ELECLINK: SHEDDING SOME LIGHT ON A KEY EUROPEAN PROJECT

A contribution from the academic world

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Altermind

AUTHOR

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EXECUTIVE SUMMARY

ElecLink is an electricity interconnector between France and Great Britain, going through the Channel Tunnel, which is expected to be commissioned in 2020. It will generate a capacity of 1,000 MW, increasing the current interconnection exchange capacity by +50% between France and Great Britain.

While almost all other European interconnectors are regulated, ElecLink is a merchant transmission investment, partially exempted from some regulatory requirements.

This study, carried out by Prof. Axel Gautier and Altermind at Getlink's request, aims to describe the role of interconnectors in the context of European integration and decarbonisation and to clarify the merits of the transmission investment model and its underlying economic model.

Mobilising rigorous academic knowledge, it shows in a pedagogical way that merchant transmission investments such as ElecLink have many advantages from a European social welfare perspective and rely on diversified and long-term revenues.

5 HIGHLIGHTS ON ELECLINK

1 By reducing congestions between countries, interconnectors increase the security of supply, allow for a better integration of renewable energy sources and favour price convergence within the integrated zone.
Investment needs between Great Britain and Continental Europe are high, as Great Britain is considered as isolated. Despite current uncertainties, the rationale behind interconnectors will continue to be strong after Brexit. In this perspective, ElecLink can help resolve the energy trilemma: it will increase security of supply for both France and the UK, support the transition to a low carbon economy and improve affordability for consumers.

2 ElecLink is a leading example of the merits of non-regulated interconnectors (also called “merchant transmission investments”): unlike other interconnectors, ElecLink is 100% financed by private funds and the company bears the full investment costs at no direct risk to the taxpayer or electricity consumers.
As interconnectors are replicable assets, they could avoid being regulated, in line with the merchant model. Compared to the regulated model, the merchant model provides appropriate incentives to invest, to manage cost, to build on time and to make the asset available. The European Union should therefore rely more on merchant transmission investments.

3 The main source of revenue of interconnectors is the congestion rent, which has three drivers: it increases with the average price differential (structural value) and the volatility of prices (volatility value) and decreases with the correlation between prices.
In the context of ElecLink, even though the structural value of the congestion rent will decrease in the future, in the long-term the value of the congestion rent will be supported by the increasing volatility of prices, in particular because of renewables from different sources and locations, and limited price correlation. The analysis of the fluctuations of the congestion rent based on historical data shows very clearly that there is value beyond the average price differential between Great Britain and France.

4 ElecLink can optimise the congestion rent through diversification between short-term and long-term products in accordance with its exemption and sale conditions allowing to sell capacity rights in both directions.

5 Besides the congestion rent, ElecLink will generate revenues from capacity market mechanisms and ancillary services to the TSOs.

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Introduction

Interconnectors such as ElecLink are an opportunity for Europe. They represent a key aspect to the creation of a competitive single electricity market to provide European citizens with "*a supply of secure, sustainable, competitive and affordable energy*"[(1)].

ElecLink, going through the Channel Tunnel, will generate a capacity of 1,000 MW, the equivalent of power needed by 1,650,000 households. It will therefore increase the current interconnection exchange capacity by +50% between France and Great Britain.

There are two key aspects to ElecLink: it is a great opportunity to increase the European integration of electricity markets and help achieve electricity policy objectives and unlike most interconnectors, it is a merchant investment project, with significant advantages.

INTRODUCTION

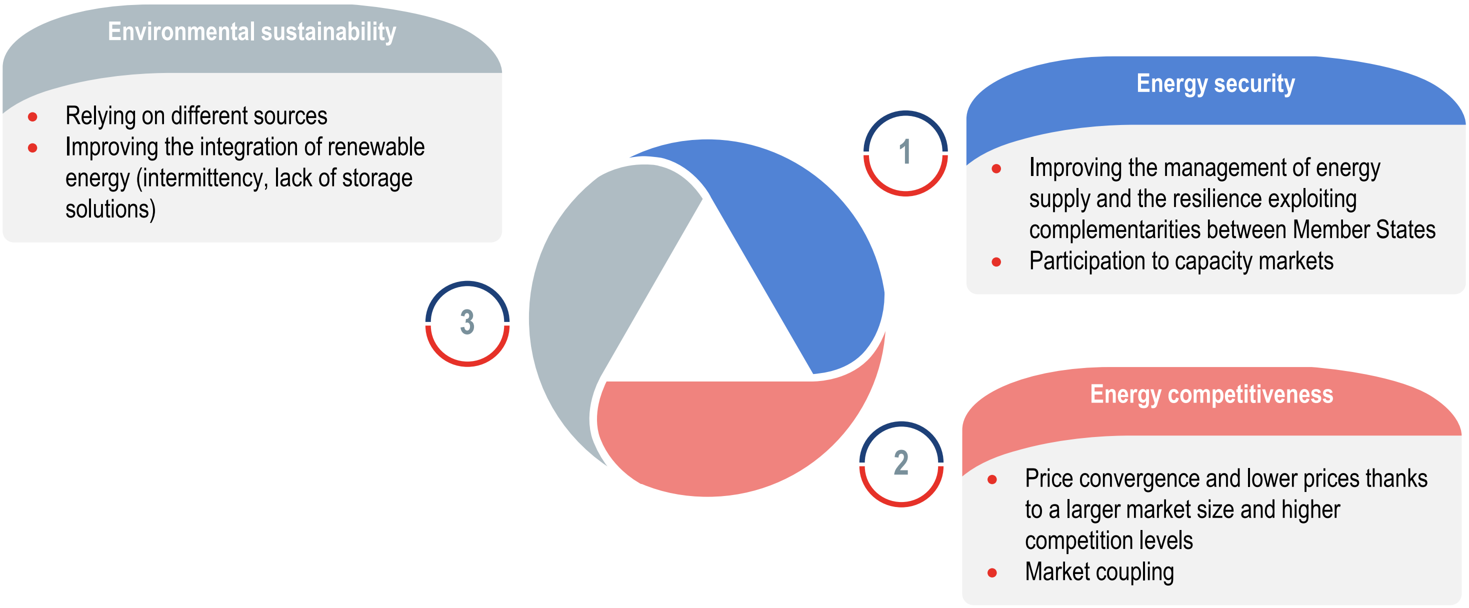
A great opportunity for European integration and electricity policy objectives

Electricity policy often faces a trilemma. It must ensure energy security, energy competitiveness and environmental sustainability, objectives which generally conflict. However, interconnectors provide an answer to this trilemma (Figure 1).

- Energy security: this refers to the effective management of energy supply from domestic or foreign sources as well as the reliability of energy producers to meet consumers' demand. By linking national energy systems, interconnectors exploit the complementarity between countries and allow "electricity to be imported when there is not enough generation capacity in the home market, and sufficient generation is available in the interconnected markets"(2). They therefore minimise the risks of electricity scarcity and black-outs. Within the European Union (EU), each Member State is both an importer and an exporter of electricity. As shown in Figure 2, imports represent between 1% and 25% of yearly consumption, underlining the key role of interconnectors. This contribution to energy security has been recognized in the design of capacity mechanisms.
- Price convergence: interconnections allow buyers in one market to find suppliers in other markets in order to make better use of differences in energy technology and the types of demand of each market. By promoting cross-border trades, interconnections can hence lower the cost of electricity to consumers, using cheaper sources of supply. As emphasized, "market integration is a prerequisite for price convergence", resulting in "lower prices on average" thanks to a larger market size and higher competition levels(3). The French Energy Regulatory Commission (CRE) has acknowledged that "the general overview is very positive in terms of the cost of energy"(4).

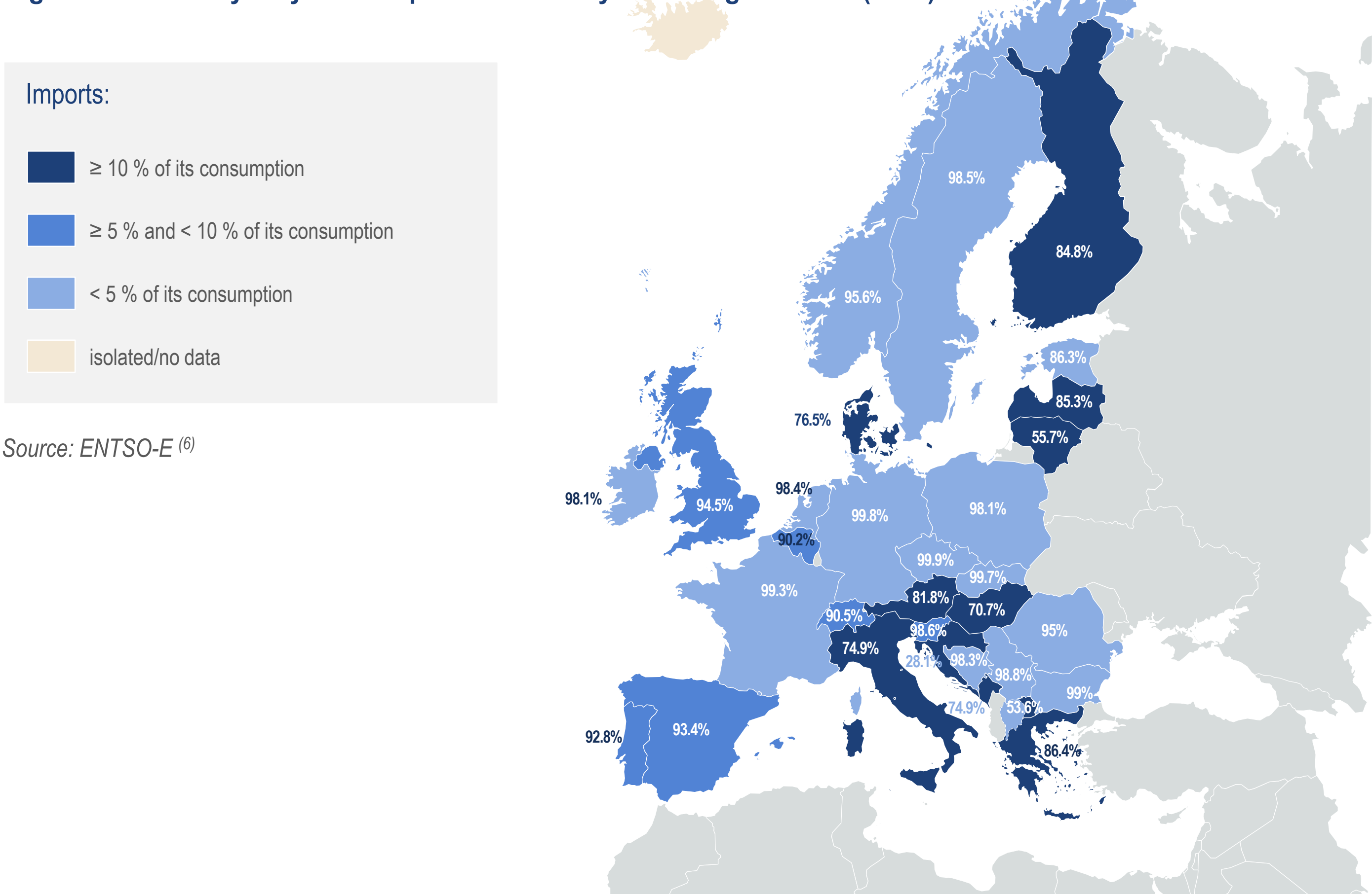
The positive impacts of interconnectors on prices is reinforced in situations of market coupling, i.e. the integration of several electricity markets through a coordinated calculation of prices and flows between countries. The European Commission estimates that over the past 7 years day-ahead market coupling alone has generated a benefit of approximately €1 billion per year to European consumers(5).

Figure 1: The energy trilemma



Interconnectors are critical to achieve security of supply, sustainability and competitiveness across Europe.

Figure 2: Share of yearly consumption covered by national generation (2017)



Source: ENTSO-E (6)

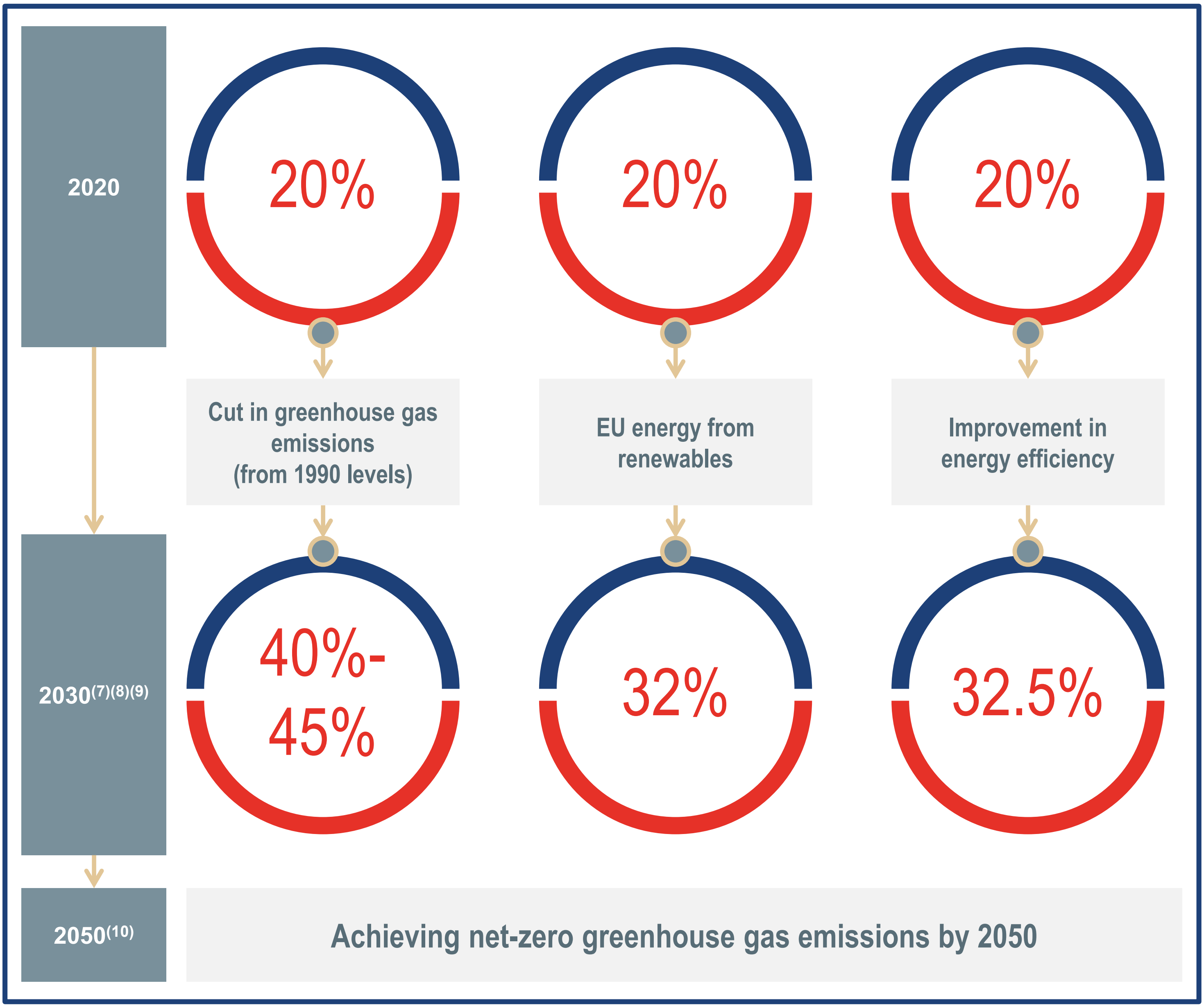
Most European countries need imports to cover their national consumption.

- Environmental sustainability: interconnectors allow to diversify energy sources and can partially solve the two mains issues arising from renewables: storage and intermittency (diurnal or seasonal patterns). Through market integration, they enable the export of potential excess of renewable production; they therefore allow a better management of renewable energies' intermittency, facilitating exchanges between Member States and offering at the same time an alternative for the lack of storage solutions. The EU has set ambitious objectives for the development of renewables, in the context of the Clean Energy Transition, which will require, among other policies, investments in interconnectors (Figure 3).

Given the benefits of interconnectors, the October 2014 European Council called Member States to achieve interconnections of at least 10% of their installed electricity production capacity by 2020, a target extended to 15% by 2030.

The Clean Energy for All Europeans package has reaffirmed these targets. It has also called for all transmission system operators (TSOs) across Europe to make available to the market at least 70% of the nominal cross-border capacities by 2025 at the latest, which shows how important the Commission considers interconnectors to be for the achievement of the EU policy objectives.

Figure 3 : The objectives set by the EU for energy



Interconnectors provide an answer to the two main issues arising from renewables: storage and intermittency.

A merchant investment project, with significant advantages

Among existing or new interconnectors between Great Britain and Continental Europe, ElecLink has a specific status: with the exception of BritNed, it is the only merchant transmission investment (as opposed to regulated projects). In the EU as a whole, only five additional merchant transmission investments have been carried out outside Great Britain.

Three types of interconnectors coexist in the European Union (Figure 4):

- Regulated transmission assets are the default route pursuant to European regulations. Under the standard approach, TSOs invest in interconnectors and recover all costs incurred for setting up and operating them, including a regulated return on investment. The economic risk of the project is borne by consumers. In situations of congestion, which occur when interconnectors cannot accommodate all physical flows resulting from international trade requested by market participants, a charge may be levied to allocate the capacity of the interconnectors. However, this congestion rent cannot be used freely by the TSOs;
- Merchant transmission investments, i.e. non-regulated interconnectors, must be issued a specific exemption, subject to various and strict conditions. Under this regime, investors invest in interconnectors and recover parts of their investment by capturing the congestion rent. They face the full upside and downside of the project;
- Between these two models, the UK has introduced a specific regulated regime called "cap and floor", under which the revenues of interconnector operators are subject to both a cap and a floor, securing the financing of projects.

As a merchant transmission investment, the profitability of ElecLink will therefore depend on the congestion rent. Its fluctuations are difficult to predict, since they will result from the price differential between Great Britain and Continental Europe, which is uncertain. This requires understanding perfectly the dynamics of the congestion rent and the various factors influencing it.

Purpose of this study

As ElecLink enters a critical phase, with commercial commissioning expected in 2020, Getlink, ElecLink's shareholder, aims to ensure that the public policy and economic stakes of its project are perfectly understood.

In this perspective, the purpose of this study, carried out by Prof. Axel Gautier and Altermind at Getlink's request, is to clarify the merits of the merchant transmission investment model and to correct potential misconceptions about its underlying economic model.

Mobilising rigorous academic knowledge, this study aims to show in a pedagogical way that:

- From a European social welfare perspective, the merchant transmission investment model has many advantages and deserves to be promoted (section 1.);
- Merchant transmission investments between Continental Europe and Great Britain such as ElecLink rely on diversified and long-term revenues (section 2.).

ElecLink is one of the few non-regulated interconnector in Europe, relying on private funds only.

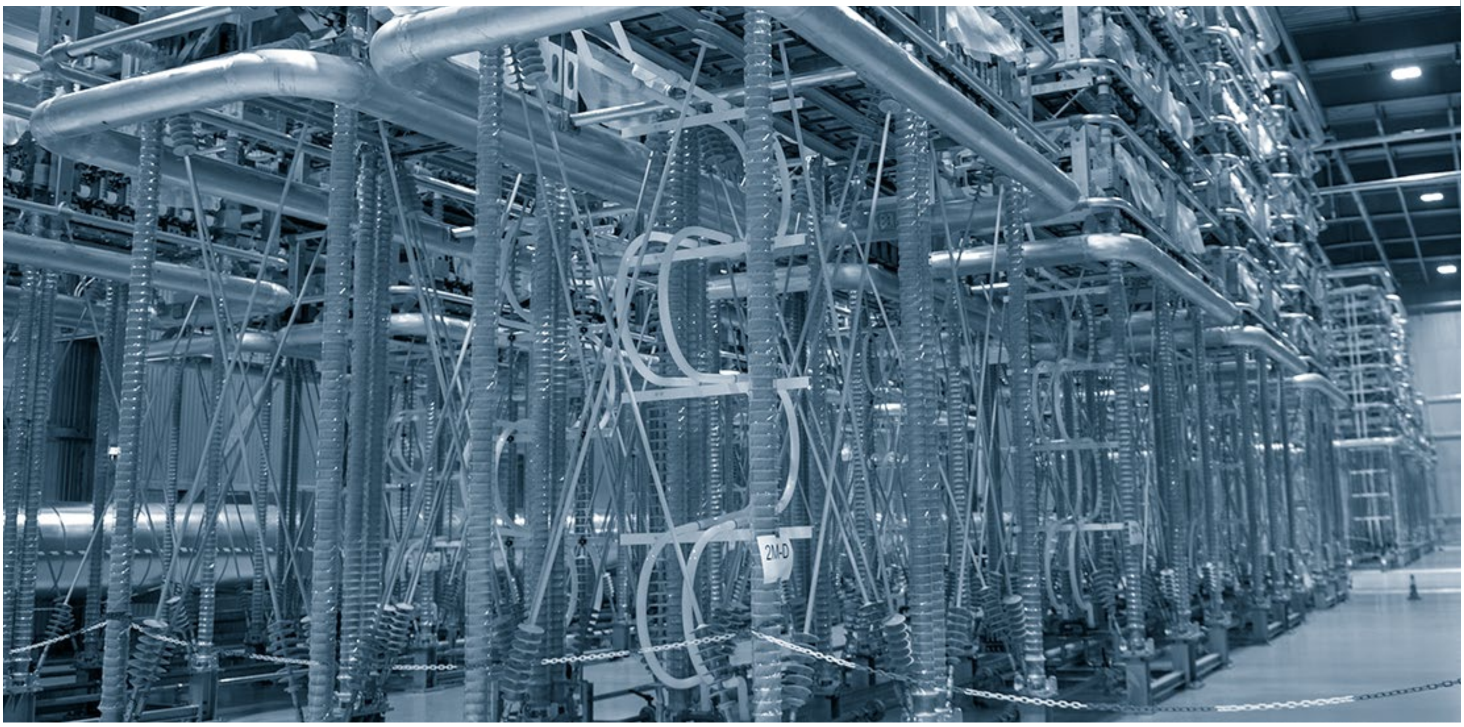


Figure 4 : The three regimes of interconnectors

Regulated interconnectors	Cap and floor regime (UK)	Merchant interconnectors (non-regulated)
• Default route pursuant to European regulations • Projects developed by TSOs • Regulated revenues covering all incurred costs, including a regulated return on investment • Economic risks borne by consumers • Regulated use of the congestion rent	• UK specific regulated regime • Floor: minimum amount of revenue of the interconnector • Cap: maximum amount of revenue of the interconnector	• Merchant transmission investments = non-regulated interconnectors • Subject to specific exemptions • Projects developed by other parties than TSOs • Full upside and downside on private investors

1. ElecLink: A Merchant Transmission Investment Optimising Collective Value

Interconnectors such as ElecLink reduce congestions between Continental Europe and Great Britain (section 1.1). It can be demonstrated that the merchant transmission investment model has several advantages over the regulated asset base (RAB) model. This should lead to a review of the merits and limits of both models, in a context where almost all European interconnectors are regulated (section 1.2).

1.1 ELECLINK: A MAJOR CONTRIBUTION TO THE EUROPEAN INTERNAL MARKET

Congestions represent a major issue for the European electricity market, which calls for more interconnectors, especially between Great Britain and Continental Europe (section 1.1.1). In this context, ElecLink makes a major contribution to its integration, under socially optimal conditions (section 1.1.2).

1.1.1 CONGESTION: A MAJOR ISSUE FOR THE EUROPEAN ELECTRICITY MARKET AND GREAT BRITAIN

European electricity markets are increasingly interconnected, which allows cross-border flows of electricity and contributes to the integration of energy markets. But the European electricity market is still far from being a fully integrated market. This applies in particular to Great Britain, which remains isolated and weakly connected to the western Europe continental electricity market. Despite current uncertainties, the needs for interconnectors should remain strong even after Brexit.

General outlook

Interconnection is based on physical cross-border infrastructure for transporting electricity from one country to another (interconnectors) and on market coupling algorithms to determine prices and allocate production and interconnection capacities in both countries.

As discussed in the introduction, interconnection has many recognized and well-documented advantages: it increases the security of supply, allows for a better integration of energy produced by renewable energy sources and favours price convergence within the integrated zone. For example, it is predicted a net annual welfare gain for the Italian market from interconnection and market coupling ranging between €33 million and €741 million (in the most credible scenario, market coupling would generate a net annual welfare gain ranging between €33 million and €132 million) (Pellini, 2012)[(11)].

However, cross-border trade is constrained by the physical capacity of interconnectors, creating congestions. This leads to a sub-optimal economic performance, notably price differentials, as explained in Box 1.

Congestions lead to sub-optimal economic performance, notably price differentials.

Box 1: Congestion, congestion rent and congestion costs

Without any restriction on trade, prices in countries N (North) and S (South) should converge. In the absence of congestion, market integration leads to uniform pricing with the same price in the two zones (ignoring transportation costs). Furthermore, the market should select the least costly production units. It is therefore efficient.

Figure below (from Joskow and Tirole, 2005) represents the net supply and the net demand in both countries N and S. In this Figure, there is a net supply in the North and a net demand in the South. Electricity should flow from N to S and in the absence of congestion, prices should converge (point B on the figure).

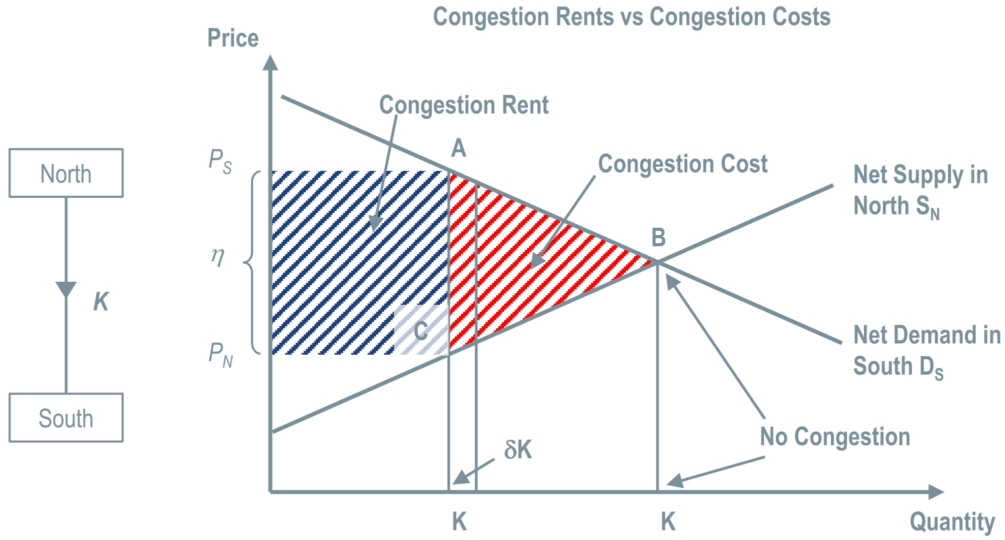
There is however a physical limit to cross-border trade given by the capacity of the interconnecting lines, denoted by K. If price convergence requires greater flows than the interconnection capacity, there is congestion on the line; If, on the contrary, price convergence requires less power flow than the interconnection capacity, there is no congestion on the line (and hence no value to capture).

In this case, there will remain a price difference between the two countries. The price in N will be lower than in S because it is physically impossible to transport the cheap electricity from N to satisfy the demand in S.

This leads to both a congestion rent and a congestion cost:

- The congestion rent is the potential revenue of the interconnection. It is the profit that is created by buying lower-priced electricity in N and selling it in S and is measured by the price differential multiplied by the interconnection capacity (δK on the figure). In Figure 3, the production cost in S is given by the net demand and the production cost in N by the net supply;
- The congestion cost is the cost of producing more expensive electricity in S instead of buying it in N. It is represented in the figure by the shaded triangle ABC.

In the figure, an increase in the interconnection capacity by K increases the congestion revenue and reduces by the same amount the congestion cost. This equality between the revenue and the cost is the reason of the efficiency of the merchant investment model as described below (see section 1.2.2).



Given the existence and consequences of congestions, the EU has set ambitious interconnection targets of at least 10% of Member States' installed electricity production capacity by 2020, extended to 15% by 2030. The European Commission estimated in 2015 that up to €40 billion were needed to reach the 10% target[12].

To ensure these investments are undertaken, powerful public policy tools are used to incentivise Member States and investors. The Project of Common Interest (PCI) procedure, for example, allows key cross-border infrastructure projects, such as ElecLink, to benefit from accelerated planning and permit granting and from funding from the Connecting Europe Facility (CEF).

However, Member States are behind schedule on such targets. On Novembre 2017, eleven Member States, including the United Kingdom (UK), did not reach the 10% target and according to their predictions, four of them, including the UK, will not be able to reach this target in time: Cyprus, Spain, the UK and Poland. The UK's expected interconnection level in 2020 is 8%[13].

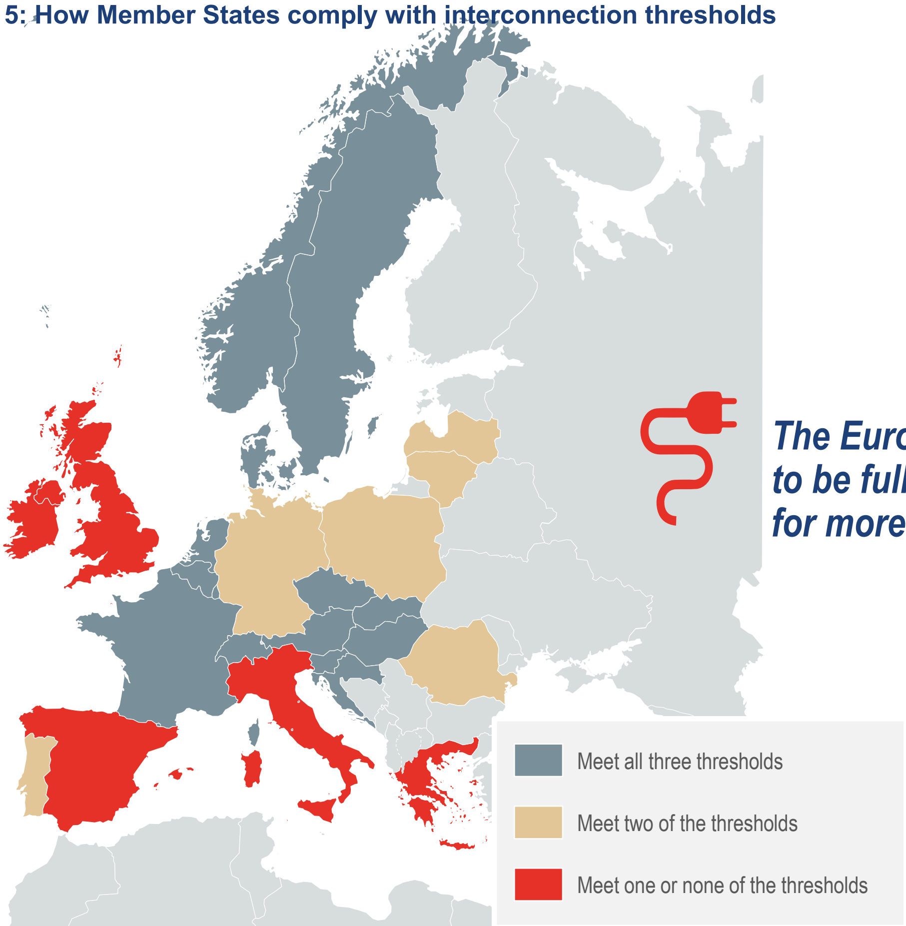
It is worth noting that, in 2017, an expert group (ITEG) proposed that the European Commission replace the 2030 15% interconnection criteria by a new methodology based on three concepts[14] :

- Minimising price differentials: Member States should aim to achieve yearly average of price differentials as low as possible. Additional interconnections should be prioritised if the price difference between relevant bidding zones, countries or regions exceeds €2 per MWh;
- Ensuring that electricity demand, including through imports, can be met in all conditions: in countries where the nominal transmission capacity of interconnectors is below 30% of their peak load, options for further interconnectors should urgently be investigated;
- Enabling export potential of excess renewable production: in countries where the nominal transmission capacity of interconnectors is below 30% of their renewable installed generation capacity, options for further interconnectors should urgently be investigated.

In light of the ITEG report, the European Commission proposed to operationalise the recommended 15% target through a set of additional indicators and minimum thresholds, which serve as indicators of the urgency of the action needed[15]. The review of these indicators and thresholds give a clear view of the current state of the integration of the European electricity market (Figure 5).

Specifically, as shown below for the fourth quarter of 2018, current prices of electricity on the wholesale market can vary significantly from one country to another (Figure 6).

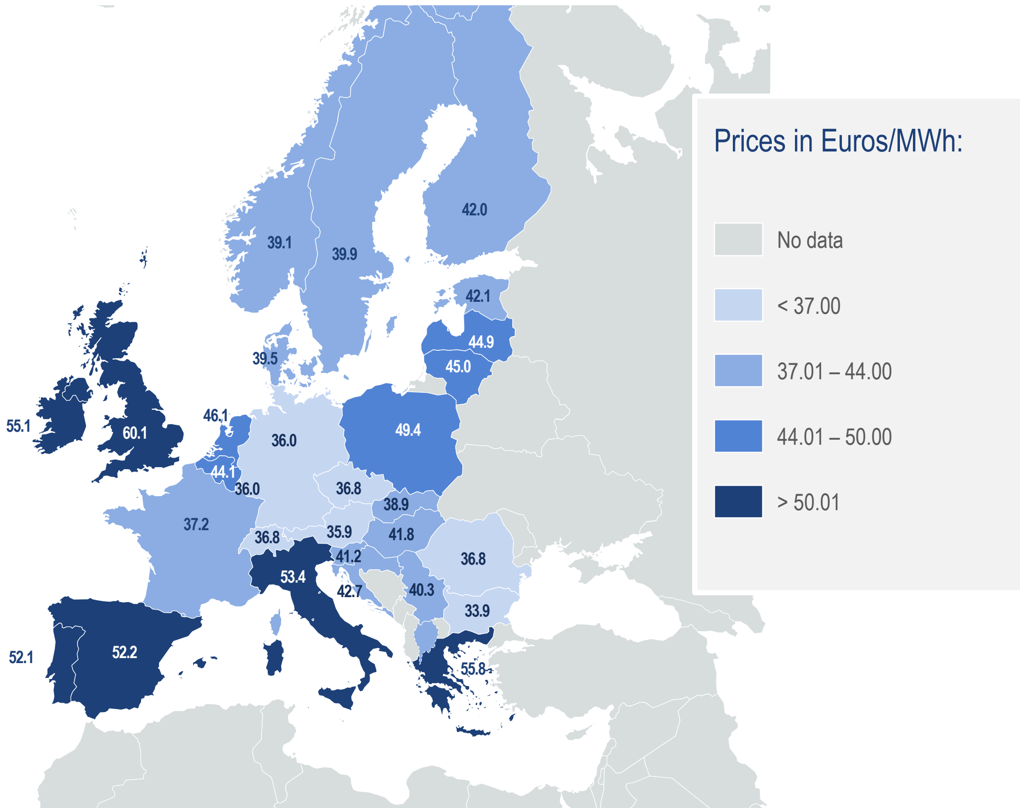
Figure 5: How Member States comply with interconnection thresholds



The European electricity market fails to be fully integrated: there is a need for more interconnectors.

Source: European Commission[16]

Figure 6: Monthly average prices of electricity on the wholesale market in the EU (Q4 2018)



Current prices of electricity on the whole sale market can vary significantly from one country to another.

Source: European Wholesale Power Exchanges [17]

Great Britain: an “isolated and weakly connected peninsula”

The electrical “boundaries” between Great Britain and Ireland and between Great Britain and Continental Europe are considered two of the top 10 barriers that need to be addressed in order to prevent the power exchange market from remaining sub-optimal and market nodes from occurring[18] (Figure 7). The European Network of Transmission System Operators for Electricity (ENTSO-E) considers Great Britain and Ireland as “isolated and weakly connected peninsulas of the European network”.

Great Britain currently has 5 GW of interconnector capacity, broken down as follows: 2 GW to France, 1 GW to the Netherlands, 1 GW to Belgium (since 1 February 2019), 500 MW to Northern Ireland, and 500 MW to the Republic of Ireland. Existing interconnectors are described in Table 1 below.

Based on quarterly data[19], the UK has been a net importer of electricity, since the second quarter of 2010, with 19.1 TWh total net imports in 2018. This made up 5.7 per cent of the total electricity supplied over the year. Annual data even show that the UK has been a year-on-year net importer of electricity since 1998 (Figure 8).

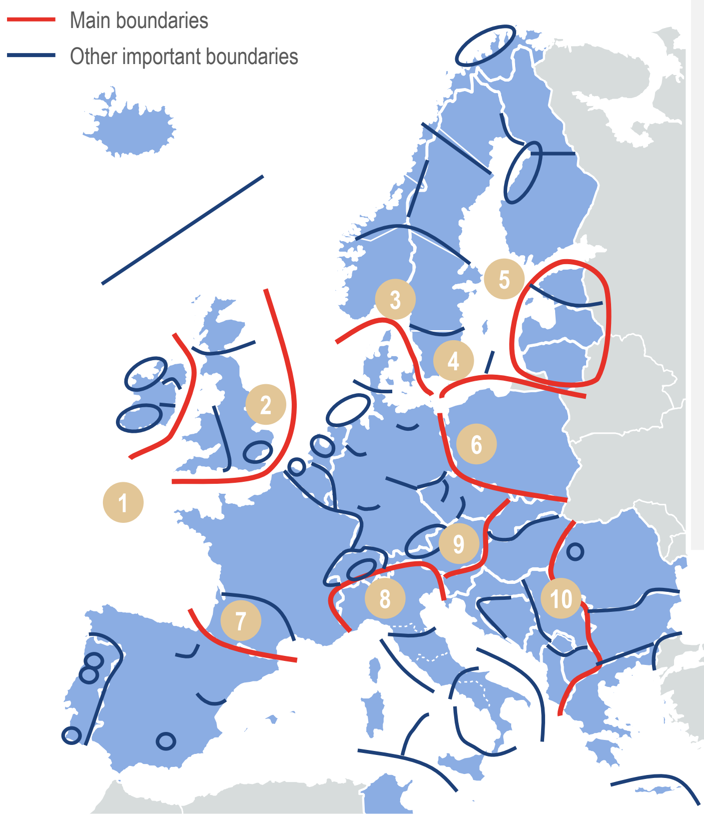
Apart from Ireland, the UK is usually a net importer from every other country. In 2018, net electricity imports from France accounted for more than two thirds of the UK’s total net imports.

This reflects the high price differential between Great Britain and Continental Europe, especially France. For instance, in Q3 2018, the monthly average price differential between Great Britain and France was €12.1 per MWh (€69.4 per MWh in GB and €57.3 per MWh in France)[20].

In this context, the development of interconnections between Great Britain and Continental Europe will help to address the issue of high price differentials, make the market more competitive and face the development of intermittent renewable energy.

Also, it should be mentioned that France is becoming increasingly reliant on electricity imports to meet peak demand during winter. This is due to the widespread use of electric heating which causes consumption to spike during cold spells. The importance of interconnectors for security of electricity supply in France is acknowledged by the national TSO, RTE: *In January [2017], [France] relied on imports because of the cold spell that occurred that month, illustrating the important role of interconnections between European countries in guaranteeing security of electricity supply*“”[21].

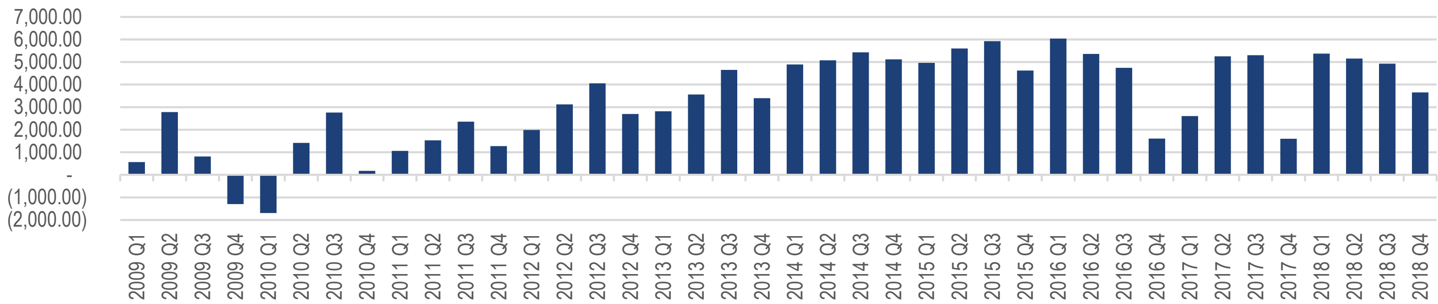
Figure 7: Main electrical boundaries across the EU



The Great Britain – Continental Europe electrical boundary is one of the main market node in Europe.

Source: TYNDP 2018

Figure 8: Net imports of electricity to the UK (GWh) (2009-2018)



Source: Office for National Statistics

Table 1: Existing interconnectors[22]

Project	Developers	Connecting country	Capacity (MW)	Status	Delivery date	Cap and floor regime / Exemption
IFA	National Grid Interconnector Holdings (NGIH) and RTE	France	2,000	In operation	1986	No
Moyle	Mutual Energy	Northern Ireland	500	In operation	2002	No
BritNed	NGIH and TenneT	Netherlands	1,000	In operation	2011	Exempted (second package)
EWIC	EirGrid	Ireland	500	In operation	2012	No
NEMO	NIGH and ELIA	Belgium	1,000	In operation	2019	Cap and floor (Pilot)

To answer these issues, there are currently several projects of interconnectors in the UK, at various stages of development (Figure 9). With respect to the border between France and Great Britain, there are currently two projects under construction (ElecLink and IFA2), increasing the interconnection capacity to 4,000 MW, and three others are currently under study (Aquind, FABLink and GridLink, with a total capacity of 4,800 MW).

ENTSO-E's 10-year network development plan (TYNDP) helps to assess the impact of future investments based on various scenarios.

The implementation of current proposed projects, as contemplated in the TYND 2018, will allow an improvement in the constitution of a common electricity market by 2030 (Figure 10).

The determination of the proper level of interconnections between Great Britain and Continental Europe is complex, as it depends on numerous factors (electricity demand, development of renewable sources, trends in nuclear energy, carbon pricing, etc.):

- In 2016, before the Brexit vote, the UK Government set an objective of a market delivery of at least 9 GW of additional interconnection capacity (an 80% increase on previous estimates)[23];
- In 2018, the Agency for the Cooperation of Energy Regulators (ACER) estimated that, from a European energy system-wide welfare perspective, it would be socially beneficial to build interconnection capacity from 8 to 9 GW and considered that, on the France – Great Britain border, "three new projects (for a capacity of 4.8 GW) appear to be needed beyond the capacity provided by the 'firm projects' (the existing IFA interconnector and two projects under construction, ElecLink and IFA2, for a capacity equal to 4 GW)"[24];
- The French CRE has a more conservative view and has recently called for "caution and temporization", based on a study according to which, beyond the 4,000 MW interconnection capacity expected to be commissioned by 2021/22 on the France – Great Britain border, the benefits of new interconnectors will not be high enough to cover their costs[25].

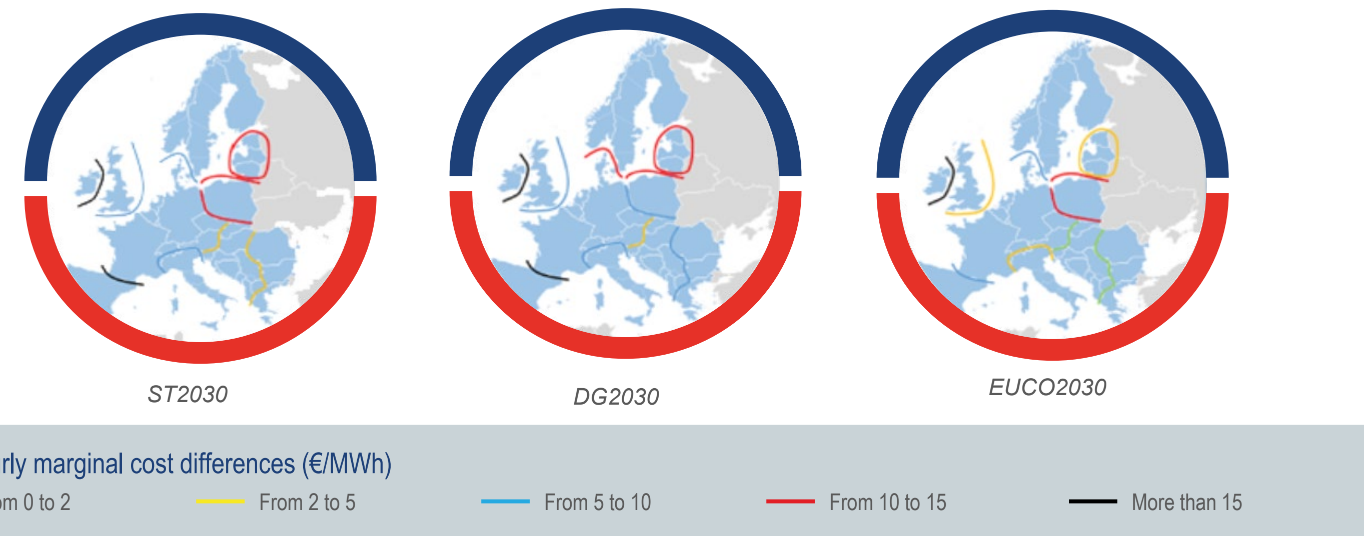
Figure 9: Existing and future interconnectors in the UK

Project	Developers	Connecting country	Capacity (MW)	Status	Delivery date	Cap and floor regime / Exemption
ElecLink	Getlink	France	1,000	Under construction	(2020)	Exempted (3rd package)
IFA2	NGIH and RTE	France	1,000	Under construction	(2020)	Cap and floor (1st window)
NSL	NGIGH and Statnett	Norway	1,400	Under construction	(2020)	Cap and floor (1st window)
Greenlink	Element Power	Ireland	500	Under development	(2021)	Cap and floor (1st window)
FABLink	Transmission Investment and RTE	France	1,400	In permitting	(2022)	Cap and floor (1st window)
Viking	NGIH and Energinet.dk	Denmark	1,400	Under construction	(2023)	Cap and floor (1st window)
GridLink	Elan Energy Limited	France	1,400	In permitting	(2022)	Cap and floor (2nd window)
NeuConnect	NeuConnect Britain Limited	Netherlands	1,400	In permitting	(2022)	Cap and floor (2nd window)
NorthConnect	NorthConnect	Norway	1,400	In permitting	(2022)	Cap and floor (2nd window)
Atlantic Super Connection	Atlantic Superconnection LLP	Iceland	1,000	Under development	(2025)	N/A
IceLink	NGIH, Landsvirkjun, and Landsnet	Iceland	800-1,200	Under development	(2030)	N/A
Aquind	Aquind Limited	France	2,000	In permitting	(2022)	Exemption denied by ACER

Source: Ofgem [26], ENTSO-E [27]

There are currenty several projects of interconnectors in the UK, at various stages of development.

Figure 10: Impact of the interconnectors commissioned by 2027 on marginal cost differences based on the three TYNDP scenarios



Source: TYNDP 2018

Discussion on the impact of Brexit

The prospect of Brexit has brought some uncertainties about the benefits associated to interconnections between Great Britain and Continental Europe and has led to mixed reactions:

- In France, the CRE has adopted a cautious stance, considering Brexit will reduce the value of interconnectors between France and Great Britain, both in financial and socio-economic welfare terms, especially in case of a "hard Brexit"[(28)]. It has decided that it was not in a position to express an opinion on the interest of any new interconnection project between France and the UK before its conditions for leaving the European Union were clarified[(29)];
- In the UK, the critical importance of interconnectors has been reasserted after Brexit by British authorities. According to the UK Houses of Parliament, "it is widely agreed that trade is likely to continue post-Brexit" and the UK should continue to be able to access the internal electricity market (IEM)[(30)]. Moreover, at the commissioning of the Nemo interconnector in December 2018, the Secretary of State for Energy stated that "Not only will [new interconnection] help us to accommodate more renewable energy on our grid and provide cheaper, greener energy for consumers as part of our modern Industrial Strategy, it will also see continued and close cooperation on energy across borders with our European partners"[(31)];
- Investors confirmed their intention to continue the development of their interconnection projects.

Despite uncertainties, it appears that interconnectors will remain important between Great Britain and Continental Europe after Brexit. The CRE itself recommend to build the already decided interconnectors, though being more cautious about future ones.

The rationale behind interconnectors will remain in order to support the competitiveness, the decarbonisation and the security of electricity supply, which will remain critical objectives in the UK and in the EU.

For instance, the UK Government has recently reaffirmed ambitious targets for the development of renewable sources of electricity (please see section 2.1.2). It is expected that the UK will still lean towards the 15% target set by the European Union.

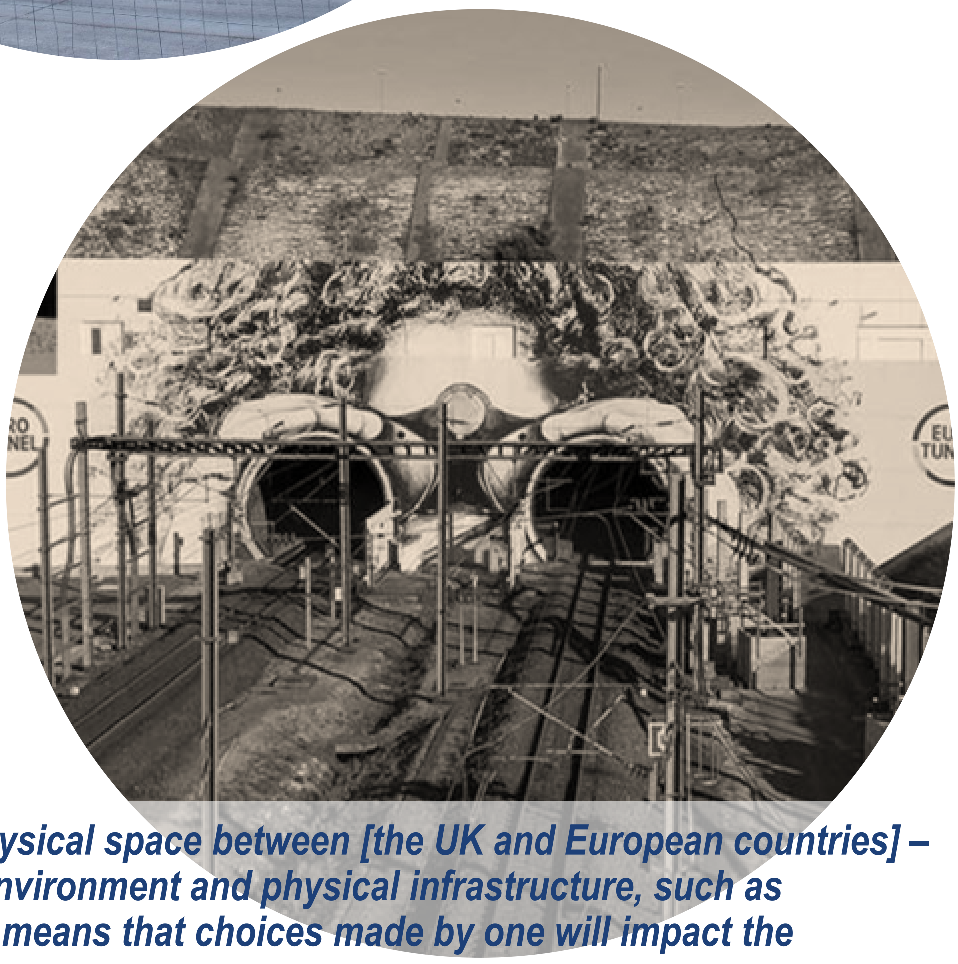
Brexit will not end the need for cooperation between the UK and European countries, as "the connected physical space between them – both the natural environment and physical infrastructure, such as interconnectors – means that choices made by one will impact the other"[(32)]. As a matter of fact, interconnectors could be a key aspect of the EU – UK relationships after Brexit.

However, Brexit will probably make the development and the operation of interconnectors more difficult. This will depend on the conditions of Brexit:

- In the event of a "soft" Brexit, the UK could have to comply with the IEM rules even without EU membership, like Norway, which means the country would have to comply with existing and future EU regulations regarding energy, environment or competition;
- In the event of "no deal", cross-border flows across electricity interconnectors will no longer be governed by EU regulations[(33)]. The UK Government confirmed that "the UK's electricity markets will be decoupled from the Internal Energy Market"[(34)] and alternative trading arrangements will have to be developed[(35)].

British authorities are working on new rules which would apply in case of a no deal in order to support interconnectors and maintain continuity of supply[(36)]. Some clarity has already been provided in respect of access rules[(37)], EU's regulation on Energy Market Integrity and Transparency (REMIT)[(38)], and tariffs[(39)].

Interconnectors will remain critical between Great Britain and Continental Europe after Brexit to address the high price differential, improve the security of supply of Great Britain and France and face the development of renewables.



The connected physical space between [the UK and European countries] – both the natural environment and physical infrastructure, such as interconnectors – means that choices made by one will impact the other[32].

1.1.2 FOCUS ON ELECLINK

ElecLink is a major European project, which addresses part of the congestion issues between Great Britain and France. It was given PCI status in October 2013 by the European Commission[40].

The interconnector will function on a High Voltage Direct Current (HVDC) bidirectional transmission capacity (Figure 11). It will generate a capacity of 1,000 MW, representing a 50% increase of the current interconnection exchange capacity with France and a 25% increase with Continental Europe.

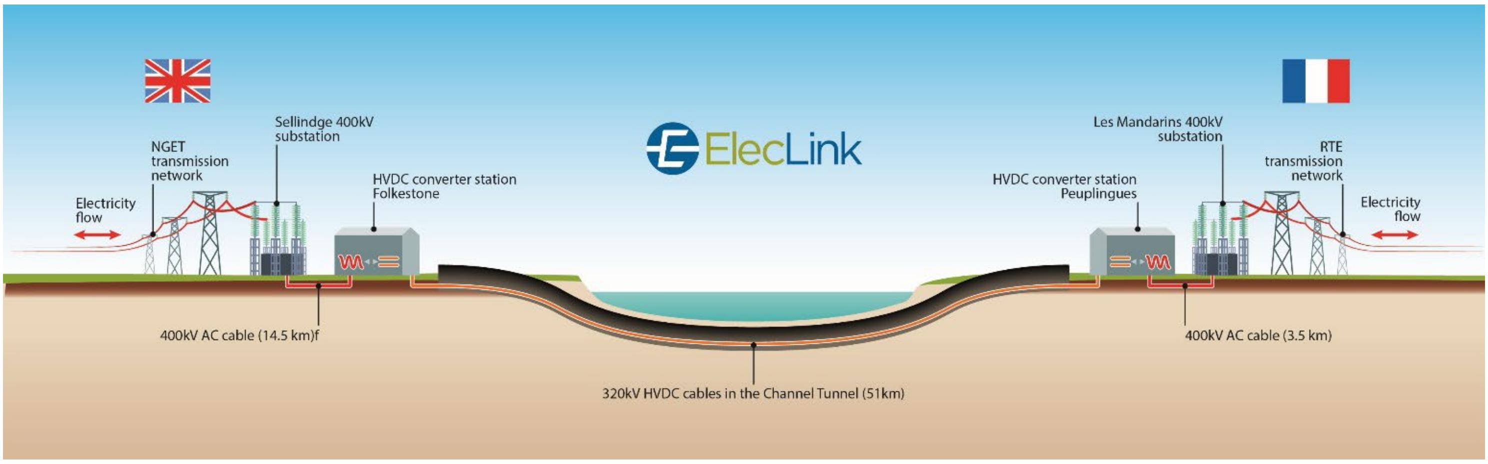
The project is designed to be cost-efficient with high quality standards:

- Using the Channel Tunnel, ElecLink has technical advantages inherent to the presence of Getlink's existing infrastructures: it will not need any undersea cables or overhead lines and will use primary utilities, including cooling equipment, already installed. As a result, ElecLink is expected to have the most efficient cost structure among its competitors, costing less than the others in both absolute value and per MW of exchange capacity (Table 2).
- The ElecLink project is also set to guarantee low transmission losses (the loss factor applied by ElecLink is expected to be 2.5% from one end of the interconnector to the other) and a high level of availability and reliability.

It is also worth noting that the use of existing infrastructure will reduce the project's environmental impact: it will avoid the installation of undersea cables or overhead lines and there will be no impact on marine life, as no extra intervention will be needed outside the Channel Tunnel.

ElecLink is designed to be cost-efficient and to have a limited impact on the environment thanks to the use of the Channel Tunnel.

Figure 11: ElecLink interconnector



Source: ElecLink

Table 2: Cost comparison of interconnectors between France and Great Britain

Interconnector Project	Capacity (MW)	Cost of the Project (k€)	Cost per MW (k€)
ElecLink	1,000	580,000	580
IFA 2	1,000	690,000	690
FAB Link	1,400	850,000	607
GridLink	1,400	900,000	643
Aquind	2,000	1,400,000	700

Sources: European Commission, National Commission for Public Debate (CNDP, France), 4coffshore.com

Overall, according to ElecLink, the net social welfare gains estimated for the project are approximately €600 million over the operating lifetime of the interconnector. Reinforcing the mix towards more renewables, the usage of ElecLink is expected to reduce CO_2 emissions by 6.1 million tonnes by 2030, contributing to the objectives of decarbonisation across Europe.

It will also improve the security of supply, especially in France, as recently underlined by RTE[41].

It should be noted that these positive outcomes will have no cost implication for taxpayers or electricity consumers, except for the consequences on other segments of the network (such as the network reinforcement costs) and on the incomes of other interconnectors.

Indeed, unlike other interconnectors which are underwritten by consumers, ElecLink bears 100% of the project costs and risks.

Key finding No. 1

By reducing congestions between countries, they increase the security of supply, allow for a better integration of renewable energy sources and favour price convergence within the integrated zone.

Investment needs between Great Britain and Continental Europe are high, as Great Britain is considered as isolated. Despite current uncertainties, the rationale behind interconnectors will continue to be strong after Brexit. In this perspective, ElecLink can help resolve the energy trilemma: it will increase security of supply for both France and the UK, support the transition to a low carbon economy and improve affordability for consumers.

ElecLink has many benefits at no direct cost for taxpayers or electricity consumers.

€600 million

of net social welfare gains

1,000 MW

representing

50%
increase of the current interconnection exchange capacity with France

25%
increase with Continental Europe

6.1 million tonnes

of CO_2 emissions saved by 2030

1.2 THE MERCHANT INVESTMENT MODEL: A SOCIALLY OPTIMAL SOLUTION

In accordance with European regulations, ElecLink is a merchant transmission investment, which has been granted a partial exemption from the regulated regime (section 1.2.1). Given their merits and in light of other sectors, the EU should rely more on merchant transmission investments in order to increase the level of interconnections in Europe (section 1.2.2).

1.2.1 THE EXEMPTION REGIME APPLICABLE TO ELECLINK

ElecLink's model differs from the default route defined by European regulations for interconnectors: it has an exemption from regulatory requirements for 25 years from the date the interconnector starts commercial operation. This exemption was granted by the CRE[(42)] and Ofgem[(43)] in 2014, following a decision by the European Commission to support their initial decision subject to some conditions[(44)].

The regulated regime

Transmission lines are generally considered natural monopolies, characterised by important economies of scale. This is why, as a principle, interconnectors are regulated assets pursuant to European regulations (Regulation 714/2009[(45)] and, starting from 1 January 2020, Regulation 2019/943)[(46)].

Under such regulated regime, National Regulatory Authorities (NRAs) approve investments in new capacities and regulate the incomes of the investor, which shall cover all costs incurred for the setting up and operation of the interconnector, including a regulated return on investment.

The economic risks of the project are borne by consumers, meaning that if the revenues of the project (the congestion rent) are less than expected, the investor will nevertheless be able to cover the costs of the interconnector (through the regulated tariff or top-up payments)[(47)].

The regulated regime relies on three main obligations:

- Use of revenue: the revenue must be used either for guaranteeing the actual availability of the allocated capacity, maintaining or increasing interconnection capacities through network investments (in particular in new interconnectors) or network tariffs reduction[(48)]. This means that consumers (as opposed to investors) benefit from revenues in excess of the costs of the project;
- Third party access: capacity allocation must be carried out using non-discriminatory market-based solutions (e.g. auctions) approved by the competent NRA[(49)];
- Ownership unbundling: the same person cannot exercise direct or indirect control over a TSO or transmission system and at the same time exercise direct or indirect control over or have any right over an undertaking performing the functions of generation or supply[(50)].

The detailed characteristics of the regulated regime vary by jurisdiction with respect to (i) operators which may be allowed to develop, build and operate interconnectors and (ii) risk-sharing between investors and consumers (Box 2).

Although the regulated model is the default route for cross-border lines, it is not the only model available to build and operate interconnections.

By default, interconnectors are regulated assets: their revenues are regulated and their risks borne by consumers.

Box 2: The regulated regimes in France and UK

The regulated regime in France

In France, RTE is in charge for the development, construction and operation of interconnectors[51] and no private investors have ever built and operated an interconnector project under the regulated regime.

The regulated regime intends to incentivize RTE through risk-sharing mechanisms. The network access tariff (TURPE) approved by the CRE provides for "appropriate incentive measures", both in the short and long terms, to encourage RTE to improve its performances, favour the integration of the European electricity market and the security of supply and increase productivity gains[52].

The TURPE 5 HTB[53] currently sets the general framework for this incentive regulation, which relies on three main measures:

- Financial incentive for undertaking necessary investments: a bonus depending on the collective value of the interconnector (defined prior to the final investment decision and payable upon the commissioning of the project);
- Financial incentive for costs minimization: a bonus or penalty depending on the differential between the target total cost of the project and the actual total cost (the penalties cannot lead to a return on the capital invested inferior to WACC minus 1%);
- Financial incentive for the effective use of the interconnector (during 10 years): a bonus or penalty, on a yearly basis, depending on the actual flows compared to the flows initially expected by the CRE in its assessment of the project (capped to the amount of the bonus defined prior to the final investment decision).

The calculation parameters of these financial incentives are established on a case-by-case basis by the CRE, considering the characteristics of each interconnector. For risky projects, the CRE can for example define stronger incentive regulation mechanisms in order to ensure a more balanced sharing of risks and benefits between RTE and the network users[54].

The regulated regime in the UK

In the UK, any entity operating an interconnector must be licensed[55]. Parties other than the System Operator (SO, i.e. NGESO) or Transmission Operators (TOs, i.e. NGET, Scottish Power Transmission and Scottish Hydro Electric Transmission) can implement regulated transmission investments.

The UK has introduced a specific regulated regime called "cap and floor", in order to encourage more investments in interconnectors. According to Ofgem, "Before the cap and floor regime was introduced, only a limited number of electricity interconnectors had been either built or proposed. Ofgem therefore created the cap and floor regime to unlock beneficial investment by reducing risks" [56].

Under the new regulated regime, the revenues are subject to both a cap and a floor [57] (Figure 12):

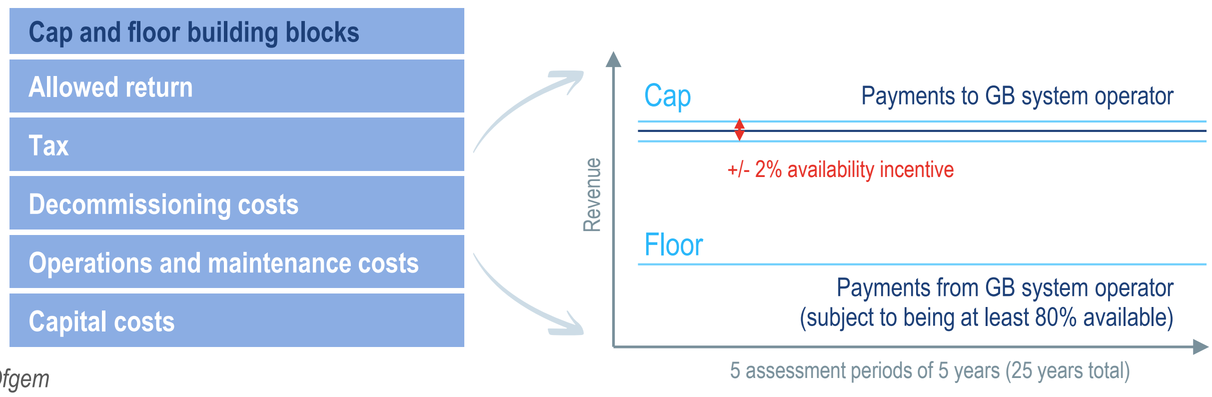
- The floor is the minimum amount of revenue that an interconnector can earn (through top-up payments if revenues fall below the floor). The floor is set at a level that ensures that an interconnector can cover its annual operating expenditure and service its debt, subject to a minimum availability performance;
- The cap is the maximum amount of revenue (with excess revenues returned to consumers through lower network tariffs). The cap is set to ensure that equity investors receive sufficient but not excessive returns and can vary by +/- 2% depending on availability performance;
- Caps and floors are project specific. The duration of this regime is 25 years, with actual revenues earned assessed against the cap and floor levels every five years.

Projects under this cap and floor regime have to comply with all aspects of European legislation on interconnections.

The cap and floor regime is granted by Ofgem during "windows" when it assesses several projects. The assessment process follows three stages: the Initial Project Assessment (IPA), the Final Project Assessment (FPA) (when the preliminary cap and floor levels are determined) and the Post Construction Review (PCR) (with the fixing of final cap and floor levels).

The Nemo Link project was awarded a cap and floor regime in 2014, as a pilot project. The first cap and floor application window was held in 2014 and five projects were awarded this regime in 2015. A second application window was open in 2016 and Ofgem decided to grant the GridLink, NeuConnect and NorthConnect projects a cap and floor regime (IPA stage) in 2018 (Table 3).

Figure 12: The cap and floor regime



Source: Ofgem

The exempted regime

In theory, there is a case for merchant transmission investments as soon as a congestion rent exists:

- If the price at different nodes of the network is the same, the regulated model is the only viable model for pricing and investment. This means that when the market is fully integrated, transmission prices should be regulated;
- If prices at two nodes of the transmission system are different, which is generally the case if transmission lines are congested —and therefore there is a need for increasing capacity of the lines —, then there is another model for pricing and investment based on the congestion rent;
- With different prices in two zones, a connecting capacity can capture part of the congestion rent. Hence, congestion rents can be a driver for investment in transmission lines. In this merchant investment model, the owner of the transmission line captures the congestion rent (or part of it), i.e. the difference between nodal prices in the two zones.

European regulations leave room for the merchant investment model: Regulation 714/2009 allows for exemptions for new interconnectors from some regulatory requirements provided for in the Regulation itself and in Directive 2009/72. This regime was first introduced in Regulation 1228/2003 and is maintained under Regulation 714/2009.

The exempted regime seeks to find a balance between two objectives:

- Allowing the development of projects by parties other than TSOs which are too risky to be developed under the regulated regime, notably in relation to non-use of the interconnector or variations in costs or revenues.

  Under the exempted regime, developers bear the full risk of the investment; hence their profits are not capped as in the regulated regime, with potential upside. In that perspective, exemptions can relate to, for a limited period, the use of revenue, third party access and ownership unbundling.
- Minimising potential adverse effects of merchant transmission investments on the integration of the European electricity market (e.g. if the operator is allowed to create scarcity in order to maximise the congestion rent) and on market competition in electricity supply (e.g. if a dominant undertaking in one of the linked market uses the interconnector to consolidate its position).

As a result, exemptions are granted on a case-by-case basis by regulatory authorities[58], subject to strict conditions[59] :

a) The investment must enhance competition in electricity supply;

b) The level of risk attached to the investment is such that the investment would not take place unless an exemption is granted;

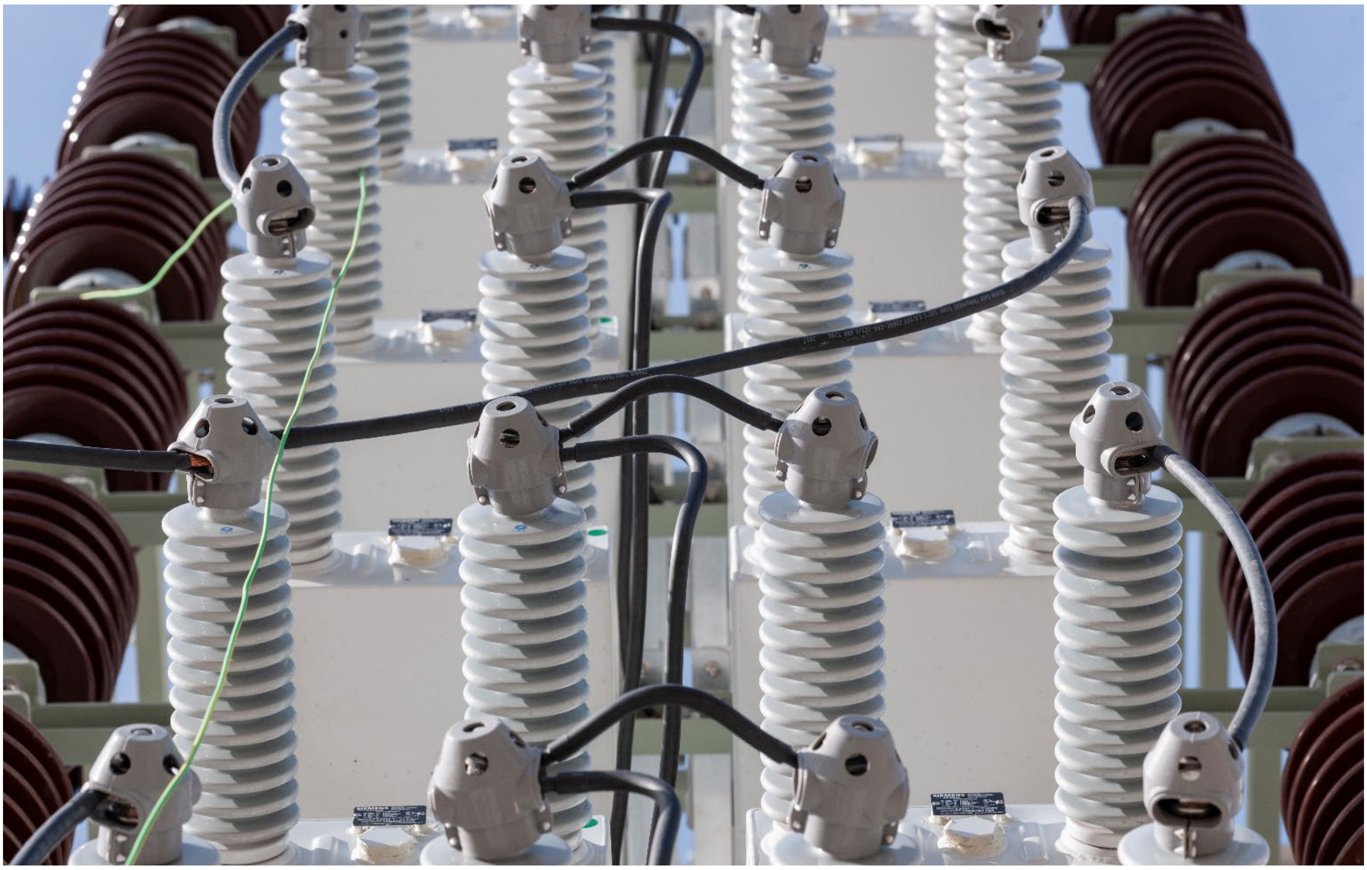
c) The interconnector must be owned by a natural or legal person which is separate, at least in terms of its legal form, from the system operators in whose systems the interconnector is to be built;

d) Charges are levied on users of the interconnector;

e) Since the partial market opening referred to in Article 19 of Directive 96/92/EC, no part of the capital or operating costs of the interconnector has been recovered from any component of charges made for the use of transmission or distribution systems linked by the interconnector; and

f) An exemption would not be to the detriment of competition or the effective functioning of the internal market for electricity, or the efficient functioning of the regulated system to which the interconnector is linked.

Furthermore, exemptions may be partial, in order to ensure market integration and protect competition: they can cover only a part of the overall capacity of the interconnector or only a part of the obligations from which the exemption is requested. The same obligations as those provided for under the regulated regime may therefore also apply to merchant investments.



Non-regulated (merchant) interconnectors are authorised in order to develop projects which risks are borne by private investors.

In accordance with European regulations, ElecLink's exemption provides for various conditions, presented in Table 3 below.

As of today, besides ElecLink, only one interconnector between Continental Europe and Great Britain was granted an exemption: BritNed. It should nevertheless be noted that the European Commission requested that BritNed's profits be capped on competition-related grounds. This limit on the upside for the project's investors, with no equivalent protection against downside risk, ultimately led to the creation of the cap and floor regime by Ofgem.

Outside the UK – Continental Europe border, merchant transmission investments include: Estonia-Finland Estlink (between Estonia and Finland, 2005), Imera East-West cables (between Wales and Ireland, 2008), Tarvisio-Arnoldstein (between Italy and Austria, 2010), Piemonte-Savoia (between Italy and France, 2016) and SI-IT Interconnectors (between Slovenia and Italy, 2014, modified in 2019).

The European approach towards merchant transmission investments can be considered as restrictive:

- The conditions to grant an exemption are severe and strictly interpreted by regulatory authorities. For example, on 19 June 2018, ACER rejected the application by Aquind Limited for an exemption to build a merchant interconnector between France and Great Britain, as it considered that the condition provided for by Article 17(1)(b) of Regulation 714/2009 ("the level of risk attached to the investment is such that the investment would not take place unless an exemption is granted") was not fulfilled. This decision was confirmed by the Board of Appeal of ACER on 17 October 2018[61];
- The conditions imposed to merchant transmission investments have been tightened over time, which may have a deterrent effect on investors[62].

However, such restrictive approach may be questioned.

ElecLink has been granted a partial exemption, aiming at finding a balance between meeting investors' expectations in terms of risk/return ratio and minimising potential adverse effects.

Table 3: Exemption granted to ElecLink

Use of revenues

- ElecLink is allowed to keep congestion revenues, subject to a profit-sharing mechanism whereby ElecLink would return to electricity consumers (via the fully regulated national system operators) 50% of its profits over a predetermined threshold which has been set by the regulatory authorities.

Third Party Access

- ElecLink is permitted to allocate multi-year capacity through an open season
- 80% of the interconnector capacity may be reserved for multi-year products. ElecLink is permitted to sell a mix of contract types with a maximum term of 20 years, and an average term of 15 years. ElecLink must facilitate a secondary market for capacity trading that will allow holders of long-term capacity rights to sell such rights to other market participants
- The remaining capacity must be allocated to the market in the form of different products not exceeding one year in terms of duration: long-term (e.g. yearly, seasonal, quarterly and monthly), daily and intraday
- For multi-year products, no entity is permitted to hold more than 40% of the total capacity of the interconnection (400MW) in either direction. The dominant market player (EDF in France) may not hold more than 20% (200MW) of the total French import capacity
- The access and charging arrangements for the capacity allocated through the open season and non-exempt capacity (ElecLink Access Rules and the Charging Methodology Statement) must comply with the same provisions as regulated interconnectors between Great Britain and France, notably in respect of compensation for curtailment, and the European network codes, in particular the CACM Regulation[63] and the FCA Regulation[64]. A first version of the ElecLink Access Rules and Charging Methodology Statement was approved by the CRE and Ofgem in April 2016. Between 1 April and 1 May 2019, ElecLink conducted a public consultation on a new version taking into account the new Regulations (assuming the UK remains part of the IEM)[65]. A new consultation was held between 16 August 2019 and 13 September 2019 on non-IEM access rules, in the event that the UK no longer participates in the European IEM

Ownership unbundling

- ElecLink may be partly exempted from Article 9 of 2009/72, subject to some conditions. The CRE[66] and Ofgem[67] certified that ElecLink respect the full ownership unbundling model in the UK and France in 2019.

1.2.2 RELEVANCE AND MERITS OF THE MERCHANT MODEL IN THE EU

Although it currently has a marginal role in the European Union, the merchant transmission investment model should be more valued. The assessment of this model covers two distinct issues: should interconnections be necessarily regulated given their characteristics? Is the regulated model superior to fulfil the European electricity policy objectives? The answers to these questions call for a revised approach to merchant interconnectors in Europe.

Should interconnections necessarily be regulated?

What infrastructures and services should be regulated and why? It can be concluded from the comparison with other sectors that a key factor for regulating assets is the existence of alternatives or their degree of replicability.

Since regulated network industries have been opened to competition, competitive segments and regulated segments coexist (Box 3). The scope of regulation of network assets varies across time, countries and industries.

Three main situations should be distinguished:

- Assets for which alternatives exist: when alternatives to network assets exist, the latter are not (and should not be) regulated. This is the case, for instance, of gas and oil pipelines, which connect the production/extraction sites to the main transport infrastructure (oil terminals and gas hubs);
- Assets that are replicable: they should be, at best, temporarily regulated, and not in the same way as non-replicable assets . Regulation should ensure that entry occurs, sometime through "entry assistance") In this respect, it is worth noting that the degree of replicability of an asset is not only a technical attribute; replicability also depends on competition and technologies. This situation is well illustrated by the regulation of telecommunication and the ladder of investment theory (Box 4).
- Assets that have no alternatives and are not replicable (because of their prohibitive costs): they should be permanently regulated. Such infrastructures are defined as essential facilities. This is the case, for example, of train tracks and stations in the rail transport sector, or national electricity and gas grids in the energy sector.

Where do interconnectors stand in this classification?

In the electricity sector, the national transmission grid is a bottleneck: it cannot be replicated and it does not need to be if prices are uniform within the country, i.e. if there is no congestion. However, interconnections between countries are much more replicable:

- There are different technical ways to interconnect markets, as illustrated by the large number of interconnection projects (Table 3);
- Interconnections become even more replicable as the European electricity market becomes more integrated. Indeed, with the integration of various markets (France, Germany, Netherlands, Belgium and UK), an interconnection line between Belgium and Great Britain (such as Nemo) is a substitute to an interconnection between France and Great Britain, albeit not necessarily a perfect one. All these competing projects aim to integrate the market further and can be profitable when congestion rents exist.

Therefore, the need to regulate these assets in the market progressively disappears as competition exists both at the wholesale and the interconnection levels. As interconnections are replicable assets, they could avoid being regulated.

As interconnections are replicable assets, they could avoid being regulated.

Box 3: Principles of regulation in network infrastructures

Liberalisation is organized around four main principles (de Streel et al., 2011)[68] :

- Vertical separation of competitive and regulated activities (mainly networks);
- Third party access to infrastructures with access being provided to competitors on a regulated basis (e.g. price controls, transparent and non-discriminatory basis);
- Competition for the contestable segments of the market;
- Residual regulation for the non-contestable segments.

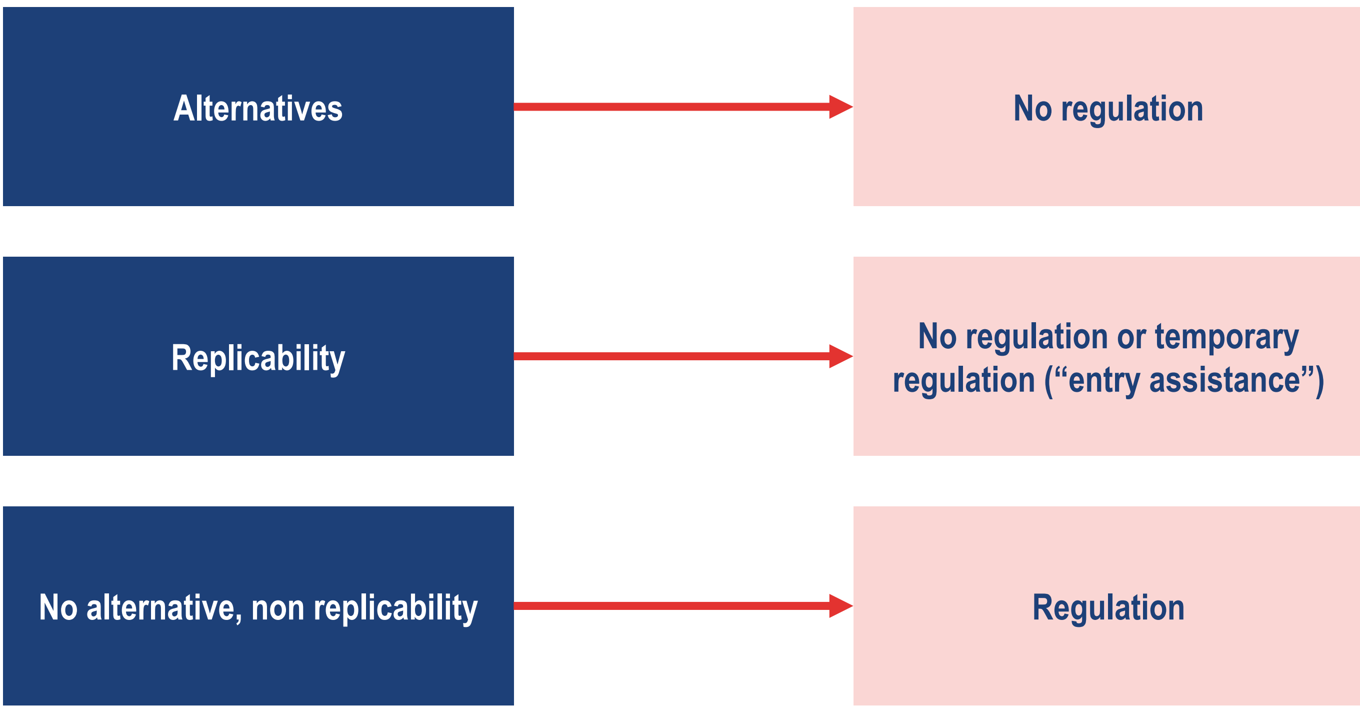
Network infrastructures are generally bottlenecks, i.e. assets that are economically difficult to replicate, notably because of important economies of scales. Therefore, to enable competition in the contestable (potentially competitive) segments of the market, competitors must be granted access to bottlenecks, often on regulated terms.

Table 4 below schematically distinguishes the competitive and regulated segments in several network industries.

Table 4: Competitive and regulated segments in network infrastructures

Industry	Competitive Segments	Regulated Segments
Electricity	Generation, Commercialization	High and low voltage grids
Gas	Production, shipping	Storage, transport grid, distribution grid
Telecommunication	Telecom retail services	Local loop
Rail	Passenger and freight transport	Rail tracks and stations

Usually, for non-competitive regulated segments of the market, there is a regulatory supervision of investments, while in competitive segments prices and investments are market driven.



Advantages of the merchant model over the regulated model

The academic literature shows there are difficulties entailed by the regulated model, notably in terms of incentives, which can be addressed under the merchant transmission investment model.

First, setting a regulated price or income (which aims at recovering the investment costs) is often complex as there is information asymmetry between the regulated firm and the regulator (the latter being less informed) on a number of variables (e.g. cost, efficiency, expected demand). This is why some NRAs use quasi-market mechanisms, such as benchmarking methods and yardstick competition, which are useful tools to regulate transmission activities (Agrell and Bogetof, 2017)[(69)]. They nevertheless remain imperfect.

Second – and this appears to be the major difficulty faced by regulation –, in a regulated market, investment in new transmission capacities is not completely market driven. Investments by TSOs are subject to regulatory approval and the TSO must demonstrate the economic value of the new capacity. Two main problems arise from this situation:

- Cost-benefit analyses (CBA), which are necessary to demonstrate the economic benefit of new transmission capacity, are highly complex and may inaccurately evaluate the opportunity to invest. Using two case studies, De Nooij (2011) shows that such evaluations are misleading and concludes that the current investment decisions in Europe are unlikely to maximise social welfare[(70)];
- Besides the difficulties to evaluate the full costs and benefits associated with investments, another key issue is that, although the regulatory approval of regulated investments is theoretically based on a European scope, the planning of investment in transmission and interconnection capacity is mainly done at the national level and takes into account national welfare. This national focus leads to suboptimal investment in interconnection capacity compared to what would be optimal when considering both countries involved in the interconnection.

Sagan and Meeus (2014) observe that national interests seem to drive investments approval policies. This can result in suboptimal transmission investments because cross-border projects that are beneficial for Europe, but not for all involved Member States, can be blocked as Member States can veto or delay projects that are partly developed on their territories[(71)]. Regulators in the low-price zones may for instance be reluctant to agree on increased interconnection as price convergence is likely to lead to price increases in the low cost/price zone (De Vries and Hakvoort, 2002)[(72)].

For instance, Malaguzzi Valeri (2009) shows that additional interconnection capacity between Ireland and Great Britain benefited consumers in Ireland, the high price zone, but was detrimental to consumers in Great Britain, the low-price zone[(73)].

National regulators may then be reluctant to authorise investments that lead to higher prices and a lower surplus in their country. While the benefits and welfare should be evaluated at the global and supranational level, Sagan and Meeus (2014) show with a simulated model that a lack of coordination at the European level leads to significantly less investment in interconnection than a centralized planning, leading them to label the current regulatory framework as "imperfect"[(74)].

Lack of coordination in investments by NRAs is detrimental and reduces social welfare, particularly as the increasing share of renewable energy sources requires more energy trading between countries.

Despite all the efforts of NRAs to fully integrate the European electricity market, it is a fact that several bottlenecks remain, i.e. there are not enough interconnection capacities compared to the needs of the market (please see section 1.1.1).

Box 4: Telecommunication and the ladder of investment theory

In the telecommunication sector, competitors have the choice between two modes of competition:

- Access or service-based competition: competitors buy access to the existing infrastructure and use the leased infrastructure to provide services to their clients; or
- Infrastructure-based competition: competitors develop their own infrastructure to compete with the incumbent.

According to the ladder of investment theory (Cave, 2006), regulated access to infrastructure is a transitory measure in the development of competition[75]. Competitors should be granted a transitional access to infrastructures to progressively acquire clients and revenues and they should be encouraged to progressively make investments in network assets which are less and less easily replicable, i.e. they should climb the ladder of investment. Investments in new assets progressively suppress the need to regulate access to the incumbent's infrastructure as competition spreads across the value chain.

Bourreau and Dogan (2005) show that providing access delays investment in competing infrastructures[76]. With access, competitors can be active on the market even without investing in their own infrastructure. As a consequence, the profit under access-based (or service-based) competition is an opportunity cost for the competitor and this might delay the emergence of infrastructure-based competition. The authors call for limited access to infrastructures to encourage the development of service-based competition. Based on a comparison of different OECD countries, Bouckaert et al. (2010) find that the degree of mandatory access obligations imposed by the regulator on the dominant network firm is a key driver of investment in broadband infrastructures and that countries providing less generous access have experienced a higher broadband penetration[77].

Currently, in the telecommunication sector, the scope of mandatory access to infrastructure has been progressively reduced as competitors developed their own competing infrastructures.

Despite all the efforts of NRAs to fully integrate the European electricity market, it is a fact that several bottlenecks remain.

The difficulties inherent to the regulated model do not exist in a pure merchant transmission investment model.

The main merit of the merchant model is to provide appropriate incentives for investment under certain conditions. Joskow and Tirole (2005) show that if nodal prices correctly reflect production costs (in other words, if the electricity wholesale markets in both zones are competitive), then the merchant investment model leads to efficient investment[78]. This means that all profitable investments are efficient in the sense that they positively contribute to social welfare. Congestion rents provide adequate incentives for investments. In this respect, the transmission of electricity through interconnectors can be largely deregulated.

The efficiency of the merchant investment model can be illustrated as described in Box 5.

Another major merit of the merchant investment model is that, contrary to regulated investments whose risk is borne by consumers, merchant interconnectors financed by private funding have strong economic incentives to minimise costs (given they get to keep the upside), build the asset on time and maximise the availability.

The comparison between the regulated and the merchant investment models can be summarized as follows (Table 5).

The advantages of the merchant investment model are confirmed by a study of Australia, where both models have coexisted (Box 6).

It should be noted that the cap and floor mechanism for interconnections, as a hybrid mechanism mixing the regulated and the merchant investment models, does not completely solve the issues arising from the regulated model. Indeed, while this model aims at guaranteeing the return on investment, thereby insuring investors against risks, the resulting incentives to invest might be biased as low return projects can be financed thanks to the floor while high return projects might be deterred by the cap.

Box 5: Illustration of the efficiency of the merchant investment model

Suppose that there is a price differential between the two zones Δ=pN-pS>0. Suppose further that the prices reflect the marginal cost of production: pN=cN and pS=cS. The congestion rent is equal to the price differential Δ. But this differential is also the cost of congestion to the system (the "congestion cost"). Electricity is produced in the North at cost cN while it could be more efficiently produced in the South at cost cS<cN.

In this context, an investment that allow to increase electricity flows from S to N by one unit is efficient from a global point of view if the investment cost (denoted by I) is lower than the cost of congestion, that is if I<cN-cS. In the merchant investment model, the investor will capture the congestion rent pN-pS. The investor will increase the capacity if its benefit is larger than the cost, that is if pN-pS>I. With "cost-oriented" prices (which would be the case if markets are competitive), these two conditions coincide: if pN-pS>I (the investment is privately profitable) then cN-cS>I (the investment is socially desirable) and private and social incentives coincide.

If wholesale markets are imperfectly competitive, then prices differ from marginal costs as they include a margin. Let us denote the wholesale margin in the two zones by mN and mS. The price in zone i is equal to pi=ci+mi. If those price cost margins are different in the two market zones mN≠mS, the price differential will not be equal to the cost differential: pN-pS=(cN-cS)+(mN-mS). The private investor will carry out the investment if pN-pS>I.

In this case, the private and social incentives to invest no longer coincide and the private incentives to invest are distorted. These distortions can go both ways. There are excessive investments (compared to the social optimum) if mN>mS, that is if the importing market has a higher margin than the exporting one, and under-investments in the reverse case if mN<mS.

Several empirical evidences suggest that European wholesale markets remain imperfectly competitive[79]. However, in an important and influential study, Borenstein et al. (2000) show that interconnection capacity contributes to make markets more competitive and that even a limited investment in transmission capacity can have large payoffs in terms of increased competition[80]. In a dynamic perspective, margins in the two markets will converge when new connections are constructed. For instance, Malaguzzi Valeri (2009) documents that increased interconnection between Ireland and GB contributes to make the Irish market more competitive[83].

Box 6: The Australian example

In Australia, the two models – the merchant and the regulated investment models – coexisted and Littlechild (2011)[81] compared the merits of the two. According to the reviewed experiences, there are problems and difficulties associated with both models. However, he shows that "the merchant transmission (broadly defined to include private initiatives) has generally not exhibited the standard examples of market failure but regulated transmission generally has exhibited the standard examples of regulatory failure". In particular, he documents that investment planning was less effective in the regulated model with regulated project proposals being uneconomic. Based on this experience, he recommends to favour the development of the merchant investment model.

Table 5: Regulated model vs merchant transmission investment model

	Regulated model	Merchant investment model
Description	Investments and incomes are approved by NRAs. The economic risks of the project are borne by the consumers	Investments and incomes are market-driven. Developers bear the risks of the project
Rationale	Transmission assets are considered as a natural monopoly with important economies of scales	Congestion rents can be a driver for investment in transmission
Merits	✓ Revenues are used for guaranteeing availability, maintaining or increasing interconnection capacities ✓ Third party access is guaranteed using non-discriminatory market-based solutions ✓ Ownership unbundling favours competition on the commercial segments of the market	✓ Provided that nodal prices correctly reflect production costs, all profitable investments are efficient in the sense that they positively contribute to social welfare ✓ Merchant interconnectors financed by private funding have strong economic incentives to minimize costs, build the asset on time and maximize the availability
Limits	× Setting a regulated price or income is complex as there is a lack of information on e.g. cost, efficiency and demand for the regulator ➔ Issue of incentives × Investments are inefficiently low because of the national focus of regulators and lack of coordination at the European level × Costs-benefit analysis inaccurately evaluate the opportunity to invest	× If wholesale markets are imperfectly competitive, the private and social incentives to invest no longer coincide

Compared to the regulated model, the non-regulated model provides appropriate incentives to invest, to manage cost, to build on time and to make the asset available.

Two main arguments may be invoked to justify the restrictive approach of European regulatory authorities to merchant transmission investments: the imperfect characteristic of wholesale markets, which may create distortions and limit the efficiency of merchant transmission investments and the desire to share the congestion rent with consumers, to guarantee third party access and to favour commercial competition through ownership unbundling.

However, potential distortions associated with different levels of competition in the wholesale markets should be traded-off with the inefficiency resulting from the regulated model. Moreover, European regulations provide for mitigations, which would allow to minimise significantly or avoid the potential adverse effects of the merchant transmission investment model on market integration and competition (please see section 1.2.1). Operators of interconnectors may be subject to strong legal and statutory obligations, in respect of profit-sharing mechanisms, third party access and ownership unbundling. This applies in particular to ElecLink, which exemptions is subject to various conditions (Table 3).

In this context, prominent academics such as William Hogan, research director of the Harvard Electricity Policy Group (HEPG) share the view that European authorities should promote merchant transmission investments more.

Key finding No. 2

ElecLink is a leading example of the merits of merchant transmission investments: unlike other interconnectors, ElecLink is 100% financed by private funds and the company bears the full investment costs of the interconnector at no direct risk to the taxpayer or electricity consumers.

As interconnectors are replicable assets, they could avoid being regulated, in line with the merchant model. Compared to the regulated model, the merchant model provides appropriate incentives to invest, to manage cost, to build on time and to make the asset available. The European Union should therefore rely more on merchant transmission investments.

The restrictive approach of the EU towards non-regulated interconnectors may be questioned.

Both the generation of electricity and the transmission of electricity can be largely deregulated.

Paul Joskow and Jean Tirole[82]

While regulated investments may be needed to supplement merchant electricity transmission investments in specific circumstances, it is inconsistent with the design of efficient electricity markets for regulatory policy to start from the premise that all transmission investments should be regulated. Rather, an approach supporting efficiency in the context of competitive electricity markets would be for merchant investments to be the "default" option supplemented with regulated investments for specific cases where there is a market imperfection forestalling investments that are shown to improve social welfare.

William Hogan[83]

2. ElecLink: A Diversified and Long-term Revenue Stream

Interconnectors such as ElecLink rely on three types of revenues: energy market revenues, i.e. the congestion rent (section 2.1), capacity market revenues and ancillary revenues (section 2.2). This section aims to clarify each of these revenue streams, as well as their dynamics.

2.1 THE FUNDAMENTAL VALUE DRIVER OF ELECLINK: THE CONGESTION VALUE

The congestion rent is expected to be the main source of revenues for ElecLink. To value EleLink correctly, it is essential to take into account all sources of the congestion value (section 2.1.1) and to understand the dynamics of each of them (section 2.1.2). It should also be noted that ElecLink has means to maximise the congestion rent through diversification between short-term and long-term products and the conditions under which capacity rights are sold (section 2.1.3).

2.1.1 THE THREE SOURCES OF THE CONGESTION RENT: A THEORETICAL PERSPECTIVE

The value of the congestion rent depends on three main sources: the average price differential (structural value), the volatility of prices (volatility value) and the correlation of prices. These value drivers are influenced by various factors.

Value drivers of the congestion rent

If electricity prices in two zones are different, then the interconnector can be used to do arbitrage, i.e. to buy electricity in the low-price country and sell it to the high-price country. The arbitrage potential is the sum of the price differentials in all the periods, where the differential is taken as the difference between the highest and the lowest price (i.e. the absolute value of the average price differential).

This value depends on three main drivers:

- The average price differential: a structural difference in price between the two countries, measured by the average price differential, increases the value of the interconnector (Figure 13).
- The volatility of prices in country N and country S: for a given average price difference, the value increases with the volatility of prices in each of the two countries. A higher volatility creates more room for arbitrage and increases the value of the interconnection capacity (Figure 14).
- The correlation of prices between country N and S: if prices are correlated in the two countries and move in the same direction, then the value of the interconnector decreases, everything else being equal, especially for a given mean price and variance of price (Figure 15).

As a result, even if the average prices over the periods are the same in both countries, the average rent can still be positive because the fact that the averages are the same does not necessarily means that the prices in each of the periods are the same. The volatility and the correlation of prices must also be taken into account. This can be further demonstrated through statistics (Appendix 2).

The value of the congestion rent depends on three main sources: the structural price differential, the volatility and the correlation of prices.

Figure 13: Impact of average price differential on the congestion rent

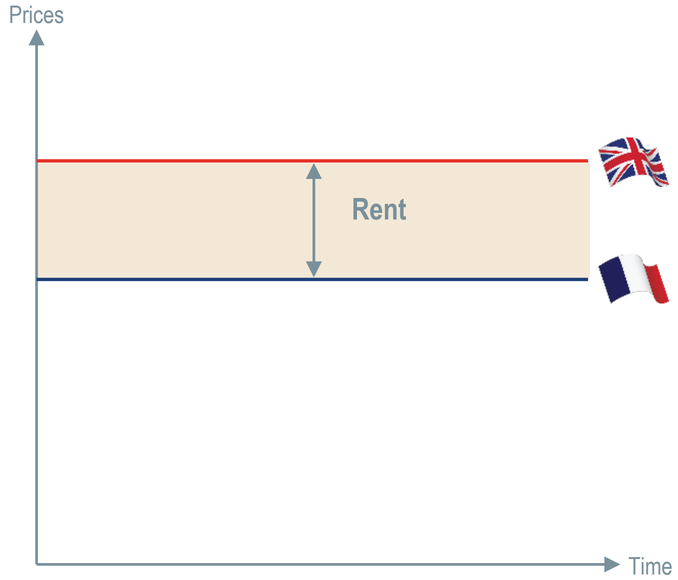


Figure 14: Impact of volatility on the congestion rent

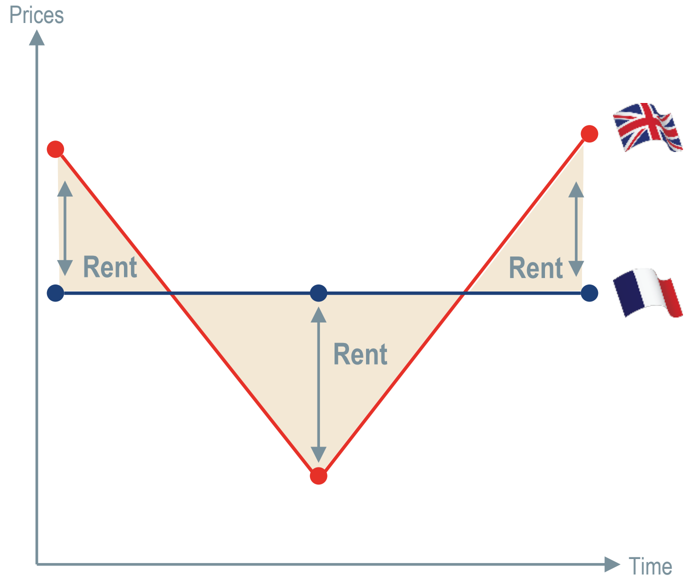
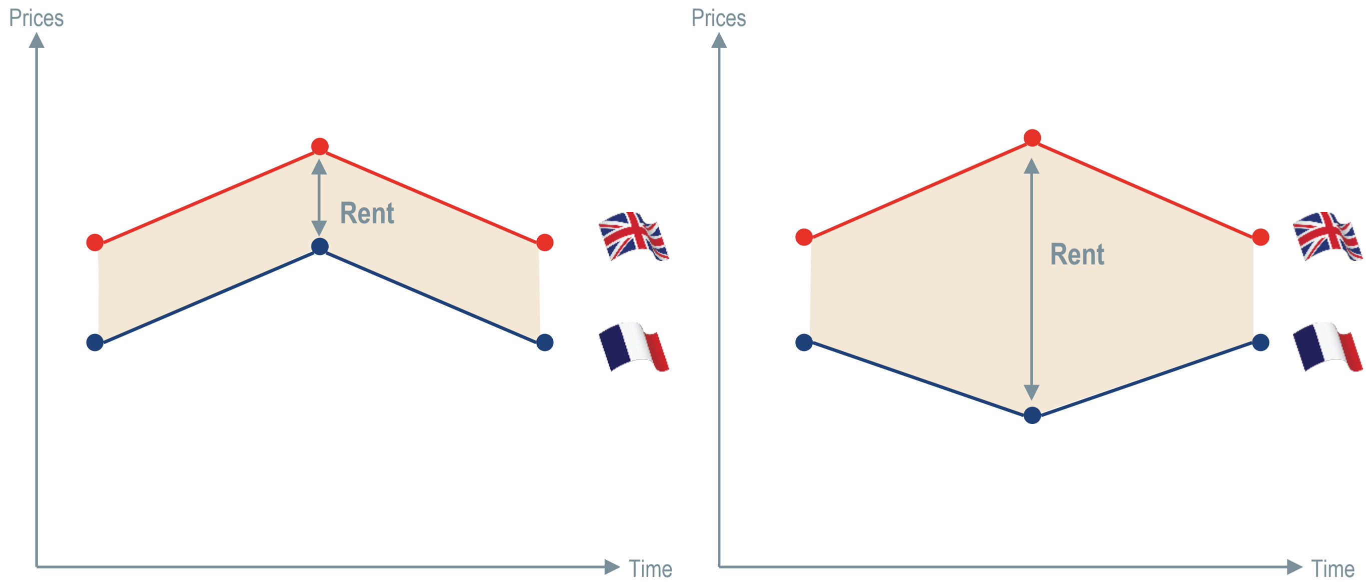


Figure 15: Impact of correlation on the congestion rent



Factors influencing the congestion rent

The three sources of the congestion rent are influenced by several factors:

- The main factor influencing average price differential is market integration: a greater market integration, which can be achieved by increasing the interconnection capacity or by facilitating cross-border trade through market coupling, contributes to price convergence between the two countries. The paper by Boffa et al. (2010) illustrates that for Italy and estimates the benefits of a better integration of the two market zones (South and North)(84). For consumers, the benefits of integration are substantial, even if some congestion remains. It is therefore expected that higher market integration will reduce the average price gap between the two zones;

- Volatility is essentially influenced by renewables: electricity from renewable sources, especially wind and solar, have a zero-marginal cost of production and they have the priority in the merit order curve. Therefore, the residual market demand is the difference between the actual demand and the wind and solar production. Given the intermittent nature of the latter, the residual demand is expected to have a higher volatility. It is well documented – see in particular Ketterer (2014)(85) – that the larger integration of renewable energy sources has two effects on prices: on the one hand, renewables (zero-marginal cost generators) contribute to reduce the mean electricity price and, on the other hand, their intermittent nature increases price volatility;

- Correlation depends on various factors, such as time zones and energy mix (e.g. proportion of renewables): the price in each country depends on the residual demand that must be satisfied with non-intermittent generator with a higher residual demand resulting in higher prices as non-renewable electricity is more costly to generate. Demands in two countries obviously have a correlated element as the demand from consumers have the same aggregate profile, except for the fact that the two countries are in two different time zones. Hence, there is a lag between the price peaks in the two countries. Regarding the production of renewable, the available studies indicate that there is an important variation in wind production across time and space due to the geographical dispersion of wind farms (Boccard, 2010)(86). Therefore, it is not clear that intermittent wind power leads to more correlation between electricity prices in the two countries.

2.1.2 THE DYNAMICS OF THE CONGESTION RENT: ELECLINK CASE STUDY

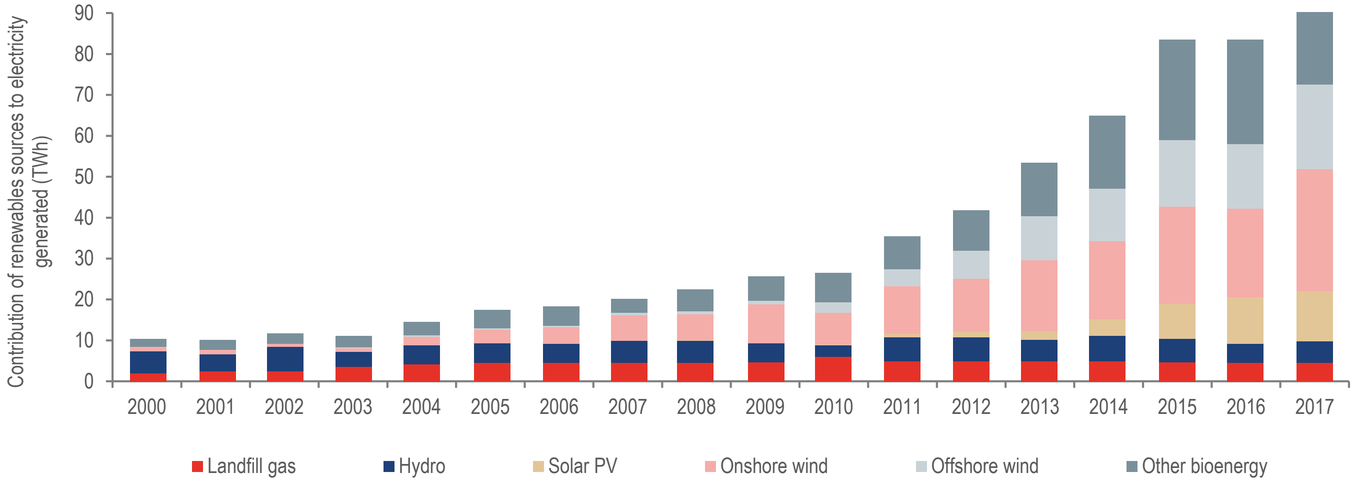
Forecasting the price spread between two zones is a complex and uncertain exercise, as it depends on numerous parameters.

In the context of ElecLink, it is expected, from a general perspective, that the average price differential between Great Britain and Continental Europe will decrease over time, as market integration improves (in particular taking into account the proposed interconnectors listed in Table 3).

However, other factors increasing the congestion rent should be taken into account when assessing the economic fundamentals of ElecLink. Using historical data and projected future trends in renewable energy sources, this section aims to show that the congestion rent of ElecLink has strong value even if price convergence occurs.

The structural value decreases with market integration; the volatility value increases with expanding renewables.

Figure 16: UK electricity generation from renewable sources since 2000



Source: Department for Business Energy and Industrial Strategy

Fluctuations of the congestion rent based on historical data

Using the methodology described in Appendix 3, the analysis of the fluctuations of the congestion rent based on historical data shows very clearly that the average price differential between Great Britain and France does not explain all the congestion rent.

Figure 17 illustrates that there is no correlation between the average price differential and the congestion rent.

Even when the price differential is very low (as for instance in 2007 where it was equal to €1.4), the congestion rent is substantial. This means that there is value beyond the price differential.

Figure 18 is another way to represent that there is no correlation between the average price differential and the congestion rent.

The price differential is important to determine the congestion rent when countries trade only in one direction. If trade goes both ways, the average price differential is a bad predictor of the congestion rent.

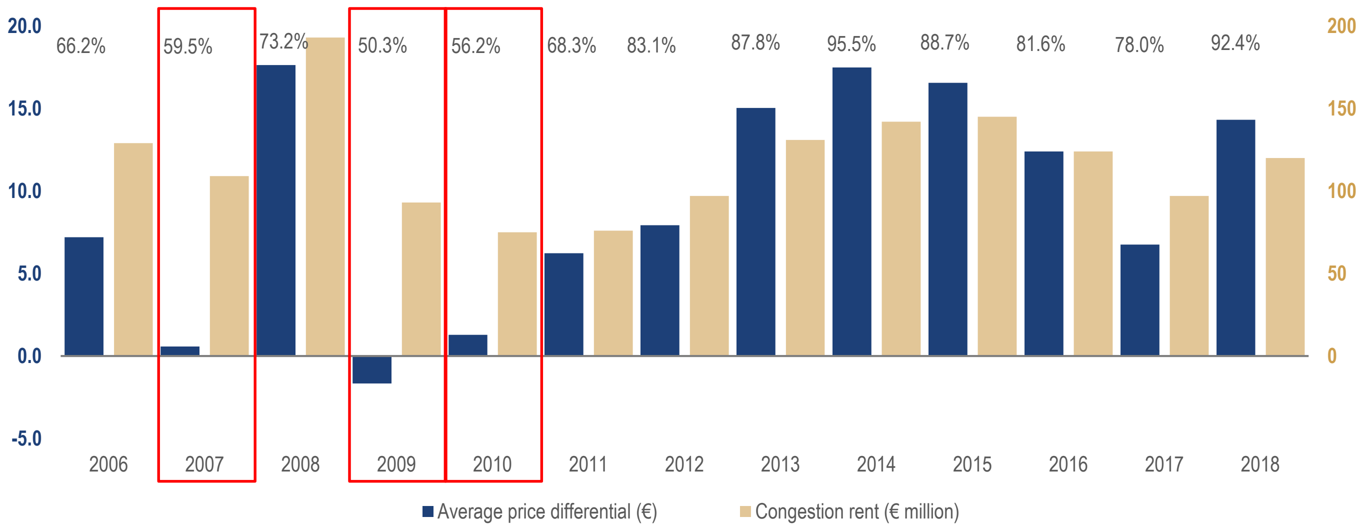
In the context of the Great Britain – France electricity trade:

- There are several years where prices were almost always higher in Great Britain than in France. This is notably the case for 2013, 2014 and 2015 where prices were higher more than 87% of the hours. In such instance, the power flows most of the time in one direction, from France to Great Britain. The price differential is important to predict the congestion rent;
- There are however years where trade took place in both directions. In 2007, 2009 and 2010, prices in Great Britain were higher than in France less than 60% of the hours. In this case, there is more trade from Great Britain to France and the average price differential between the two countries does not explain the congestion rent. In the future, it is expected that such situation will occur more frequently (please see below).

Formulas presented in Box 7 show the differences between the congestion rent and the average price differential.

An econometric analysis of historical data allows to confirm that the congestion rent depends on the average price in Great Britain and France, the variances of prices and the correlation between the prices (Appendix 3).

Figure 17: Average price differential between GB and France and congestion rent (2006-2018)*

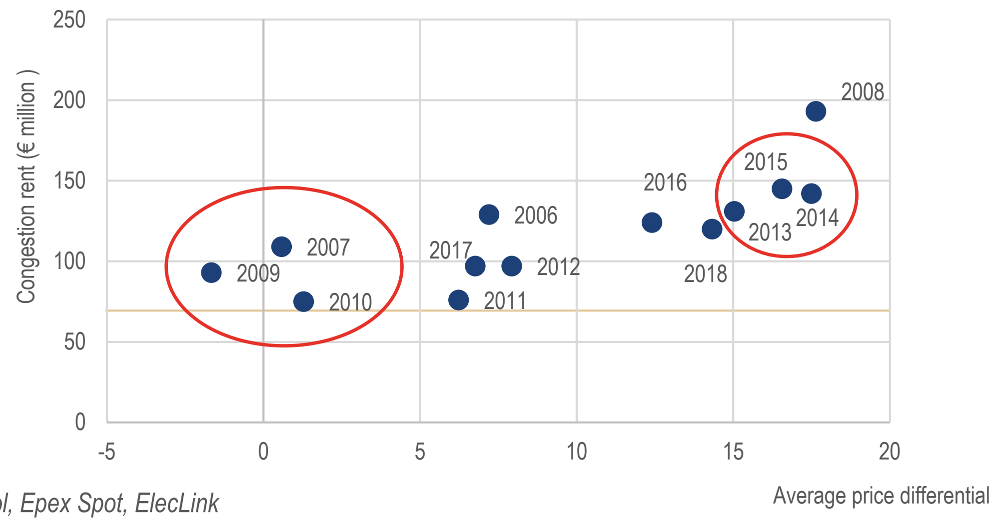


Source: Nord Pool, Epex Spot, ElecLink

* The percentages stand for the frequency (% of hours) when the price differential between France and GB is positive and larger than €2 per MWh and when the price differential between France and GB is negative and larger than €2 per MWh (in absolute value).

There is value beyond the average price differential; the congestion rent is significant when trade goes both way.

Figure 18: Correlation between the average price differential and the congestion rent (2006-2018)



Source: Nord Pool, Epex Spot, ElecLink

Box 7: Computation formulas of the congestion rent and the average price differential

Consider the following four variables:

1. The probability Prob(Price_FR > Price GB) that the price in France exceeds the price in Great Britain;
2. The probability Prob(Price_GB > Price FR) that the price in Great Britain exceeds the price in France. Ignoring the rare case where they are equal, we have Prob(Price_GB > Price FR)+ Prob(Price_FR > Price GB)=1,
3. The average price difference between Price_FR and Price_GB conditional on Price_FR > Price_GB noted hereafter E(Price_FR-Price_GB| price FR > Price GB); and
4. The average price difference between Price_GB and Price_FR conditional on Price_GB > Price_FR, noted hereafter E(Price_GB-Price_FR| Price GB > Price FR).

Using the above variables, the congestion rent per MWh can be approximated (ignoring power losses and unavailability of the interconnection) as:
Prob(Price_FR > Price GB)E(Price_FR-Price_GB| Price FR > Price GB) + Prob(Price_GB > Price FR) E(Price_GB-Price_FR| Price GB > Price FR)
The congestion rent is the average value of the price differential in absolute value.
By contrast, the average price differential E[Price FR-Price GB] is computed as:
Prob(Price_FR > Price FR)E(Price_FR-Price_GB| price FR > Price GB) - Prob(Price_GB > Price FR) E(Price_GB-Price_FR| Price GB > Price FR)
The average price differential does not take the absolute value of the price differential but its true value, positive when Price FR > Price GB and negative when Price_GB > Price FR.

Fluctuations of the congestion rent based on renewables projections

The expanding share of intermittent renewables is a major factor of price volatility in Great Britain and France.

- In the UK, in 2018, the renewable energy capacity surpassed fossil fuels for the first time, tripling in the past five years, "even faster growth than the 'dash for gas' of the 1990s"(87). In the same period, fossil fuels capacity has fallen by one-third as the result of power stations reaching the end of their life or becoming uneconomic. Renewable sources contributed 10.2% of final energy consumption in 2017(88).

  In the electricity market, renewable electricity contributed 29.3% of electricity generated in 2017(89). The evolution, since 2003, of the contribution of renewable sources to total electricity generation has been steady, growing almost exponentially over the past ten years, as illustrated by Figure 16 (p. 46).

  This contribution will increase in the future. Figure 19 below shows electricity generation by technology, and also net imports.

  On 7 March 2019, the UK Government announced that offshore wind is set to power more than 30% of British electricity by 2030, with the launch of the new joint government-industry Offshore Wind Sector Deal(90).

- In France, in 2017, the energy mix in metropolitan France is 40.4% from nuclear sources, 29.1% from oil, 15.5% from natural gas, 3.7% from coal and 11.2% from renewables and waste (slightly above the 10.2% in the UK in the same year). The 2019 Programmation Pluriannuelle de l'Energie (PPE), a strategic plan for energy transition, set out a target to increase the share of renewable energies to 27% of final energy consumption in 2023 and 32% in 2028(91).

  In the electricity market, nuclear power contributed 71.6% of the electricity generated in France, with heat sources and renewable energy contributing 10.3% and 16.7% respectively(92). The 2015 law on energy transition set a target of 40% of energy renewables in final electricity consumption in 2030. The government plans to achieve this target through "a major change in the electrical system with an acceleration [in the development] of all renewable energy sources"(93).

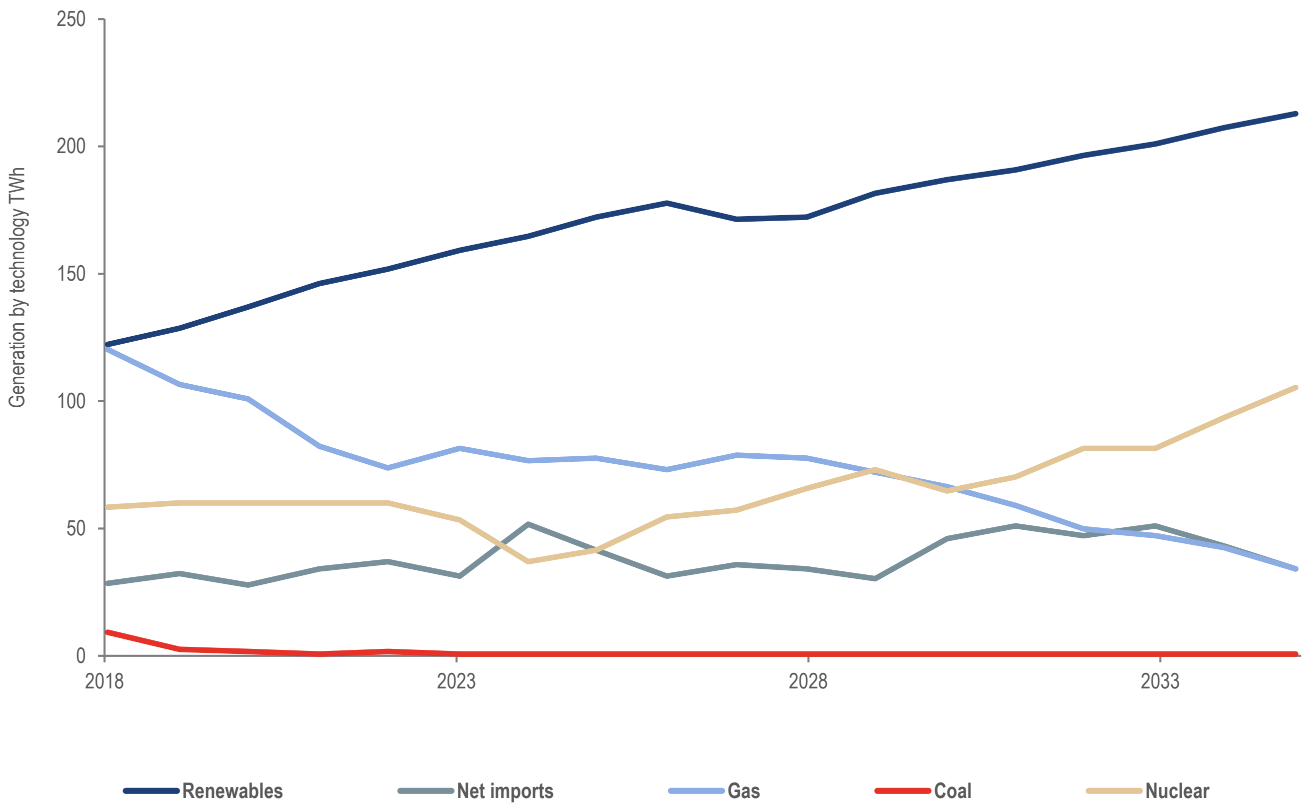
  The predicted electricy mix by 2023 and 2028 is given by Table 8 below.

Given these trends, it can be expected that, in the context of ElecLink, the volatility value of the congestion rent will increase over the duration of the project and at least partially compensate the decrease in the structural value of the congestion rent resulting from the integration of the IEM.

Key finding No. 3

The main source of revenue of interconnectors is the congestion rent, which has three drivers: it increases with the average price differential (structural value) and the volatility of prices (volatility value) and decreases with the correlation between prices. In the context of ElecLink, even though the structural value of the congestion rent will decrease in the future, in the long-term the value of the congestion rent will be supported by the increasing volatility of prices, in particular because of renewables, and limited price correlation. The analysis of the fluctuations of the congestion rent based on historical data shows very clearly that there is value beyond the average price differential between Great Britain and France.

Figure 19: UK electricity generation by fuel source



Source: Department for Business, Energy and Industrial Strategy[94]

With the expanding share of renewables in the electricity mix in the UK and in France, the volatility value of ElecLink's congestion rent will increase.

Table 6: French electric mix projected under PPE

		2023		2028	
		TWh	%	TWh	%
Nuclear		393	67%	371-382	61%-69%
Fossil	Coal	0		0	
	Fuel	34		32	
	Gas				
	Total Fossil	34	6%	32	5%-6%
Renewables	Hydro	62		62	
	Onshore wind	53-55		79-83	
	Solar	24-25		43-53	
	Bioenergy	9		9-10	
	Offshore wind and other renewables	9		17	
	Total Renewable	157-160	27%	142-210	34%-26%

2.1.3 THE MAXIMISATION OF THE CONGESTION RENT BY ELECLINK

ElecLink can optimise the congestion rent: it can offer both short-term and long-term products in accordance with its exemption and sale conditions allow ElecLink to sell capacity rights in both directions.

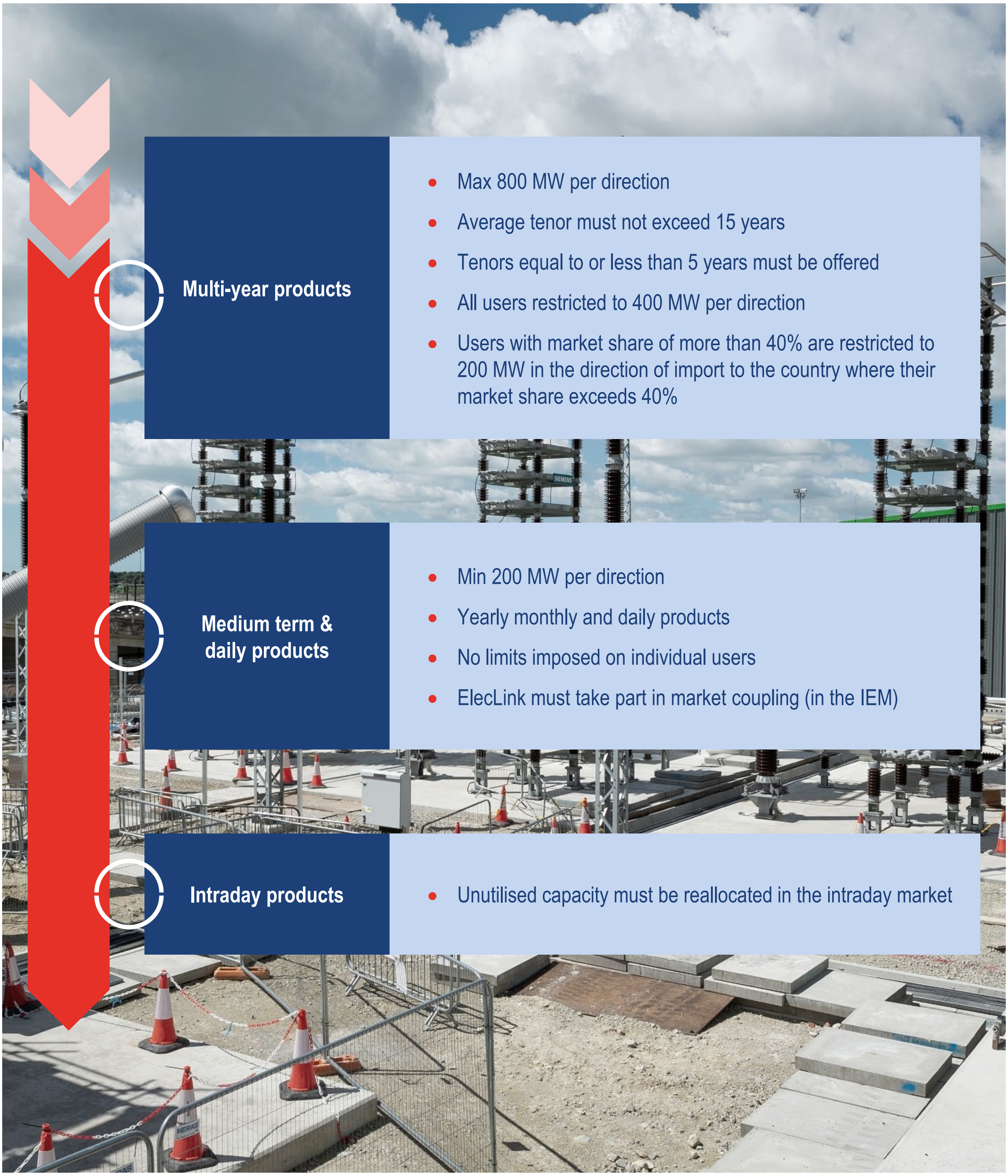
Diversification between short-term and long-term products

ElecLink can choose to monetise congestion rents by selling capacity rights through three distinct auction products:

- Forward contracting, which ranges from multiple days to multiple years ahead of delivery: it enables the interconnector to “lock in” the revenues in advance of capacity usage. The capacity is sold separately from the electricity (“explicit auction”). The long-term transmission rights will be Physical Transmission Rights (PTRs), which entitle the owner of the rights (the “off-taker”) to physically transfer power, or Financial Transmission Rights (FTRs), which hedge the off-taker against market price differences. The value of these long-term contracts is based on market participants' assumptions regarding hourly electricity price differentials in the future;
- Day ahead (DA) auctions, which cover delivery on the following day. Interconnection capacity and electricity should normally be sold together (“implicit auction”, made possible by market coupling). However, in the event that the UK no longer participates in the European IEM, daily capacity will have to be explicitly allocated[95]. The capacity sold on the DA markets consists of non-nominated capacity from forward contracts and capacity reserved for DA allocation;
- Intraday (ID) capacity allocation, which allows players to trade closer to real time. It should be noted that the interconnector cannot be reserved for ID allocation; only the capacity which remains unsold on the DA markets can be allocated in the ID market.

ElecLink is allowed to sell up to 80% of its capacity in each direction under multi-year contracts, with a maximum term of 20 years and an average term of 15 years. This exemption was sought and granted in order to secure the financing of ElecLink, which was initially expected to be a non-recourse project finance structure, requiring stable and predictable cashflows in order to underpin the required debt service.

ElecLink can offer both short-term and long-term products.



Multi-year products

- Max 800 MW per direction
- Average tenor must not exceed 15 years
- Tenors equal to or less than 5 years must be offered
- All users restricted to 400 MW per direction
- Users with market share of more than 40% are restricted to 200 MW in the direction of import to the country where their market share exceeds 40%

Medium term & daily products

- Min 200 MW per direction
- Yearly monthly and daily products
- No limits imposed on individual users
- ElecLink must take part in market coupling (in the IEM)

Intraday products

- Unutilised capacity must be reallocated in the intraday market

Capacity sales in both directions

ElecLink can capture the congestion value in either direction, depending on the price differential (which is determined by supply/ demand conditions): from France to Great Britain or from Great Britain to France.

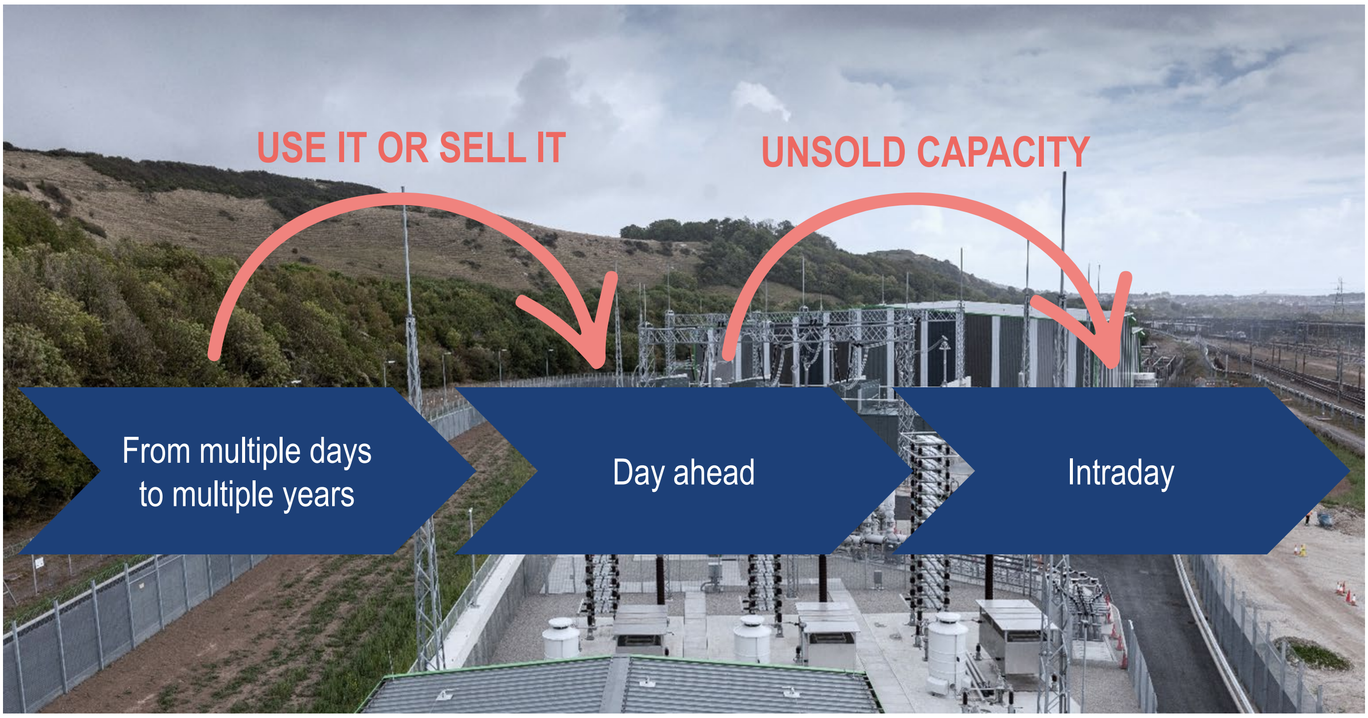
It is worth noting that the conditions under which capacity rights are sold ensure the efficiency of the interconnector:

- ElecLink can sell long-term capacity rights from France to Great Britain. However, if at the time of delivery prices are higher in France, it will be able to sell capacity rights from Great Britain to France. At the time of delivery, given the price differential between Continental Europe and Great Britain, long-term capacity rights owners can either nominate physical flows up to the amount of capacity they purchased, or make the capacity available to use in the DA market (under the CACM Network Code, the Use-It-Or-Sell-It (UIOSI) mechanism is compulsory for PTRs). This ensures that multi-year products have no detrimental impact on short-term markets;
- ElecLink can maximise the capacity it makes available to the DA market through the netting of flow nominations in opposite directions, which means that any capacity used in one direction is netted off against capacity used in other directions.

Key finding No. 4

ElecLink can optimise the congestion rent through (i) diversification between short-term and long-term products in accordance with its exemption and (ii) sale conditions allowing to sell capacity rights in both directions.

ElecLink's sales conditions are designed to optimise the trading flows.



2.2 ADDITIONAL REVENUES: CAPACITY MARKETS AND ANCILLARY REVENUES

Besides the congestion rent, ElecLink will generate additional revenues, consisting of capacity market revenues (section 2.2.1) and ancillary services provided to the TSOs (section 2.2.2).

2.2.1 CAPACITY MARKET REVENUES

Capacity mechanisms are "measures aimed at correcting market failures that distort investment incentives and creates a concern for future capacity adequacy in energy markets", notably by providing a payment for reliable sources of capacity[96]. Capacity markets are currently necessary to ensure the security of supply of the European market.

Both Great Britain and France have recognised the contribution of interconnectors to the security of supply by taking into account cross-border capacities in capacity mechanisms.

Capacity mechanisms in Great Britain

Great Britain introduced a capacity market in December 2014. Capacities are awarded annual contracts[97], the price of which is determined through auctions. The main auction is called T-4 because it is held four years in advance, allowing new capacities time to be built. A smaller second auction is held one year ahead (T-1). New and existing interconnectors have been eligible to participate in the auctions since the December 2015 auction for the capacity delivered as of Winter 2019/2020[98].

All capacity participating in the auction has a de-rating factor (DRF) applied. For interconnectors, the DRF corresponds to the percentage of time when GB is expected to be importing electricity from an interconnector during identified system stress period. ElecLink was assigned a DRF of 56% for the December 2015 auction[99], 65% for the December 2016 auction[100] and 69% for the February 2018 auction[101].

ElecLink secured an agreement in the February 2018 auction for the capacity delivered in 2021/2022. This auction cleared at a record low price of £8.40/kW[102]. At this price, this would translate into a £5,8 million annual revenue for ElecLink. It can be expected that prices will increase in the future, but this will depend on the volume of the auctions.

However, it should be noted that on 15 November 2018 the European Court of Justice cancelled the approval of the UK capacity market by the European Commission on State aids grounds (appeal pending).
On 21 February 2019 the European Commission announced that they will be launching an in-depth investigation as required for the scheme to be approved again.

On 28 February 2019 the UK Government announced some measures to ensure the functioning of the capacity market[103]. A T-1 capacity auction for delivery in 2019/20 was organised on 12th June 2019. A three-year ahead (T-3) auction for the 2022/23 delivery year (to replace the T-4 auction which had been scheduled for January 2019) and a T-4 auction for the 2023/24 delivery year should also be run in early 2020, in which ElecLink will participate.

Both Great Britain and France have recognised the contribution of interconnectors to the security of supply by taking into account cross-border capacities in capacity mechanisms.

£5.8 million

revenue for ElecLink in 2021/22 Winter Season

Capacity mechanisms in France

In France, a new regulatory framework entered into force on 29 December 2018[104]. The French capacity market mechanism requires a certification of capacity market units in order to guarantee their availability during periods of strong demand.

Cross-border contributions to the security of supply in France are taken into account through two mechanisms:

- The detailed procedure, which will allow foreign generation and demand capacity providers to participate directly in the capacity market, but will require implementing a contractual agreement with the TSO of the participating interconnected State;
- The streamlined procedure, by which capacity guarantees from the certification of interconnections will be offered for sale at auction, in accordance with the set of rules approved by the CRE[105]. In 2019, only the streamlined procedure will be applied by RTE[106].

As long as the detailed procedure is not applicable between Great Britain and France, ElecLink will be eligible to directly participate in the French capacity market mechanism.

2.2.2 ANCILLARY REVENUES

ElecLink will be able to provide ancillary services to TSOs.

Such services include:

- Enhanced frequency response: this service is being developed to improve management of the system frequency pre-fault, i.e. to maintain the system frequency closer to 50Hz under normal operation;
- Reactive power: this service consists of injecting/withdrawing reactive power at correct locations of the transmission system to ensure that voltage levels do not exceed their statutory limits;
- Emergency assistance and cross-border balancing, in order to facilitate close-to-real-time trades between the two TSOs.

ElecLink will be remunerated based on contracts entered into with the TSOs

Key finding No. 5

Besides the congestion rent, ElecLink will generate revenues from capacity market mechanisms and ancillary services to the TSOs.

ElecLink may provide services to TSOs.

Congestion rent: energy market revenues

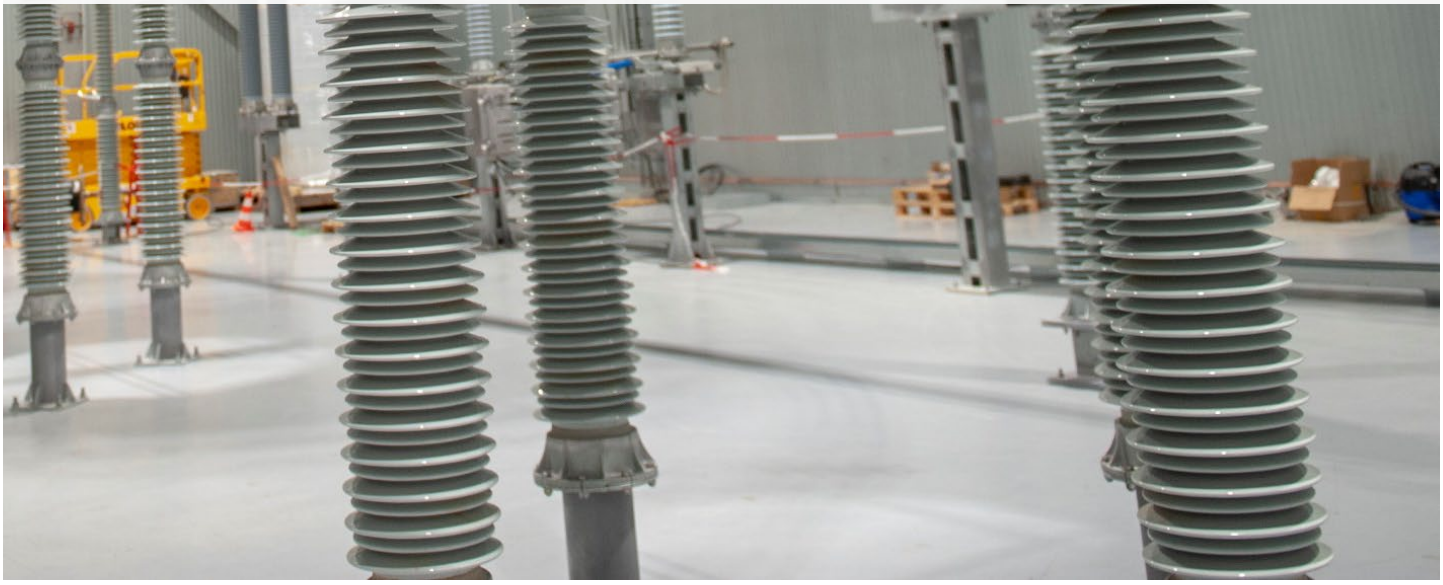
- Fundamental value driver of ElecLink
- Structural value
- Volatility value
- Correlation of prices

Capacity market revenues

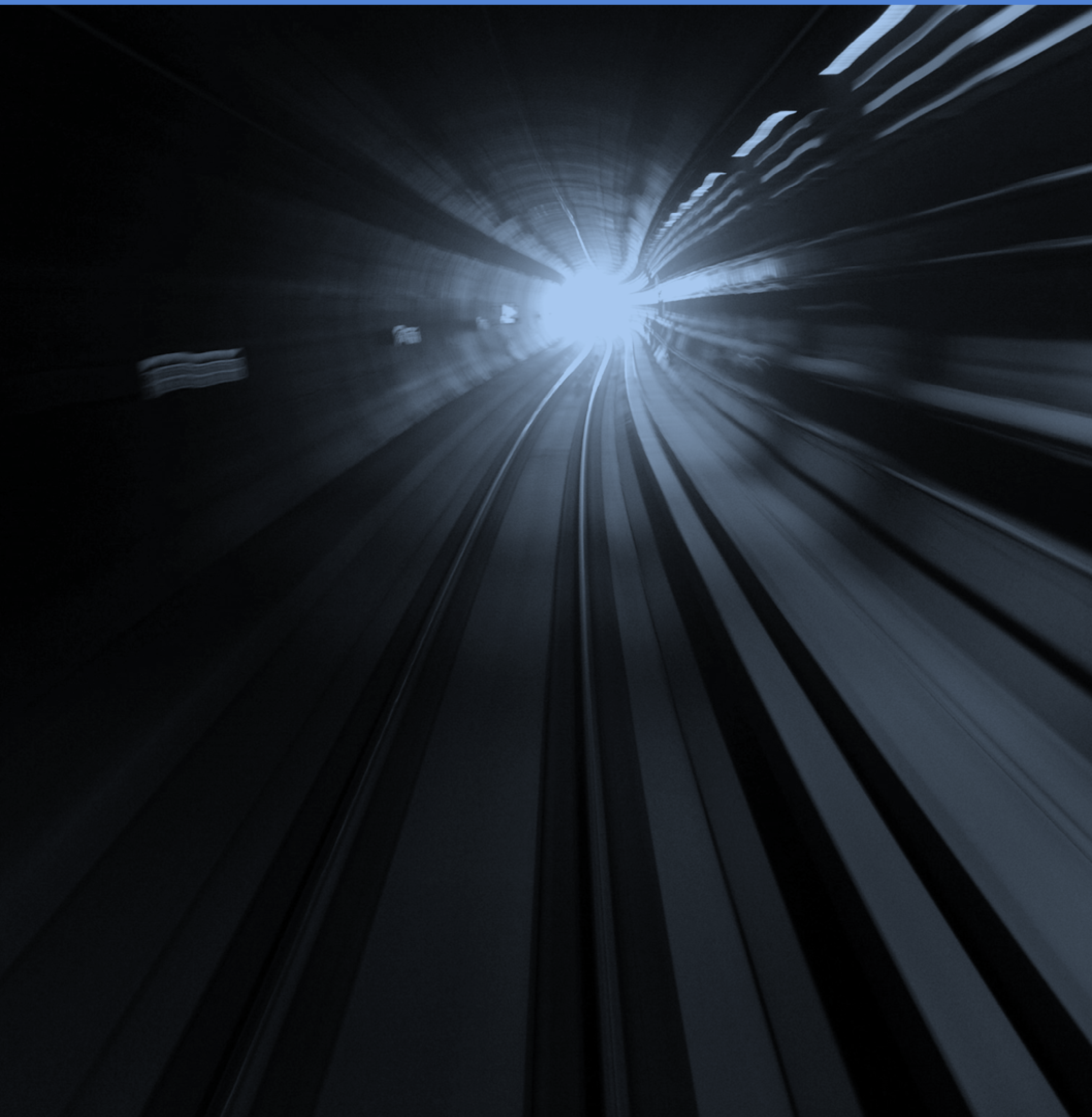
- Capacity payments in GB and France

Ancillary services revenues

- Enhanced frequency response
- Reactive power
- Emergency assistance and cross-border balancing



APPENDICES



APPENDICES

APPENDIX 1: GLOSSARY

ACER	Agency for the Cooperation of Energy Regulators
CEF	Connecting Europe Facility
CRE	French Energy Regulatory Commission (Commission de Régulation de l'Énergie)
Directive 2009/72/EC	Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC
ENTSO-E	European Network of Transmission System Operators for Electricity
EU	European Union
GB	Great Britain
IEM	Internal Electricity Market
IFA	Interconnexion France Angleterre
INEA	Innovation and Networks Executive Agency
NRA	National Regulatory Authority
Ofgem	Office for Gas and Electricity Markets
PCI	Project of Common Interest
PPE	Programmation Pluriannuelle de l'Energie
Regulation 714/2009	Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003
TSO	Transmission System Operator
SO	System Operator
TYNDP	ENTSO-E's 10-year network development plan
UK	United Kingdom

This statistical exercise intends to show that if prices in two countries (N and S) are jointly normally distributed, the value of an interconnector (E(|D|)) increases with the mean price differential (E(D)) and the variances of prices in country N and S (σ_N^2 and σ_S^2) and decreases with the correlation coefficient between the two prices (r).

Suppose that the prices p_N and p_S are jointly normally distributed random variables. The parameters of the joint normal distribution are the means m_A and m_B, the variances σ_N^2 and σ_S^2 and the covariance s_{NS}. The correlation coefficient r is $s_{NS}/s_N s_S$.

The sum of two random variables is a random variable and, for jointly normally distributed variables, the distribution of the sum is a normal variable. Therefore, the variable $D=p_N-p_S$ is a normally distributed random variable with mean $m_D=m_N-m_S$ and a variance $\sigma_\Lambda^2 = \sqrt{\sigma_N^2 + \sigma_S^2 - \rho\sigma_N^2\sigma_S^2}$.

The variable D follows the following normal law $N(m_D, \sigma_\Lambda^2)$.

The mean value of the interconnector is given by E[|D|].

If $m_N = m_S$, then |D| follows a half-normal distribution. The mean of a half normal distribution depends on the variance of the corresponding normal with a higher variance implying a higher mean. More precisely, the mean of the half normal is given by: $E[|\Lambda|] = \sigma_\Lambda^2\sqrt{2/\pi}$.

The mean value of |D| is the value of the interconnector. From the above expression, the value is clearly increasing when the price differential has a higher variance (given zero-mean). And the variance of the price differential depends positively on the variance of the price in country N, the variance of the price in country S and negatively on the coefficient of correlation. In other words, higher price volatility increases the interconnector value while correlation between prices decrease its value.

If $m_A \neq m_B$, then |D| follows a folded normal distribution. The mean of such a distribution is given by:

$$E[|\Delta|] = \sigma_\Delta\sqrt{2/\pi}\exp\left(-\frac{\mu_\Delta^2}{2\sigma_\Delta^2}\right) + \mu_\Delta[1 - 2\Phi(-\frac{\mu_\Delta}{\sigma_\Delta})$$

The interpretation is the same as in the first case. The only difference is that there is a positive term linked to the average price difference mu.

Calculation of the congestion rent based on historical data

We use hourly price data for France and Great Britain from 1 January 2006 to 30 April 2019[107]. These data are used by ElecLink to estimate the congestion rent. We also use them to construct the following variables on a monthly and a yearly basis:

- The mean price in France and in Great Britain (Mean_FR and Mean_GB);
- The mean price differential (Mean_Diff = Mean_GB – Mean_FR);
- The variance of the price in France and in Great Britain (Var_FR and Var_GB);
- The correlation coefficient between France and Great Britain (Corr_FR_GB);
- The frequency (percentage of hours) where the price differential between France and Great Britain is positive and the percentage of hours where the price differential between France and Great Britain is negative;
- The frequency (percentage of hours) where the price differential between France and Great Britain is positive and larger than €2 per MWh, and the percentage of hours where the price differential between France and Great Britain is negative and larger than €2 per MWh (in absolute value). For simplicity, given the power losses, we assume there is no possibility to trade when the price differential is less than €2 per MWh;
- The expected value of the absolute value of the price differential between France and Great Britain, conditional on having a differential larger than €2. To compute this variable, when the differential is less than €2, its value is set to zero. This variable measures the value of an interconnection of 1 MW (such as ElecLink), ignoring power losses and unavailability periods.

Econometric analysis of historical data

To test the computation of the congestion rent described in section 2.1.1, we run a linear (OLS) regression of the form:

Congestion rent= a+b1 Mean_FR + b2 Mean_GB + b3 Var_FR + b4 Var_GB + b5 Corr_FR_GB +e

Where e is an error term.

The theory predicts a negative coefficient for b1 (a higher price in France, the exporting country, reduces the congestion rent) and a positive coefficient for b2 (a higher price in the importing country increases the congestion rent). We also expect a positive coefficient for the variances and a negative coefficient for the correlation.

We estimate this relation using the monthly observations based on historical data (170 observations). In the second specification, we add monthly dummies to take a possible seasonality into account, but they have no impact on the estimated coefficients.

In the regressions, all coefficients have the predicted sign and are significant at the 1% level, except for the variance of price in Great Britain, which is not significant.

Results of the linear regression

	(1) ExPriceUKPrice FRxy	(2) ExPriceUKPrice FRxy
MeanPriceFR	-0.289*** (-5.21)	-0.233*** (-3.83)
MeanPriceUK	0.475*** (9.25)	0.441*** (8.58)
VapriceFR	0.000754*** (4.04)	0.000716*** (4.15)
VapriceUK	0.000967 (1.02)	0.000957 (1.07)
CorrelationpriceFRUK	-19.59*** (-5.31)	-20.95*** (-5.67)
Month dummies	No	Yes
_cons	11.99*** (3.96)	12.14*** (3.85)
N	160	160
R-square	0.76	0.78

t statistics in parentheses; * p<0.05; ** p<0.01; *** p<0.001

Boxes

Figures

Tables

Official reports

ENTSO-E, TYNDP 2018, Executive Report, "Connection Europe: Electricity, 2025, 2030, 2040", 28 November 2018.

European Commission, "Fourth report on the State of the Energy Union", COM(2019) 175 final, 9 April 2019

European Commission, Market Observatory for Energy, Quarterly Report on European Electricity Markets, volume 11, Issue 4, fourth quarter of 2018, 2019

Houses of Parliament Postnote, Overseas Electricity Interconnection, February 2018.

Report of the Commission Expert Group on electricity interconnection targets, "Towards a sustainable and integrated Europe", November 2017

Stratégie Française pour l'Énergie et le Climat, Programmation Pluriannuelle de l'Energie, 2019-2023, 2024-2028

Economic studies and articles

Agrell, P. and P. Bogetoft (2017) Regulatory Benchmarking: Models, Analyses and Applications, Data Envelopment Analysis Journal, Vol. 3, p. 49-91

Boccard, N. (2010) Economic Properties of Wind Power, A European Assessment Energy policy

Boffa, F., Pingali V., Vannoni D. (2010) Increasing market interconnection: An analysis of the Italian electricity spot market, International Journal of Industrial Organization

Bouckaert, J., T. van Dijk and F. Verboven (2010) Access regulation, competition, and broadband penetration: An international study, Telecommunications Policy 34 (2010) 661–671

Borenstein,S., Bushnell,J., Stoft,S., (2000). The Competitive Effects Of Transmission Capacity in deregulated electricity industry. Rand Journal of Economics, 21(2), 294–325

Bourreau and Dogan (2005) Unbundling the local loop, European Economic Review

Cave M. (2006), Encouraging infrastructure competition via the ladder of investment, Telecommunication Policy

Cuomo, M. Glachant, J.-M., "EU Electricity Interconnector Policy : Shedding Some Light on the European Commission's Approach to Exemptions", Florence School of Regulation, Policy Brief, 2012/06, June 2012

de Nooij, M. (2011) Social cost-benefit analysis of electricity interconnector investment: A critical appraisal, Energy Policy 39, 3096-3105

de Streel, A., Gautier, A., & Wauthy, X. (2011). La régulation des industries de réseau en Belgique. Reflets et Perspectives de la Vie Économique, L(3), 73-92

De Vries, L.J. and R.A. Hakvoort (2002), 'An Economic Assessment of Congestion Management Methods for Electricity Transmission Networks', Journal of Network Industries, Vol. 3, pp. 425-466

Economic studies and articles

Dutton, J., "UK-EU Electricity Interconnection: The UK's Low Carbon Future and Regional Cooperation after Brexit", E3G, January 2019

E3G Briefing Paper, "UK-EU electricity interconnection: the UK's low carbon future and regional cooperation after Brexit", January 2019

Hogan, W. (1992) Contract Networks for Electric Power Transmission, Journal of Regulatory Economics; 4:211-242)

Hogan, W.W., Lindovska, M., Mann, J.R.H., Pope, S.L. (2018), Embracing Merchant Transmission Investment, October 2018

Joskow, P. and J. Tirole (2005), Merchant transmission investment, Journal of industrial economics

Ketterer, J. (2014) The impact of wind power generation on the electricity price in Germany, Energy Economics 44, 270–280

Littlechild S. (2012), Merchant and regulated transmission: theory, evidence and policy, J Regul Econ, 42:308–335

Malaguzzi Valeri L. (2009) Welfare and competition effects of electricity interconnection between Ireland and Great Britain, Energy Policy 37, 4679-4688

Musgens (2006) Quantifying market power in the German wholesale electricity market using a dynamic multi regional dispatch model, Journal of industrial economics

Pellini (2012) Measuring the impact of market coupling on the Italian electricity market, Energy Policy

Sagan, M. and Meeus L. (2014) Impact of the regulatory framework for transmission investments on the cost of renewable energy in the EU, Energy Economics 43, 185–194

Vaughan A. "UK renewable energy capacity surpasses fossil fuels for first time", The Guardian, 6 November 2018

WU Vienna Regulierungsworkshop, Gugler K., Haxhimusa, A. Liebensteiner, M. (2015), "Integration of European Electricity Markets: Evidence from Spot Prices".

Websites

https://www.cre.fr/

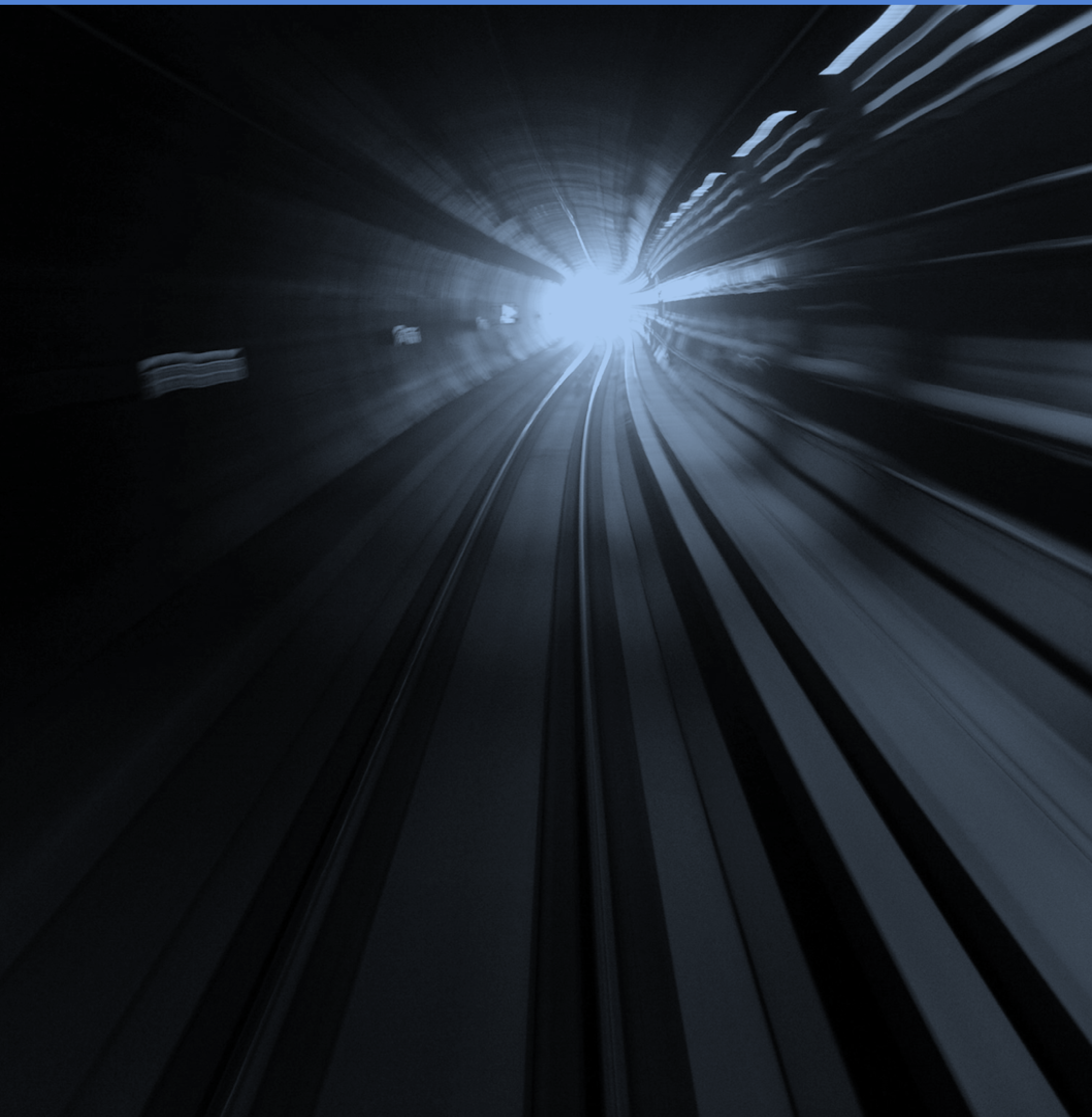
https://ec.europa.eu/energy/en

http://www.eleclink.co.uk/index.php

https://www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy

https://www.ofgem.gov.uk/

Sources



SOURCES

(1) European Commission, “Fourth report on the State of the Energy Union”, COM(2019) 175 final, 9 April 2019.

(2) Report of the Commission Expert Group on electricity interconnection targets, “Towards a sustainable and integrated Europe”, November 2017.

(3) WU Vienna Regulierungsworkshop, Gugler K., Haxhimusa, A. Liebensteiner, M. (2015), “Integration of European Electricity Markets: Evidence from Spot Prices”.

(4) CRE, “Electricity and gas interconnections in France”, July 2018.

(5) European Commission, “Fourth report on the State of the Energy Union”, COM(2019) 175 final, 9 April 2019.

(6) ENTSO-E, “Electricity in Europe 2017”, 2018.

(7) European Commission, Communication “A policy framework for climate and energy in the period from 2020 to 2030”, COM(2014) 15, 22 January 2014.

(8) Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.

(9) Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 on energy efficiency.

(10) European Commission, Communication “A Clean Planet for all - A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy”, COM(2018) 773 final, 28 November 2018.

(11) Pellini (2012) Measuring the impact of market coupling on the Italian electricity market, Energy Policy. See also Boffa, F., Pingali V., Vannoni D. (2010) Increasing market interconnection: An analysis of the Italian electricity spot market, International Journal of Industrial Organization.

(12) European Commission, “Connecting power markets to deliver security of supply, market integration and the large-scale uptake of renewables – Fact Sheet”, 2015.

(13) European Commission, “Communication on strengthening Europe's energy networks”, 23 November 2017.

(14) Report of the Commission Expert Group on electricity interconnection targets, “Towards a sustainable and integrated Europe”, November 2017, p. 6-7.

(15) European Commission, “Communication on strengthening Europe's energy networks”, 23 November 2017.

(16) Ibid.

(17) European Commission, Market Observatory for Energy, Quarterly Report on European Electricity Markets, volume 11, Issue 4, fourth quarter of 2018, 2019.

(18) ENTSO-E, TYNDP 2018, Executive Report, “Connection Europe: Electricity, 2025, 2030, 2040”, 28 November 2018.

(19) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/789368/ET_5.6.xls

(20) European Commission, Market Observatory for Energy, Quarterly Report on European Electricity Markets, volume 11, 2018.

(21) RTE Electricity Report 2017, p. 78.

(22) “Electricity Interconnectors”, Office for Gas and Electricity Markets, consulted on March 26, 2019.

(23) HM Treasury, Budget 2016, 2016.

(24) ACER, Decision on the exemption request for the Aquind interconnector, 19 June 2018. ACER did not assess benefits and costs beyond 9 GW capacity.

(25) CRE, Communication on the assessment of the optimal interconnection capacity and new interconnection projects with UK, 11 July 2019. See also Artelys, Determination of an interconnection capacity target between France and the UK, 17 July 2019.

(26) Ofgem, “Electricity Interconnectors”, consulted on March 26, 2019.

(27) ENTSO-E, TYNDP 2018, Executive Report, “Connection Europe: Electricity, 2025, 2030, 2040”, 28 November 2018.

(28) See Artelys, “Study on the value of interconnections between France and Great Britain”, 3 October 2017.

(29) CRE, Guidance on new interconnection projects with the United Kingdom and decision to transfer the exemption request submitted by AQUIND Ltd to ACER, 16 November 2017.

(30) Houses of Parliament Postnote, Overseas Electricity Interconnection, February 2018.

(31) National Grid, 5 December 2018, ‘Launching Nemo – National Grid launch £600 million subsea cable between the UK and Belgium’, quoted by Dutton, J., “UK-EU Electricity Interconnection: The UK’s Low Carbon Future and Regional Cooperation after Brexit”, E3G, January 2019.

(32) Dutton, J., “UK-EU Electricity Interconnection: The UK’s Low Carbon Future and Regional Cooperation after Brexit”, E3G, January 2019.

(33) Government of the UK – Department for Business, Energy & Industrial Strategy, "The electricity sector and preparing for EU Exit", February 12, 2019.

(34) Government of the UK – Department for Business, Energy & Industrial Strategy, "Trading electricity if there's no Brexit deal", last updated on 25 March 2019.

(35) In a study carried out in 2018, British academics estimated that a less efficient market and the abandonment of some planned interconnectors would raise generation costs by €560m a year (1.5%) compared to remaining in the Single Electricity Market, with 60% (€300m) of these welfare losses occurring in Great Britain (Geske, J., Green, R., Staffell, I. (2018), "Elecxit: The Cost of Bilaterally Uncoupling British-EU Electricity ", working paper, Imperial College, London).

(36) Besides, between 16 August 2019 and 13 September 2019, ElecLink conducted ElecLink a public consultation on the ElecLink non-IEM Access Rules and Charging Methodology Statement in the event that the UK no longer participates in the European IEM (please see sections 1.2.1 and 2.1.3 below).

(37) On 15 March 2019, Ofgem issued a decision approving the modified access rules proposed by the individual interconnectors between Great Britain and Continental Europe. The CRE and Ofgem rendered a joint opinion on the access rules for the IFA interconnector.

(38) Government of the UK – Department for Business, Energy & Industrial Strategy, "Trading electricity if there's no Brexit deal", last updated on 25 March 2019.

(39) Ibid. If the UK leaves the EU without a deal, a temporary tariff regime will be implemented. This would apply for up to 12 months while a full consultation, and review on a permanent approach, is undertaken. Under the temporary tariff regime, imports of electrical energy into the UK would be eligible for tariff free access.

(40) Therefore, ElecLink benefited from accelerated planning and permit granting and gained access to two grant agreements from CEF amounting to €1.7 million and €0.5 million.

(41) In a recent publication dated April 2019, RTE further reinforces the importance of ElecLink for French consumers. In particular, it concludes that, in a very unfavourable scenario, whereby both the new nuclear plant in Flamanville (being developed by EDF) and ElecLink are late, the probability that RTE may have to interrupt consumers during a system stress event will almost double from 14% to 27% (RTE, Analyses complémentaires sur la demande d'électricité en France sur la période 2019-2023, avril 2019).

(42) CRE, Final deliberation on ElecLink Ltd's exemption request under article 17 of Regulation EC No. 714/2009 of 13 July 2009 for an electricity interconnector between France and Great Britain, 28 August 2014.

(43) Ofgem, Final decision on ElecLink Limited's request for an exemption under Article 17 of Regulation (EC) 714/2009 for a Great Britain-France electricity interconnector, 16 September 2014.

(44) European Commission, Decision on the exemption of ElecLink Limited under Article 17 of Regulation (EC) No. 714/2009 for an electricity interconnector between France and Great Britain, 28 July 2014.

(45) Regulation (EC) No 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003.

(46) Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity. This report will indicate the main changes introduced by this new regulation.

(47) However, Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC (Directive 2009/72) provides that these costs must be economically and efficiently incurred, which leaves room for incentive measures. Please note that this Directive will be repealed with effect from 1 January 2021 by Directive (EU) 2019/944 of the European Parliament and of the Council of
5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU. This report will indicate the main changes introduced by this new regulation.

(48) Article 16(6) of Regulation 714/2009. Article 19 of Regulation 2019/943 introduces some changes in respect of use of revenue, providing that:
"2. The following objectives shall have priority with the respect to the allocation of any revenues resulting from the allocation of cross-zonal capacity: (a) guaranteeing the actual availability of the allocated capacity including firmness compensation; or (b) maintaining or increasing cross-zonal capacities through optimisation of the usage of existing interconnectors by means of coordinated remedial actions, where applicable, or covering costs resulting from network investments that are relevant to reduce interconnector congestion.
3. Where the priority objectives set out in paragraph 2 have been adequately fulfilled, the revenues may be used as income to be taken into account by the regulatory authorities when approving the methodology for calculating network tariffs or fixing network tariffs, or both. The residual revenues shall be placed on a separate internal account line until such a time as it can be spent for the purposes set out in paragraph 2".

(49) Article 16(1) of Regulation 714/2009; articles 32, 37(6) and 37(10) of Directive 2009/72.

(50) Article 9 of Directive 2009/72.

(51) Articles L. 111-40, L. 321-1 and L. 321-6 of the French Energy Code.

(52) Article L. 341-3 of the French Energy Code.

(53) CRE, Deliberation on the decision relating to the public electricity networks' access tariff in the high-voltage (HTB) range, 17 November 2016.

(54) The CRE did so for the IFA2 project considering its benefits and uncertainties (CRE, Decision regarding the interconnector "IFA2" project, 2 February 2017).

(55) Electricity Act 1989 (as amended).

(56) Ofgem, “Cap and floor regime: unlicking investment in electricity interconnectors”, May 2016.

(57) Ofgem, “Cap and floor regime: unlocking investment in electricity interconnectors”, May 2016.

(58) The decision granting an exemption is taken (i) by NRAs concerned by the project or (ii) by ACER if the competent NRAs have not reached an agreement within six months or have jointly requested the decision to be taken by ACER. The decision is notified to the European Commission, which can require the modification or revocation of NRAs’ decisions.

(59) Article 17(1) of Regulation 1228/2003; article 63(1) of Regulation 714/2009.

(60) European Commission, Communication pursuant to the second subparagraph of Article 251 (2) of the EC Treaty concerning the common position of the Council on the adoption of a European Parliament and Council Regulation on conditions for access to the network for cross-border exchanges in electricity, SEC/2003/0160 final, COD 2001/0078.

(61) ACER, Board of Appeal, Decision on Aquind, 17 October 2018.

(62) Cuomo, M. Glachant, J.-M., “EU Electricity Interconnector Policy: Shedding Some Light on the European Commission’s Approach to Exemptions”, Florence School of Regulation, Policy Brief, 2012/06, June 2012.

(63) Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management.

(64) Commission Regulation (EU) 2016/1719 of 26 September 2016 establishing a guideline on forward capacity allocation.

(65) These rules were approved by Ofgem on 27 August 2019 and by the CRE on 17 October 2019. The CRE also approved, on the same date, the rules applicable in case the UK no longer participates in the IEM

(66) CRE, Deliberation forming a decision regarding certification of ElecLink, 31 January 2019.

(67) Ofgem, Certification under the ownership unbundling requirements of the Third Package, 11 February 2019.

(68) de Streel, A., Gautier, A., & Wauthy, X. (2011). La régulation des industries de réseau en Belgique. Reflets et Perspectives de la Vie Économique, L(3), 73-92.

(69) Agrell, P. and P. Bogetoft (2017) Regulatory Benchmarking: Models, Analyses and Applications, Data Envelopment Analysis Journal, Vol. 3, p. 49-91.

(70) de Nooij, M. (2011) Social cost-benefit analysis of electricity interconnector investment: A critical appraisal, Energy Policy 39, 3096-3105.

(71) Sagan, M. and Meeus L. (2014) Impact of the regulatory framework for transmission investments on the cost of renewable energy in the EU, Energy Economics 43, 185–194.

(72) De Vries, L.J. and R.A. Hakvoort (2002), 'An Economic Assessment of Congestion Management Methods for Electricity Transmission Networks', Journal of Network Industries, Vol. 3, pp. 425-466.

(73) Malaguzzi Valeri L. (2009) Welfare and competition effects of electricity interconnection between Ireland and Great Britain, Energy Policy 37, 4679-4688. To illustrate this, she finds, in her base scenario, that increasing connection capacity from 500 MW to 1000 MW changes the prices in Ireland from €45.1 to €42 per MWh (-7%) and from €29.5 to €29.7 per MWh in Great Britain (+0.6%).

(74) Sagan, M. and Meeus L. (2014) Impact of the regulatory framework for transmission investments on the cost of renewable energy in the EU, Energy Economics 43, 185–194.

(75) Cave M. (2006), Encouraging infrastructure competition via the ladder of investment, Telecommunication Policy.

(76) Bourreau and Dogan (2005) Unbundling the local loop, European Economic Review.

(77) Bouckaert, J., T. van Dijk and F. Verboven (2010) Access regulation, competition, and broadband penetration: An international study, Telecommunications Policy 34 (2010) 661–671.

(78) Joskow, P. and J. Tirole (2005), Merchant transmission investment, Journal of industrial economics, p. 235.

(79) See for instance Musgens (2006) Quantifying market power in the German wholesale electricity market using a dynamic multi regional dispatch model, Journal of industrial economics.

(80) Borenstein,S., Bushnell,J., Stoft,S., (2000). The Competitive Effects Of Transmission Capacity in deregulated electricity industry. Rand Journal of Economics, 21(2), 294–325.

(81) Littlechild S. (2012), Merchant and regulated transmission: theory, evidence and policy, J Regul Econ, 42:308–335.

(82) Hogan, W.W., Lindovska, M., Mann, J.R.H., Pope, S.L. (2018), Embracing Merchant Transmission Investment, October 2018. This work was supported by Aquind Limited.

(83) Boffa, F., Pingali V., Vannoni D. (2010) Increasing market interconnection: An analysis of the Italian electricity spot market, International Journal of Industrial Organization.

(85) Ketterer, J. (2014) The impact of wind power generation on the electricity price in Germany, Energy Economics 44, 270–280.

(86) Boccard, N. (2010) Economic Properties of Wind Power, A European Assessment Energy policy.

(87) Vaughan A. “UK renewable energy capacity surpasses fossil fuels for first time”, The Guardian, 6 November 2018.

(88) Department for Business Energy and Industrial Strategy, UK Energy in Brief 2018, p.34.

(89) Ibid., p.32.

(90) https://www.gov.uk/government/news/offshore-wind-energy-revolution-to-provide-a-third-of-all-uk-electricity-by-2030.

(91) Stratégie Française pour l’Énergie et le Climat, Programmation Pluriannuelle de l’Energie, 2019-2023, 2024-2028.

(92) Ibid.

(93) Ibid.

(94) Department for Business, Energy and Industrial Strategy, Updated Energy and Emissions projections 2018, Figure 5.1, p.35.

(95) Please see the consultation held by ElecLink between 16 August 2019 and 13 September 2019.

(96) European Commission, “Framework for cross-border participation in capacity mechanisms”, December 2017. Capacity mechanisms include capacity markets and strategic reserve.

(97) It being specified that new generating plant can be awarded 15-year agreements.

(98) It should however be noted that the direct participation of interconnectors in the GB capacity market was intended as an interim measure until an enduring solution is found to enable the participation of foreign generators. It is therefore subject to policy changes in the future.

(99) Confirmation of capacity auction parameters, June 2015.

(100) Confirmation of capacity auction parameters, July 2016.

(101) Confirmation of capacity auction parameters, July 2017.

(102) Provisional auction results, T-4 capacity market auction for 2021/22, February 2018.

(103) Following a judgement by the European Court of Justice dated 15 November 2018.

(104) Décret n° 2018-997 du 15 novembre 2018 relatif au mécanisme d'obligation de capacité dans le secteur de l'électricité ; Arrêté du 29 novembre 2016 définissant les règles du mécanisme de capacité.

(105) Délibération de la Commission de régulation de l'énergie n° 2018-284 du 20 décembre 2018 portant avis sur le projet de règles du mécanisme de capacité.

(106) RTE, "Capacity mechanism - RTE is submitting the following set of rules for valuation of cross-border capacity guarantees for 2019", 23 November 2018.

(107) Sources for GB prices: https://www.nordpoolgroup.com/ and for FR prices: http://www.epexspot.com/en/.

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