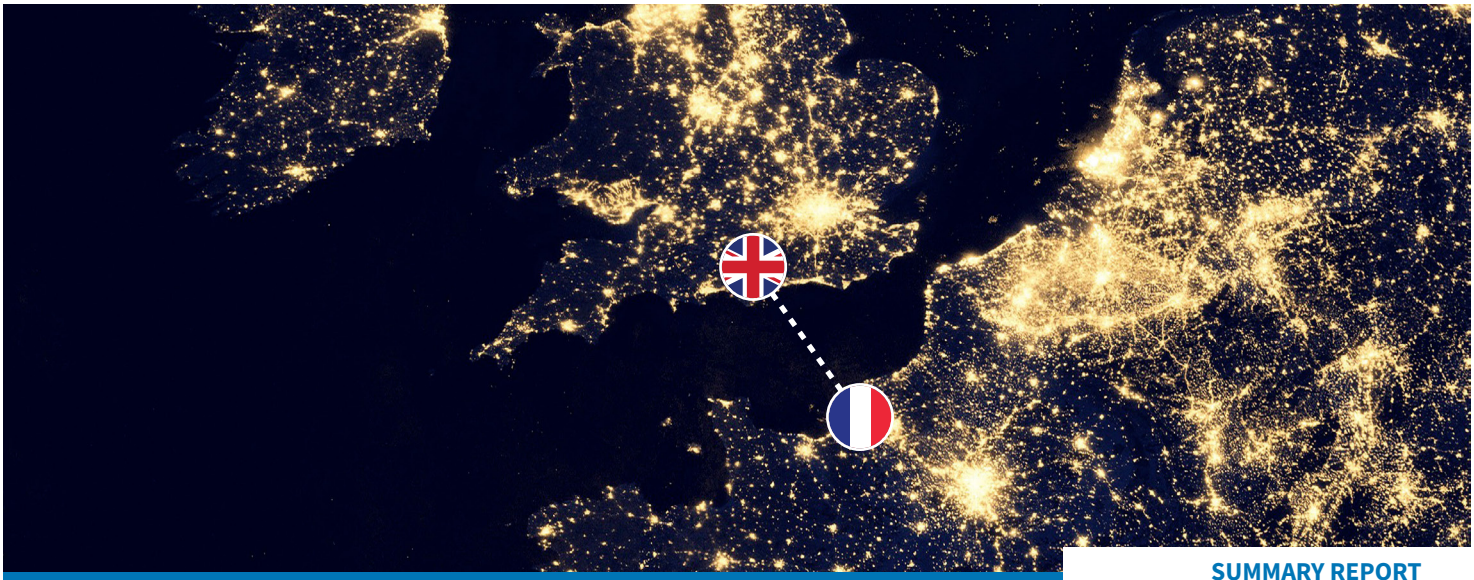


SUMMARY REPORT

AQUIND Interconnector:

Reducing the cost of transition to Net Zero for GB energy consumers

As the UK emerges from the Covid-19 pandemic, there seems to be growing consensus among policymakers and industry that a "green recovery" is required in order to achieve the UK's "net-zero" emission target by 2050. However, the growing financial strain on the economy and on individual consumers means that a cost-efficient transition to meet this target is ever-more critical.

AQUIND Interconnector, a proposed 2 GW electricity transmission cable connecting Great Britain and France, can play a role in enabling the UK to reach its net zero target while reducing the cost of electricity to consumers. Commissioning in 2024, our modelling shows that AQUIND Interconnector is expected to deliver over £2.3bn in cost savings for GB electricity consumers once operational,[1] while also improving the security of supply in both Great Britain and France.

Over £2.3bn

of consumer savings in Great Britain between 2025 and 2050

£1.2bn

of private investment by 2024 (including 750 new jobs) across Great Britain and France

UK's long-term "net zero" ambition drives significant decarbonisation efforts…

In June 2019, the UK introduced legislation with an ambitious target to reach net zero greenhouse gas emissions by 2050 (often referred to as "**Net Zero**"). As the UK progresses on the path towards this target, consumers and security of supply remain at the heart of the transition to a future low-carbon energy system.

The Committee on Climate Change ("CCC") notes in its recommendation for a net zero emissions target that it is "*essential to ensure the UK implements a 'just transition' to net-zero so that costs and benefits are fairly shared between income groups, industries and regions – as well as between current and future generations*".[2]

The approach to this transition is critical; a net zero carbon economy should be delivered at least cost to consumers, while maintaining reliable supply of electricity at all times.

1 Net of AQUIND Interconnector's capital and operational costs.
2 CCC (2019), Net Zero – the UK's contribution to stopping global warming.

…but the Covid-19 pandemic has led to greater financial strain on consumers and the management of the aftermath will be critical to delivering Net Zero

As the UK embarks on this transition, consumers are facing increasing financial strain and uncertainties in the midst of the Covid-19 pandemic.

According to a survey carried out in June 2020, up to 23% of consumers agree or strongly agree that their ability to meet financial ends has been negatively impacted by the pandemic, and around a third have delayed purchases that they had planned to make. More broadly, 85% of consumers expressed some concern about the impact of Covid-19 on the future of the UK economy.[3]

As the UK recovers from the effects of the pandemic and its aftermath, there is growing consensus that a "*climate resilient recovery*" is required, consistent with the UK's net zero targets.[4]

Similarly, parties in the EU have expressed their strong interest in a green recovery. For example, the head of the ECB recently indicated the possibility of using its €2.8tn asset purchase scheme to pursue green objectives.[5]

However, delivering on commitments to achieve net zero targets may become more challenging going forward due to price volatility and traditional sources of energy potentially becoming cheaper than low carbon technologies in some cases.

As a result of the increased pressure on consumer finances, the concerns over a fragile economy and the increased cost of decarbonisation, it is now even more vital that the net zero target is delivered as cost-efficiently as possible.

GB electricity interconnectors: introduction

Electricity interconnectors, which are transmission links that enable electricity to flow between two regions, have long been recognised for the multiple and significant benefits to GB electricity consumers. In this summary report, we set out how GB interconnectors lower electricity prices to consumers, support the transition to a low carbon system, enhance the security of supply, and deliver wider macroeconomic benefits.

Direct consumer benefits

Interconnectors allow GB to import electricity when domestic prices exceed that of connecting countries, and to export when vice versa.

This creates complementary energy systems between GB and its neighbours, with interconnectors acting as enablers to optimise the dispatch of electricity over a larger geographic footprint, helping to reduce the overall cost of serving demand.

It is frequently the case that electricity prices in GB are higher than in neighbouring countries. Thus, cheaper electricity is imported, which in turn lowers wholesale electricity prices. This reduces the costs to energy suppliers (at the expense of lower revenues for GB generators), who can then pass on these savings to energy consumers.

Indeed, electricity prices in GB were on average £13/MWh higher than electricity prices in France in 2018.[6] This is driven by a fundamentally different generation mix between the two countries, with France relying on a mix of nuclear, hydro and renewables, while GB uses a mix of gas, coal, nuclear and renewables. Apart from phasing off coal, this structural difference in the generation mix is expected to persist in the long term and drives what is known as the "**intrinsic value**" of interconnectors.

Transition to a low-carbon energy system

Interconnectors support the integration of renewables in the European energy system, allowing low carbon electricity to be imported or exported more easily. This benefit arises because the output from variable renewable generation is not entirely correlated between countries. For instance, wind conditions vary significantly across different places. This means that the production of low-cost renewable energy in one country can often be exported to benefit its neighbours.

As GB and other European countries progress towards a low-carbon energy system, the volatility of renewable output, and in turn wholesale electricity prices, will increase. This would increase the value that interconnectors provide, as greater interconnection flows would reduce the volatility of energy prices, thereby reducing the risk and cost to generators and suppliers. This, in turn, creates additional value to the consumer, and is known as "**extrinsic value**".

3 McKinsey (2020), Survey: UK consumer sentiment during the coronavirus crisis.
4 CCC (2020), Take urgent action on six key principles for a resilient recovery.
5 Financial Times (2020), Lagarde puts green policy top of agenda in ECB bond buying.
6 ACER Market Monitoring Report 2018 – Electricity Wholesale Markets Volume. The average 2018 GBP to EUR rate of 1.13 was used.

Enhancing security of supply

One of the key challenges in the transition to a low carbon energy system is the need to maintain energy security, i.e. having access to sufficient sources of electricity to meet customer demand in all time periods. With a growing penetration of intermittent generation in GB (such as wind and solar capacity), as the system transitions to net zero, the energy system needs to be able to manage increasingly volatile supply and demand balance.

Interconnectors help alleviate this challenge by diversifying the electricity sources the GB energy system is reliant on. This means interconnectors provide GB with greater access to other energy resources, particularly during times when the GB energy system is facing "system stress".

Additionally, interconnectors can also improve security of supply by providing balancing services to system operators to support the stability of the energy system. These services are known as ancillary services and will become critical as intermittent renewable generation increases.

Wider macroeconomic benefits

Interconnector investments are large-scale infrastructure projects that can help stimulate the economy and create new jobs during the planning, development, construction and operation stages. In turn, these investments may then propagate further through the economy, as the initial spending triggers additional economic activity in adjacent supply chains (known as "**multiplier effects**").

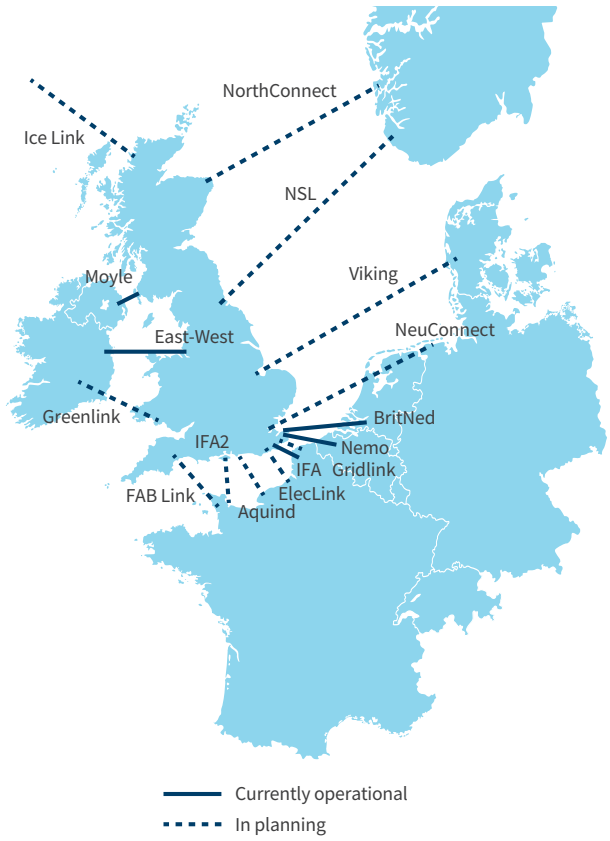
In the longer-term, lower average electricity prices facilitated by imports of cheaper electricity can also stimulate the economy by increasing consumer disposable income and business competitiveness.

The role of AQUIND Interconnector in increasing GB's interconnection capacity

Currently, GB has five interconnectors connecting to France, the Republic of Ireland, Northern Ireland, the Netherlands and Belgium with a total capacity of 5 GW.

This represents around 5% of the UK's total power capacity as at the end of 2018, which is short of Europe's target to achieve 10% electricity interconnection by 2020 and 15% by 2030.[7]

FIGURE 1: GB'S INTERCONNECTORS CURRENTLY OPERATIONAL AND IN PLANNING



Source: Ofgem, Interconnector development plans, FTI-CL Energy analysis
Note: Locations are indicative

Persistent price differentials between GB and neighbouring countries are a strong sign that interconnection would be beneficial. In addition, the need for greater interconnection is recognised by the Energy System Operator ("ESO"), which plans and operates the GB network. The ESO has identified that additional interconnection capacity in the range of 13.1 GW to 18.1 GW by 2032 would provide the "*maximum benefit for consumers*".[8]

In this context, it will be important for policymakers to promptly offer clear rules and an encouraging regulatory arrangement to both private and public developers to enable further development of interconnectors to meet this existing underlying need.

Several projects are currently under construction between GB and European countries, including to Norway (NSL), France (IFA2 and ElecLink) and Denmark (Viking Link).

In addition, several projects are under development to further strengthen the connection between GB and France. One of these projects is AQUIND Interconnector, a proposed link with a net capacity of 2GW to connect the South Coast of England with Normandy in France, due to become operational in 2024.

7 EC, 2014. Ofgem, State of the Energy Market, 2019. The case for increasing interconnection in GB is likely to remain very strong, even if the EU targets do not apply to the UK post-Brexit.
8 National Grid (2020), Network Options Assessment.

In this context, the energy teams of FTI Consulting and Compass Lexecon ("FTI-CL Energy") have been commissioned by AQUIND to estimate the value that AQUIND Interconnector is expected to bring to GB consumers from the start of its operation through to 2050.

To estimate the impact of AQUIND Interconnector, we have used our FTI-CL European power market dispatch model and assumptions developed by FTI-CL Energy. Our assumptions are broadly comparable to the 'System Transformation' scenario developed by National Grid in its Future Energy Scenarios (FES) 2020 (although we place less reliance on renewable hydrogen energy and assume some residual use of fossil fuels).[9]

In the remainder of this summary report, we set out how AQUIND Interconnector is expected to reduce electricity prices for GB consumers during the transition to net zero, enhance the security of supply and deliver wider macroeconomic benefits in the context of the Covid-19 pandemic.

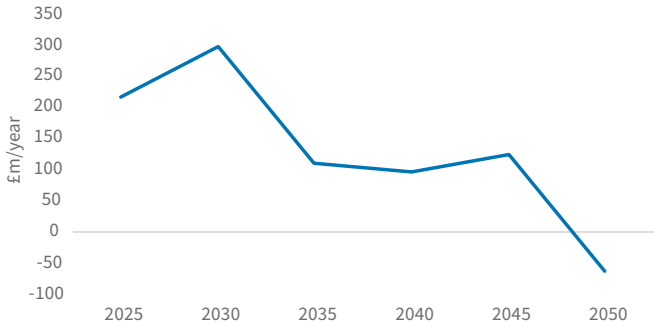
We assume that the impact of the UK's withdrawal from the EU does not impact the underlying need for greater interconnection.[10] As such, this impact has not been modelled.

Supporting GB energy consumers by enabling imports of cheaper electricity

We have undertaken new analysis to quantify the benefits to GB consumers from lower electricity prices. Our analysis models the GB, French and the wider European energy markets from 2025 to 2050, by forecasting hourly wholesale electricity prices and volumes with and without AQUIND Interconnector, to estimate the benefits of the project.[11]

Our analysis shows that AQUIND Interconnector could save GB consumers at least £2.3bn in Net Present Value ("NPV") between 2020 and 2050, assuming it becomes operational in 2024.

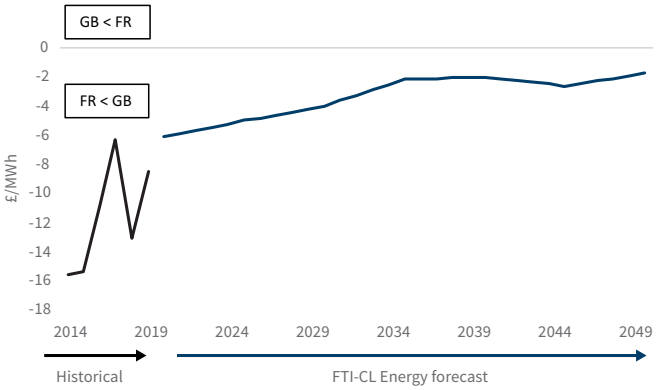
FIGURE 2: GB CONSUMER BENEFITS FROM AQUIND OVER MODELLING HORIZON



Source: FTI-CL Energy analysis

These sources of value are driven by intrinsic value, that is the structural difference in wholesale electricity prices between GB and France. Between now and the late 2040s, GB prices are expected to continue to exceed French prices. However, over time, the average price differential is expected to decline due to very high levels of renewables penetration both in France and in GB, as well as with the retirement of some of the low-marginal cost nuclear capacity in France.

FIGURE 3: ELECTRICITY PRICE SPREAD BETWEEN FRANCE AND GREAT BRITAIN



Source: FTI-CL Energy analysis

Wholesale power prices in GB and France are driven by the following:

- Commodity prices (such as coal, gas and CO_2). These affect the short-run marginal costs of power plants and, in turn, their offers in the market.
- Supply and demand of electricity. Higher demand leads to higher cost generation being supplied. Likewise, the deployment of lower cost generation technologies (such as wind power) tends to reduce electricity prices.[12]
- Policy and regulation, which can influence demand and supply. For example, policies that target specific generation types (such as offshore wind) would impact the generation mix and, in turn, power prices.

From a wider socio-economic welfare perspective, the benefit of AQUIND Interconnector is material. As a result of AQUIND interconnector, the reduction in wholesale electricity prices in GB is estimated to reduce the revenues to generators by approximately £1.1bn in NPV terms as a result of lower electricity prices. Additionally, the price

9 National Grid (2020), FES 2020. The net zero scenarios in FES 2020 all include ambitious plans for more interconnection.
10 We consider that in the worst-case scenario, trading frictions might occur. This will impact both prices and volumes but should result in a minimal net impact on GB consumers.
11 A more detailed explanation of the model methodology and assumptions is provided in the Appendix. These benefits are net of AQUIND Interconnector's capital and operational costs.
12 We assume that electricity demand will be broadly comparable to that in the 'System Transformation' scenario in FES 2020.

differentials between GB electricity prices and those in the neighbouring countries are expected to reduce over time, decreasing the revenues earned by other GB interconnectors by an NPV of around £1.0bn. However, considering all GB stakeholders together, AQUIND Interconnector delivers a positive net social welfare surplus of £0.2bn in NPV.

Supporting the transition to net zero by 2050

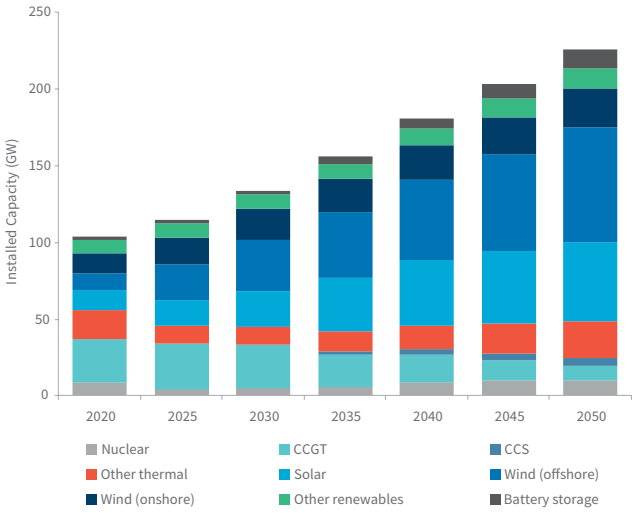
The significant expected consumer value from AQUIND Interconnector is driven by greater interconnector flows, as GB and France are able to share greater output from their growing fleets of renewable resources.

In our analysis, renewables generation is estimated to increase to 62% of gross electricity consumption in GB, and to 43% in France, in 2030. This is expected to increase to 75% in GB, and 77% in France in 2050, as both countries progress towards their respective net zero targets.

In GB specifically, it is expected that renewable capacity will exceed 50% of installed generation capacity by 2030. This will be driven mostly by offshore wind, followed by solar and onshore wind capacities.

This is, in part, supported by the existing carbon price floor mechanism which we anticipate will persist at a higher amount (€40/t) until the implied carbon price from the EU ETS begins to increase beyond this price. This would then lead to a convergence of carbon price (especially given that the UK has stated that any future system post-Brexit *"will be at least as ambitious as the EU ETS"*).[13]

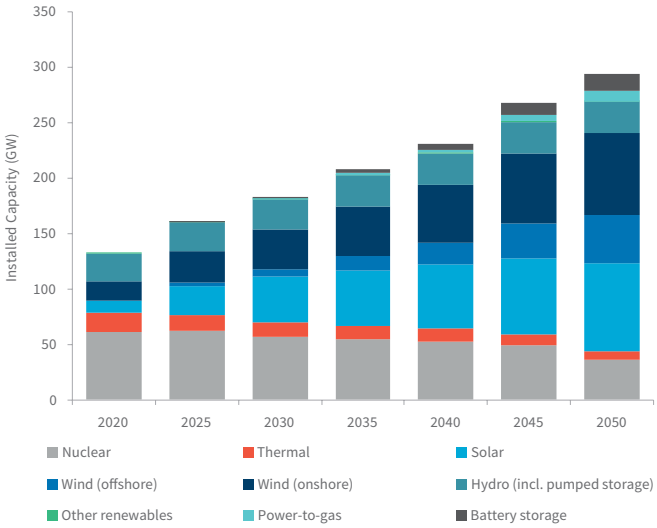
FIGURE 4: INSTALLED ELECTRICITY CAPACITY BY SOURCE (GREAT BRITAIN)[14]



Source: FTI-CL Energy analysis

In France specifically, nuclear energy will continue to be the main source of low carbon electricity, but its share of total generation is expected to decline. It is anticipated that significant investments in onshore wind and solar capacity will continue from 2030 through to 2050.

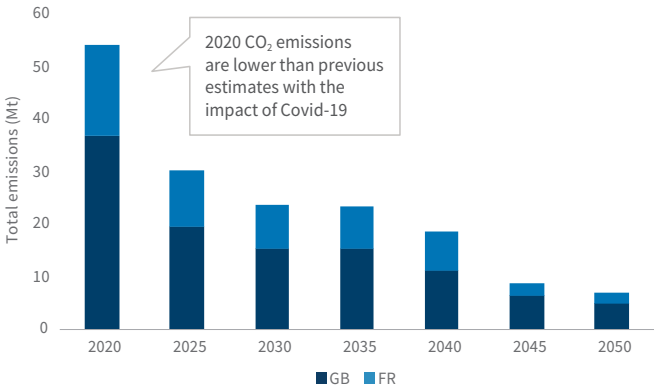
FIGURE 5: INSTALLED ELECTRICITY CAPACITY BY SOURCE (FRANCE)



Source: FTI-CL Energy analysis

The scenarios developed for this analysis show that CO_2 emissions gradually decline between 2020 and 2050 in line with the phase out of coal generation and the increase in renewables generation. By 2050, a small amount of residual CO_2 emissions are expected to remain, rather than a complete net zero outcome, due to a relatively low carbon price trajectory.

FIGURE 6: TOTAL CO_2 EMISSIONS FROM ELECTRICITY NET GENERATION



Source: FTI-CL Energy analysis

AQUIND Interconnector would allow the expected increase in renewable capacity in both GB and France to translate into a greater flow of low-cost renewable electricity across the two countries. The additional flow would consequently erode energy price volatility, reducing the level of risk faced by suppliers, generators, and consumers.

13 GOV.UK (2020), Meeting climate change requirements from 1 January 2021.
14 It is anticipated that thermal generation in GB will be largely based on imported commodities by 2030 (c.80%). This would accentuate the security of supply issue for GB, combined with the intermittent nature of renewables and the short duration of battery storage technologies.

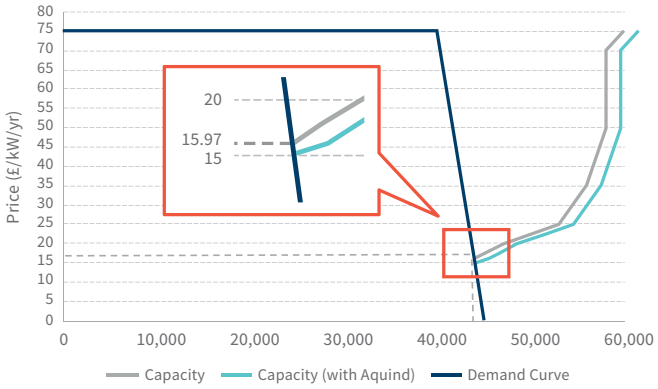
This "extrinsic value" of AQUIND Interconnector would be an addition to its "intrinsic value" of £2.3bn to GB consumers. Across the different scenarios we have modelled, we estimate that extrinsic value could be up to 15% of the intrinsic value created for GB consumers. This could result in a total net benefit for consumers in excess of £2.6bn, which would become available once the interconnector is operational.

Enhancing security of supply

Interconnectors such as AQUIND Interconnector contribute to GB's energy security by allowing greater energy supplies to be imported into the energy system. This is particularly crucial during periods of so-called "system stress", when GB might have insufficient generation available to meet the country's needs.[15] This risk would likely increase as several ageing coal and nuclear plants in GB close over the next few years.

Interconnectors can deliver these additional energy supplies at low cost. In addition to allowing the import of electricity generated from cheaper energy sources, interconnectors also lower the clearing price in the annual GB capacity market.[16] An illustrative example is shown below, taking the results of the T-4 Capacity Market Auction in 2020. If a similar auction were to occur in the future, the addition of AQUIND Interconnector would shift the supply curve for capacity to the right and would (all other things equal) lower the clearing price. This could lead to material cost savings for energy consumers. Indeed, in the most recent auction, a decrease in the clearing price by £1/kW/year would lead to £44m of savings per year.[17] This additional value from the impact on the GB Capacity Market has not been quantified for this report.

FIGURE 7: ILLUSTRATIVE IMPACT OF AQUIND INTERCONNECTOR ON THE GB CAPACITY MARKET



Source: EMR Delivery Body; FTI-CL Energy
Note: For illustrative purposes, a de-rating factor of 75% is used (same as ElecLink for the 2020 auction)

Additionally, with both GB and France progressing towards net zero, a higher penetration of renewables is likely to increase the pressure on the electricity grid by, for example, causing larger or more frequent disturbances to the frequency, or by reducing inertia. This tends to increase the need for flexibility so that the system operates in a stable and secure manner.[18]

Interconnectors can play a role in "system balancing" to provide this flexibility. They help facilitate better coordination of flows, dissipating the impact of variable generation over a larger area. This in turn, reduces the overall cost consumers have to pay for ancillary services to maintain system stability. The additional value from the impact on system balancing has not been quantified in this report.

Supporting the economic recovery from Covid-19

The ongoing Covid-19 pandemic has created significant pressures in the economy and on energy consumers. As part of ongoing efforts to stimulate the economy, the UK Government is committed to pursuing investments, particularly in the infrastructure space. While a significant proportion of planned investments are Government-led or subsidised, there is an even greater need for private sector investment, as this would create jobs and economic value without increasing the strain on the public finances.

At the same time, there are growing calls to focus on investments that will drive a "green recovery". At the European-level, the European Commission's ("EC's") Green Deal remains at the top of the agenda. Mr Timmermans, the EC's Green Deal chief has said that the EC *"firmly believe […] that a green recovery is possible"* and that the European Green Deal is *"a way to give Europe a growth strategy that is a winning strategy, not just for Europe itself but also globally"*.[19] Similarly, many in the UK have argued for a "climate resilient recovery".[20]

Private investment in large infrastructure projects, such as AQUIND Interconnector, would support the recovery in three different ways:

15 FTI (2019) analysed the contribution of interconnectors to the security of supply.
16 Reforms are underway to replace the direct participation of interconnectors with the direct participation of cross-border capacity.
17 EMR Delivery Body (2020), T-4 Auction (Delivery Year: 2023-24) - Published Round Results. The total de-rated capacity procured is 43,749MW. This results in c.£44m of savings for every £1/kW/year reduction in the clearing price.
18 This effect will be increased by the reduction of nuclear capacity in the long term.
19 EC (2020), Introductory remarks by Frans Timmermans.
20 CCC (2020), Take urgent action on six key principles for a resilient recovery.

- First, AQUIND Interconnector would contribute to the UK economy rebound in the aftermath of Covid-19 by investing £1.2bn across the UK and France and creating up to 750 jobs from 2021 up to its commissioning in 2024.
- Second, AQUIND Interconnector would deliver this stimulus (as well as the long-term energy price reductions) without any direct UK Government investment.[21]
- Third, AQUIND Interconnector would deliver these benefits while being an integral part of the green recovery agenda on the path towards net zero.

Appendix: Summary of modelling methodology and assumptions

AQUIND Interconnector creates welfare benefits as a result of enabling electricity to be transported between GB and France and thus optimises the use of resources over a larger geographical footprint. In particular, the changes in the cross-border flows have an impact on the wholesale power prices in the two connecting countries, which help reduce GB wholesale electricity prices.

This appendix presents the key assumptions behind the modelling results presented in this report.

Modelling tool and overall approach

To estimate the impact of AQUIND Interconnector, we have used our FTI-CL European power market dispatch model, which runs on the commercial modelling platform Plexos® using data and assumptions constructed by FTI-CL Energy. The model covers all of the European power market and constructs supply in each price zone based on individual plants and their characteristics. Zonal prices are found as the marginal value of energy accounting for generators' bidding strategies. The analysis also takes into account the cross-border transmission and interconnectors and unit-commitment plant constraints.

In this analysis, we have modelled 6 spot years (every five years from 2025 to 2050), to estimate the wholesale price outcomes across Europe with and without AQUIND Interconnector. The present value of the benefits has been calculated using a 3.5% discount rate.[22]

Our analysis does not consider the specific impact on greenhouse gas emissions as it is assumed that net zero would be reached by 2050. Instead, we focus on the economic benefits of additional interconnection capacity on the GB-FR border assuming the delivery of such policies and commitments.

Scenario definition: Europe

There are three key sets of assumptions underpinning our modelling: commodity prices, demand levels and policy and regulation. Each is considered below in turn.

1. Commodity prices

Coal and gas prices, in the short-term, are assumed to remain at low levels (due to Covid-19) until gas markets rebalance. In the longer-term, prices converge to the WEO New/Stated Policies scenario, reflecting the long term global gas market, which reaches around €25/MWh by 2050.

CO_2 prices are assumed to increase steadily over the period as a result of a reform of the EU ETS to align it with the EU's increased ambition to decarbonise, reaching 28€/t in 2030 and around 90€/t by 2050.

2. Demand and supply levels

Annual demand growth, following a recovery from a Covid-19 dip, is expected to be moderate in the medium-term with electrification being offset by energy efficiency measures. This would be accelerated in the long term with further electrification of transport, heat and industry. In this respect, our assumptions for GB are comparable to the 'System Transformation' scenario in FES 2020, which includes ambitious plans for more interconnection.

Demand flexibility would be developed further with the development of demand response and storage, from short-term storage (batteries or load shifting) to long-term storage (hydrogen production).

Installed renewables ("RES") capacity for 2030 would be **aligned** with national 2030 targets reflected in each country's National Energy and Climate Plan.

Phase out of **existing nuclear and coal** would continue as expected, with **new** nuclear projects developed in selected countries.

Carbon Capture and Storage ("CCS") is considered in our modelling on a limited basis and develops slowly as we assume the absence of dedicated support.

3. Regulation and structure of the power market

Renewables investment will continue to be incentivised through national tenders to meet NECP targets.

Capacity mechanisms are expected to continue to ensure security of supply amidst an increase in RES.

21 A cap and floor regulatory regime might apply to AQUIND Interconnector when it is operating. This would set minimum and maximum limits to how much revenue AQUIND might be able to retain in any given period. Under the conditions of that regime, if revenues exceed the maximum, any excess revenues will be transferred to consumers. Likewise, if revenues fall below the minimum, any shortfall in revenues will be recovered from consumers.

22 This is consistent with the social rate used for public investments.

Scenario definition: GB

A key element of the climate plan is increasing use of renewable energy in the decarbonisation of electricity, heat and transport. We consider that this plan would include:

- Supporting new **nuclear capacity** at Hinkley Point C and two additional sites by 2050;
- Planning 15-30 GW **solar capacity** by 2030 and 25-55 GW by 2050;
- Planning 17-25 GW **onshore wind capacity** by 2030 and 20-40 GW by 2050; and
- Planning 30-55 GW **offshore wind capacity** by 2030 and 40-85 GW by 2050 (providing a third of electricity by 2030).

The Carbon Price Floor is also assumed to be maintained at €40/t until EU ETS starts to increase beyond this threshold.

Scenario definition: France

France is rebalancing its generation mix with a relative decrease in nuclear capacity and a significant increase in RES capacity. Our assumptions on the future generation mix include:

- Gradual decline in reliance on **nuclear energy**;
- Planning over 35 GW **onshore wind capacity** by 2030 and 50-80 GW by 2050;
- Planning 30-80 GW **offshore wind capacity** by 2050; and
- Planning over 44 GW **solar capacity** by 2030 and 40-250 GW by 2050.

Scenario definition: interconnector investments

The development of other interconnectors in Europe is likely to interact closely with the value of AQUIND Interconnector. In this modelling, we have aligned our assumptions on interconnector build-out with the published information on expected commissioning dates, published guidance from relevant authorities (e.g. RTE's SDDR), as well as an understanding of the challenges that specific links face in progressing their development. Since we only modelled spot years, our assumptions focus on whether or not specific links have been operational before each of the spot years.

- Between France and GB, in addition to ElecLink and IFA2, one more new interconnector (other than AQUIND) of 1.4GW is assumed to be built before 2030, and another 1.4GW before 2040.
- Greenlink, NSL and Viking Link are assumed to be operational before 2025.
- NeuConnect is assumed to be operational before 2030.
- NorthConnect and Nautilus are assumed to be operational between 2030 and 2035.

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