to supplement Norway's domestic supplies.

Reducing energy prices for consumers

Interconnectors ensure that Britain has access to the lowest-priced electricity. When cheaper power is available from neighbouring countries, it can be imported and vice versa. As more interconnectors help to bring down wholesale prices, consumers will benefit from lower electricity prices.



How interconnectors operate with the energy markets

Interconnectors are a vital part of keeping electricity systems operating smoothly. Every electricity market has unique characteristics – including the generation mix, demand profile and weather. High prices tend to happen when there isn't enough local generation to meet demand.

These events can be driven by technical issues, for example if a power station is offline. They can be affected by weather if there are very calm conditions with little wind. Or they can be caused by high levels of demand such as during a prolonged hot or cold spell creating extra demand for cooling or heating.

This is where the flexibility of interconnectors comes into its own. Electricity can be moved between markets to smooth out potential issues, for example exporting to France in the morning and then importing in the evening, including balancing differences in demand due to the time zone difference between markets.

Trading on interconnectors

The interconnector trade is driven by the price of electricity. Traders purchase the right to move electricity through the interconnector via auctions, which are the primary way for interconnectors to make money. Auctions cover different time periods, from 2–3 years ahead of delivery all the way to the day of delivery itself. Traders specify how electricity should flow between the connected countries for each hour of the day – this ensures that power is transmitted to the market with the greatest need, based on price, except on occasions when an electricity system operator makes changes to meet energy and operability needs of their particular system.

Analysis of winter 2022/23

Every year, National Grid Electricity System Operator (NGESO) publishes its Winter Outlook Report, a document that looks ahead to Great Britain's electricity security of supply over the coming winter. The report uses different energy scenarios and assumptions to inform government and industry of the likely outcomes.

In October 2022 NGESO produced its Winter Outlook Report for 2022/23. It concluded that the most likely scenario for last winter was that electricity imports from mainland Europe would be available when needed. This was exactly what happened over the course of the winter.

How interconnectors kept power flowing

Winter 2022/23 was a turbulent time for the energy sector and for consumers. There was significant concern about energy security in the run-up to winter following Russia's invasion of Ukraine, restrictions on Russian gas flowing into Europe and the knock-on effect that saw huge spikes in energy prices. Interconnectors played a crucial role in supporting security of supply in the UK and neighbouring European countries over the winter – moving large volumes of power from where it was produced to where it was needed most.

The interconnectors on the GB grid played an important role in 2022, efficiently bridging the gap between domestic supply and demand during 3,000 half-hour periods. There were also frequent times when Britain had excess energy available. During these periods GB interconnectors exported power to support European neighbours such as France.

"Close co-operation between European system operators through reciprocal support has played an important role in helping maintain secure supplies for customers in Great Britain and Europe"

ESO, Winter Outlook Report, 2023

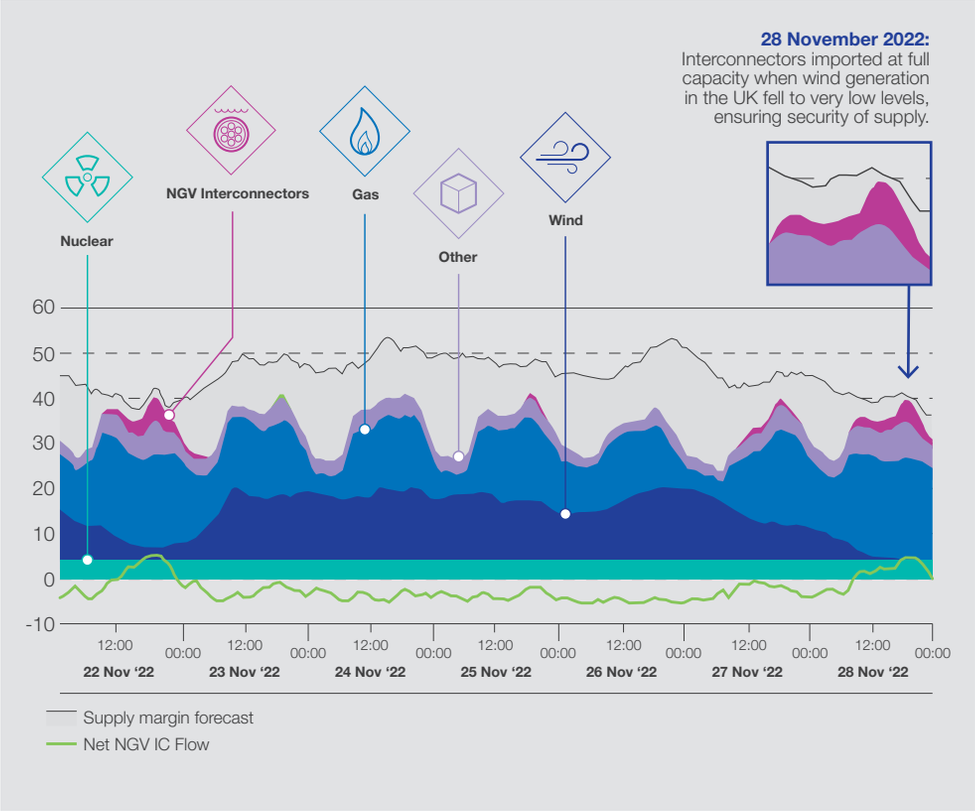
Winter 2022/23 insights

In the early winter months GB interconnectors largely exported power, in part due to low levels of nuclear generation in France. This allowed excess wind generation to be exported from the GB network, avoiding potentially expensive curtailment costs that would have been passed on to consumers.

Up until December, National Grid Ventures' interconnectors mainly provided support to neighbouring countries. However, at times when the GB system was under stress, such as on 28 November 2022 when there was low wind generation in the UK, interconnectors switched rapidly to importing at full capacity. This flexibility helped to keep supplies secure for consumers in Great Britain.

From mid-December onwards, interconnectors primarily imported electricity onto the GB grid. This reflected market pricing and gave GB consumers access to lower-priced power from the continent.

The value of interconnector flexibility – GW against CET hour
Late November 2022



A snapshot of a typical winter day – GW against CET hour
IFA and IFA2 flows (23 February 2023)

NGV interconnectors IFA and IFA2 supported the system margin (spare generation capacity) in both France and GB at different times during the day. GB wind was highest in the early morning when solar in France was not available, which reversed later in the day.

Over the late morning/midday period, GB wind decreased while French solar output increased. These changes led to lower system margin in Great Britain and higher system margin in France, leading the interconnector flows to switch so that France was providing Britain with electricity.

With GB wind output and GB system margin remaining low going into the evening and night periods, France continued to provide GB with system margin through the IFA and IFA2 interconnectors.

Winter 2023

In September 2023 NGESO published its 2023/24 Winter Outlook Report. Their analysis suggests that there should be enough capacity to meet demand – with at least 4.4GW more supply than demand during the winter peak. This is 7.4% of the typical peak demand forecast at that time of year.

NGESO emphasises the importance of a co-ordinated approach with European neighbours, with interconnectors enabling power to flow back and forth to where it is needed most.

"We expect to continue working closely with our neighbours in Europe, adopting a coordinated approach providing reciprocal support."

ESO, Winter Outlook Report, September 2023

The future for interconnectors

The North Sea has the potential to become Europe's green energy 'powerhouse'. By 2030 it could be home to up to 120GW of offshore wind – that's enough to power over 120 million homes. The ambition is to increase that to 300GW by 2050, compared to 30GW today. One of the big challenges is how to connect new capacity efficiently into the energy systems of neighbouring countries.

Existing interconnectors and offshore wind farms connect individually to electricity networks. This point-to-point approach is inefficient and unsustainable given the huge ramp-up in offshore wind capacity that is needed to help achieve net zero.

A new generation of offshore hybrid assets

We're developing a new generation of innovative offshore hybrid assets (OHAs), which combine the enormous benefits of interconnectors and offshore wind. These assets will allow clusters of offshore wind farms to connect to multiple countries in one go via interconnectors.

This is a leap in technology that will speed up the connection of offshore wind and maximise the use of wind generation. The approach will also reduce the impact on local communities by cutting the number of connection points and onshore infrastructure.

The North Sea will be the location for the world's first energy island, which is due to be built 45km off the Belgian coast. Princess Elisabeth Island will serve as a hub for future interconnectors, including the proposed Nautilus link with Great Britain. Construction of the island is set to begin in 2024.

1.4GW

The proposed Nautilus offshore hybrid asset project would link the electricity systems of Great Britain and Belgium and connect into offshore wind generation in the North Sea. The project could provide enough power for up to 1.4 million homes.

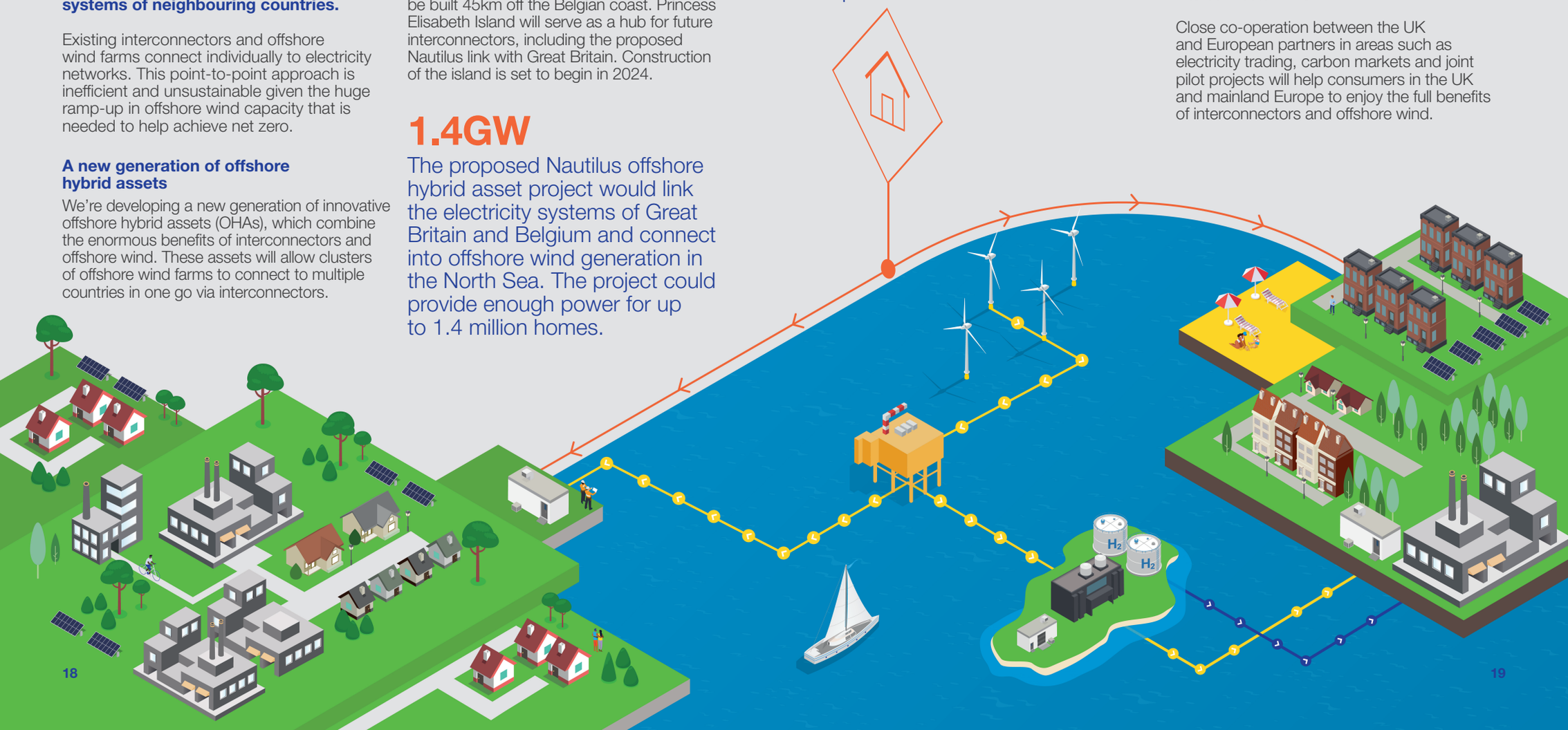
1.8 million homes

Our LionLink offshore hybrid asset is being developed in partnership with Dutch partners TenneT. It will supply 1.8GW of clean electricity between Great Britain and the Netherlands, enough to power up to 1.8 million homes.

The importance of collaboration

To meet the ambitious climate change targets of the UK and European neighbours, a co-ordinated approach to offshore development is vital. The creation of an integrated North Sea grid will help to take advantage of the rapid growth in offshore wind and strengthen cross-border interconnector links.

Close co-operation between the UK and European partners in areas such as electricity trading, carbon markets and joint pilot projects will help consumers in the UK and mainland Europe to enjoy the full benefits of interconnectors and offshore wind.



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

United Kingdom
Registered in England and Wales No.8169384

nationalgrid.com/OHA

December 2023. Simplify/NQ/DH/VS02