

A Paper by
National Grid Interconnectors

nationalgrid

Getting more connected

The opportunity from greater
electricity interconnection

MARCH 2014

Executive Summary

New analysis shows that Great Britain could unlock up to £1 billion of benefits to energy consumers through doubling its interconnector capacity by 2020.

Failure to double existing interconnector capacity to nearer the 10% proposed by the European Commission could be equivalent to foregoing wholesale electricity price reduction of nearly £3 million every day.

Interconnectors are transmission cables which allow electricity to flow between countries, and can be used to import or export power as required. Great Britain (GB) already has four of them, linking us to France, Ireland, The Netherlands and Northern Ireland. These links, totalling 4GW, represent around 5% of existing electricity generation capacity. However, this level remains low compared to the 10% benchmark proposed by the European Commission and there is strong consensus that this gap should be filled. For instance, UK Government, the regulator, consumer organisations, green groups, think tanks, academics and the main European institutions support greater interconnection.

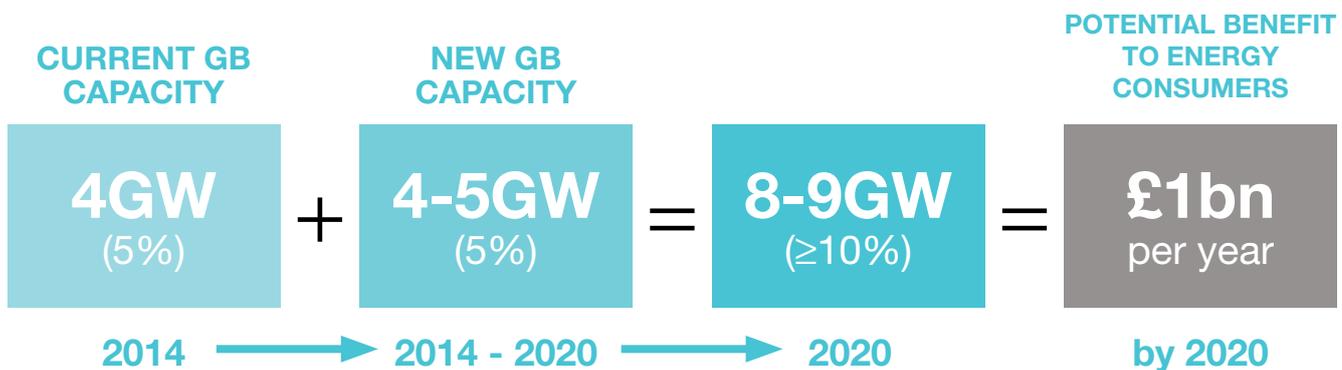
In that context, National Grid has prepared this paper to explore the potential benefits of greater interconnection. These benefits include lower energy prices for **consumers**, enhanced **energy security**, a cleaner **environment** and wider **macro-economic** effects. National Grid believes that a full understanding of the benefits of greater interconnection is important to inform the debate on an appropriate ambition to meet the country's need, and the timeframe within which it should be achieved.

Consumers: importing cheaper power from other countries reduces GB wholesale prices and benefits consumers when lower prices are passed on by retailers, with lower earnings expected for GB generators. Analysis undertaken by National Grid has estimated the impacts on wholesale electricity prices resulting from doubling Britain's current capacity to

align with the European Commission benchmark. It is estimated that each 1GW of new interconnector capacity could reduce Britain's wholesale power prices up to 1-2%. In total 4-5GW of new links built to mainland Europe could unlock up to £1 billion of benefits to energy consumers per year, equating to nearly £3 million per day by 2020.

This benefit will arise because the analysis expects British wholesale electricity prices to remain higher than those in neighbouring countries into the early 2020s, benefiting British consumers through net imports.

Energy Security: over the past five years GB's existing links have been used to import nearly four times more electricity than has been exported. With the current programme of power station closures ongoing, and demand potentially picking up as economic growth returns, the need for imports is set to continue, at least in the short term. Interconnectors offer greater diversification of electricity sources to meet this need and are one of the critical tools through which GB can benefit from the European Internal Energy Market. Most importantly, additional interconnectors provide mitigation against shortages at times of 'system stress'; these could arise, for example, through a combination of cold weather and unexpected shutdowns at power stations. Interconnectors are also an important system balancing tool, helping to integrate different sources of electricity generation across Europe, enabling better coordination of supply and demand and improving overall system stability.



Environmental: interconnectors allow low carbon electricity to flow between European countries more easily and could enable carbon and renewables targets to be met more cost effectively. Significant volumes of low carbon electricity could, for instance, be imported into GB from hydropower in Norway, wind power in Ireland and Denmark, nuclear in France and hydropower / geothermal energy in Iceland. As renewable electricity forms an increasing part of the energy mix, interconnection is becoming an important tool in managing the intermittent power flows associated with these sources.

Economic: while GB remains a net importer of power, economic benefits are available through greater disposable income from lower domestic electricity prices, and enhanced competitiveness for businesses benefitting from reduced energy input costs. Were a portfolio of new projects to be commissioned, the economy would also benefit from new jobs created in activities such as planning, construction and maintenance. They could also catalyse new domestic manufacturing industries in areas such as sub-sea cabling.

The potential downsides from increased interconnection are relatively limited. If mainland European power prices were consistently higher than those in GB, then GB would tend to export to the continent, and this could pull British prices up. However, that is unlikely in the foreseeable future. Whether importing or exporting,

interconnection's beneficial impact on security of supply can lead to Europe-wide macro-economic benefits through reduced price volatility and enhanced system stability, ultimately reducing wholesale electricity prices for consumers and businesses in all countries.

Significant progress has already been made in preparing for greater electricity interconnection. The UK Government and European institutions have provided strong support, Ofgem and its European counterpart has developed a new and innovative regulatory design, and multiple developers have come forward with proposed projects. With this regulatory and policy work due for completion in the coming months, the positive momentum can be maintained, the multi-billion pound investment unlocked, and the many benefits delivered.

01. Consensus for greater interconnection

Based on the consumer, energy security, environmental and economic benefits which could be accessed, greater GB electricity interconnection is considered a ‘no regrets’ investment by a wide range of informed stakeholders within the UK and beyond. This consensus includes the UK Government, the regulator, consumer organisations, green groups, think tanks, academics and the main European Union institutions. This is evidenced below through a selection of stakeholder comments.

European Commission

“Thanks to interconnection, Member States are not reliant merely on electricity produced locally. Overall costs can therefore be brought down by an efficient siting of new generation, and the costs of system security are kept down through interconnection.”¹

Ed Davey, Secretary of State, Department for Energy and Climate Change

“First, we must step up the integration and interconnection of European energy markets so that countries can buy clean, competitive, low carbon electricity from wherever it is cheapest. That means across Europe we must fully implement the EU’s energy liberalisation legislation by the end of next year and facilitate investment in the physical links that make the interconnections possible. It just doesn’t make sense for Europe to fail to leverage the potential advantage of a single energy market – we must get real about cross-border infrastructure, and fast.”²

Institute for Public Policy Research

“Interconnection therefore presents a cost-effective and convenient way of dealing with electricity shortages [in the UK]. In addition, in the long term, it would help to balance variable renewable energy (by aggregating supplies and demands) and also increase overall competition in Europe’s electricity market, which could lower prices.”³

Greenpeace

“A more interconnected EU grid would reduce the cost of keeping the lights on because of more effective sharing of energy resources.” “Interconnectors currently provide [the UK] with the most efficient alternative that helps increase system efficiency by increasing the access to other energy generators. They also provide additional benefits such as export opportunities for our wind industry, which is good for our balance of payments, as well as access to a wide diversity of generation technologies abroad.”⁴

Consumer Futures

“Interconnectors provide a means to inject liquidity into wholesale markets and may facilitate far more efficient investment decisions by providing a means to flow energy from member states with surpluses to those with deficits.”⁵

1. Source: http://ec.europa.eu/energy/gas_electricity/doc/com_2013_public_intervention_swd01_en.pdf

2. Source: Ed Davey speech to inaugural Annual International Energy Lecture, University College London Energy Institute

3. Source: http://www.ippr.org/images/media/files/publication/2013/06/running-on-empty_June2013_10937.pdf

4. Source: <http://www.greenpeace.org.uk/media/press-releases/eu-2030-climate-and-energy-targets-greenpeace-comment-20140122> & <http://www.greenpeace.org.uk/newsdesk/energy/analysis/viewpoint-new-gas-plants-or-new-cables>

5. Source: <http://www.consumerfocus.org.uk/assets/1/files/2009/06/Consumer-Focus-response-to-ERGE-CEER-call-for-evidence-on-generation-adequacy-treatment-in-electricity.pdf>

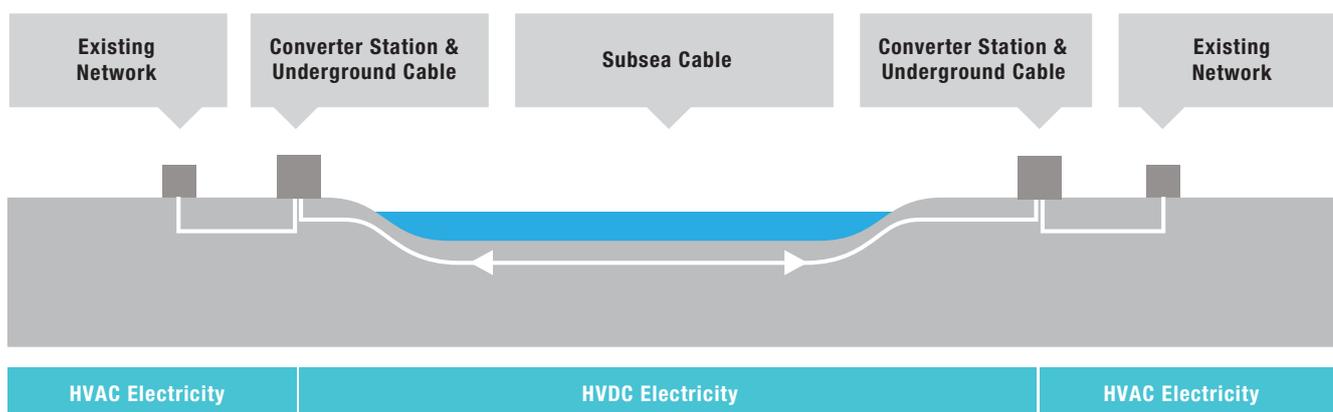
02. Background and Britain's current position

In response to this consensus, National Grid Interconnectors has prepared this paper to explore the potential opportunity available from greater interconnection, and has undertaken new analysis to quantify the benefit from lower wholesale electricity prices, which could be passed on to consumers. Primary benefits also accrue to energy security, the environment and the economy.

The debate on how Britain can best meet its energy needs has intensified over recent months. There is broad agreement that energy should be affordable, damaging greenhouse gas emissions need to be reduced, and energy supplies need to be reliable for businesses and consumers to facilitate the UK's economic recovery. Debate has focused on meeting

these needs through domestic solutions, such as alternate energy mix options. The potential for greater links with the wider European energy market has largely been under exploited, and the benefits of increased cross-border electricity transmission links in particular are worthy of much more attention.

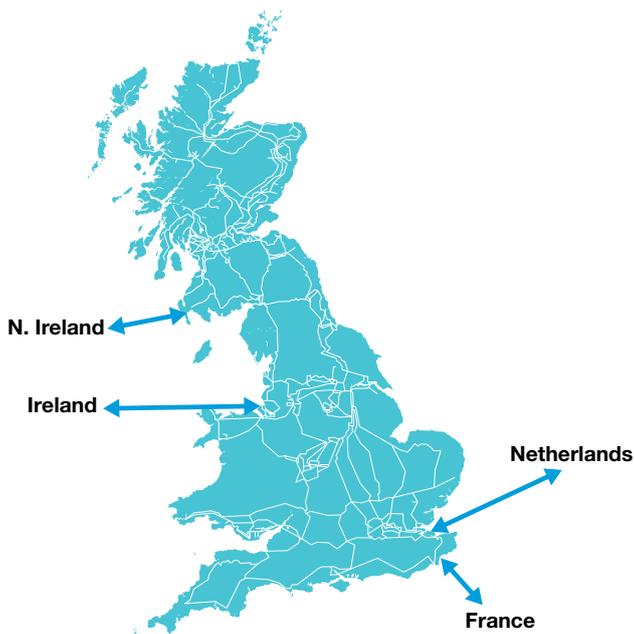
Figure 1:
Interconnector assets



HVAC = High Voltage Alternating Current
 HVDC = High Voltage Direct Current

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Figure 2:
Existing GB electricity interconnectors



Interconnectors are transmission wires which allow electricity to flow between countries, enabling countries to import power at times of shortage and export when in surplus. Great Britain already has four of them, linking us to France, Ireland, The Netherlands and Northern Ireland, totalling 4 Gigawatts (GW) of capacity⁶. The dual import-export capability unlocks a series of mutual benefits. For instance:

Figure 3:
Balance of benefits to GB customers and electricity generators from imports and exports

	GB customers	GB electricity generators
<p>GB Imports</p> <p>From lower priced country</p>	<p>✓</p> <p>Benefit from lower wholesale electricity prices</p>	<p>✗</p> <p>Disbenefit from incrementally lower earnings from reduced wholesale electricity prices</p>
<p>GB Exports</p> <p>To higher priced country</p>	<p>✗</p> <p>Disbenefit from higher wholesale electricity prices</p>	<p>✓</p> <p>Benefit from incrementally higher earnings from increased sale price of wholesale electricity</p>

- when GB prices are higher than in neighbouring countries electricity is imported, lowering GB wholesale power prices to the benefit of consumers. At the same time this allows electricity generators in other countries to access the British market and earn additional revenue, whilst incrementally increasing prices in the exporting country.

- equally, when GB prices are lower than Britain's neighbours, electricity is exported, benefiting their consumers through lower prices whilst enabling British generators to access new markets, again with a commensurate increase in GB prices.

6. 4GW of existing electricity interconnection capacity is made up of the Moyle interconnector to Northern Ireland (0.5GW), the East West interconnector to Ireland (0.5 GW), the Interconnexion France-Angleterre interconnector to France, IFA (2 GW) and the BritNed interconnector to The Netherlands (1 GW). National Grid is the joint owner of IFA (together with RTE), National Grid also has a 50% share in BritNed (with TenneT).

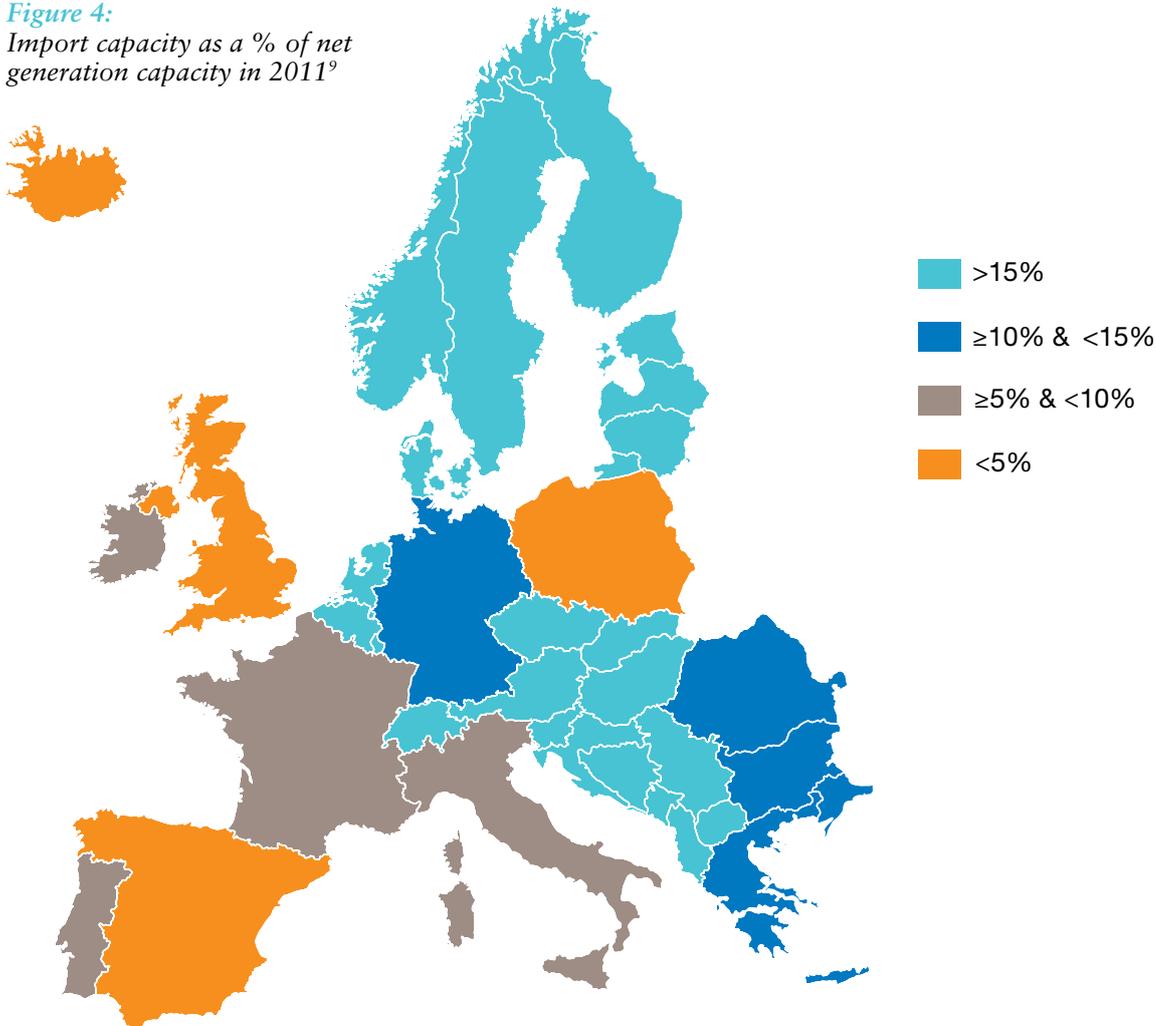
02. Background and Britain's current position continued

Despite these benefits, Britain's 4GW of existing interconnector capacity is relatively small; representing around 5%⁷ of total installed electricity generating capacity. This compares with the benchmark highlighted by the European Commission in January 2014 for all Member States to have a level of electricity interconnection equivalent to at least 10% of their

installed production capacity to realise the full benefits of the Internal Energy Market⁸.

In order to reach this benchmark Britain would need to double its existing interconnector capacity.

Figure 4:
Import capacity as a % of net generation capacity in 2011⁹



7. Current electricity interconnector capacity as a ratio of total installed electricity generation capacity (c.80GW) is 4GW / 80GW = 5%

8. In 2002 the European Council identified a non-binding target for cross-border interconnection to be at a level equivalent to at least 10% of their installed production capacity by 2005. This has been recently reiterated in the European Council's conclusions in May 2013 and the European Commission's Communication on the 2030 climate and energy framework in January 2014.
http://ec.europa.eu/energy/doc/2030/com_2014_15_en.pdf

9. Source: ENTSO-E Ten Year Network Development Plan 2012 page 214

<https://www.entsoe.eu/major-projects/ten-year-network-development-plan/tyndp-2012>

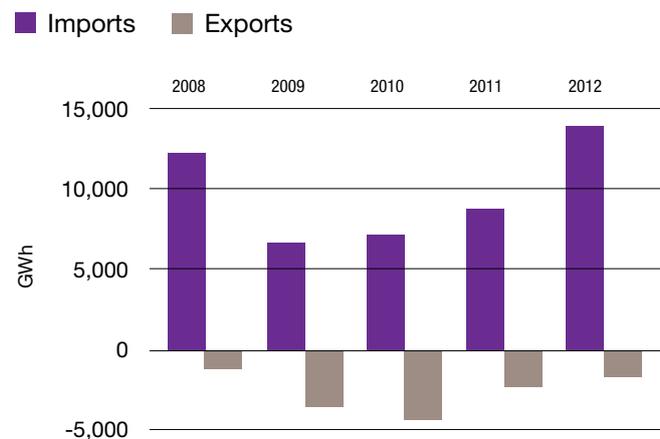
03. Securing the benefits of greater electricity interconnection

A more detailed analysis of the benefits of electricity interconnection underpins the case for greater investment. Broadly speaking, the benefits fall into four main categories; consumer, energy security, environmental and economic.

Consumer: Importing lower cost electricity from other parts of Europe enables British energy prices to be reduced (prices in the exporting country will incrementally increase), benefiting GB consumers when retailers pass this reduction on. Equally, consumers in neighbouring countries benefit from cheaper GB exports when the price differential is reversed, albeit with incrementally higher GB prices. British consumers will therefore benefit the most from lower wholesale prices from greater interconnection during periods when British prices are high relative to neighbouring countries, as has been the case in recent years. From 2008 to 2012 Britain imported nearly four times more electricity than it exported, with imports eight times greater than exports in 2012¹⁰. Over this period therefore, British consumers would have benefited through access to the generally lower wholesale electricity prices in mainland Europe.

Whilst predicting exact future electricity price differentials between Britain and its neighbours is challenging, the analysis undertaken for National Grid indicates that up to the early 2020s, British wholesale electricity prices are likely to remain higher than those of its direct neighbours in mainland Europe¹¹. Building on this analysis, if Britain's current interconnector capacity is doubled, through building 4-5 GW of new capacity by 2020, GB consumer benefits could be unlocked

Figure 5:
GB electricity imports and exports 2008-2012



through reduced wholesale electricity prices by up to £1 billion per year¹¹. As an illustration of what this means for GB households, if all of this price reduction is passed on to energy consumers, this is equivalent to an annual saving of up to £13 per household¹².

This means that a reduction in wholesale prices of nearly £3 million¹³ will be foregone for each day that this infrastructure is not built.

10. Source: Digest of UK energy statistics (DUKES)

11. Source: Analysis prepared by Baringa / Redpoint for National Grid Interconnector Holdings Ltd.

12. Based on GB domestic consumption as a 36% share of total electricity consumption (Source: DUKES), and 26.4million households in GB (Source: ONS). Percentage pass through of wholesale electricity price reductions will depend on market conditions.

13. Based on £1 billion pro-rated across 365 days and assuming no discounting

03. Securing the benefits of greater electricity interconnection continued

These figures are based on a credible scenario which reflects a continuation of current conditions, including relatively high gas prices, renewables growth to meet 2020 renewable energy / carbon targets and a mandated UK carbon price floor to compensate for a relatively low European Union carbon price. Alternative scenarios, which diverged from current conditions, were also considered. These included different gas prices and levels of renewable generation.

Across Europe, it is estimated that reduced electricity prices for households and businesses from a fully interconnected Europe-wide energy market could lead to benefits of €35 billion per year in 2015¹⁴. Interconnectors therefore represent the critical infrastructure tool through which the benefits of the Europe-wide Internal Energy Market can be accessed, resulting in consumer benefits to all member countries.

Energy Security: Interconnection can also help to guarantee secure energy supplies for Britain, and as we make long term plans for the development of our energy system.

Securing additional power supplies is becoming ever more important as Britain continues to close a substantial amount of its existing power stations due to old age and more stringent pollution standards. Britain is mid-way through a current phase of closures, which will reduce capacity in the next few years, with another phase of closures planned up to 2020 and beyond.

These closures are taking place as the UK economy has started to grow again, making increased energy demand more likely. The combined effect is that electricity capacity margins (the safety cushion of surplus capacity over what is needed to meet demand) are reducing, and new sources of power are therefore required. Increased interconnection (alongside planned reforms to incentivise new generation) would enable

Britain to access additional sources of electricity and so diversify its energy mix in the short and longer term.

More interconnectors will also play an increasingly important role in 'system balancing', with more renewable generation being deployed. Increasing numbers of wind turbines and solar photovoltaic units generate highly variable electricity output, and interconnectors allow this power to flow across Europe as changing weather patterns and electricity demand dictate. More interconnection means that the variability of renewable generation is dissipated over a larger area and so becomes more manageable. This means that less 'back-up' power stations are required (e.g. to generate when there is no wind) thus reducing overall costs to consumers.

Environmental: As well as facilitating the integration of more renewables into the European energy system, interconnectors allow renewable electricity to flow between countries more easily and could enable carbon and renewables targets to be met more cost effectively. Additional links open the possibility of GB importing low carbon electricity produced from, for instance, hydropower from Norway, wind power from Ireland and Denmark, nuclear from France and hydropower / geothermal energy from Iceland.

GB generators also have the opportunity to export to neighbouring countries, enabling access to the European energy market, which could drive future growth of our domestic renewables sector and low carbon generation sectors. Challenges remain in delivering this, with EU provisions which allow for cross-border renewable trading, requiring country-to-country agreements to be put in place. To unlock this opportunity, the UK Government has been developing the policy framework to enable renewable energy trading between Britain and other countries¹⁵, as provided for through the 'Cooperation Mechanisms'

14. When 2015 is compared with 2012. Source: http://ec.europa.eu/europe2020/pdf/energy2_en.pdf

15. Source: <https://www.gov.uk/government/consultations/defining-our-policy-on-renewable-energy-trading>

16. Source: Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009

within the European Commission's Renewable Energy Directive¹⁶.

Economic: Greater electricity interconnection could yield a range of potential benefits to the UK economy and GDP. Through net GB imports, lower electricity prices to business consumers would reduce input costs, enhance competitiveness and boost household disposable incomes and domestic spending.

Through net exports, there is also a significant opportunity for British generators in using interconnectors to access a much wider consumer base across mainland Europe and thus earn additional revenues.

These benefits need to be set in the context that the importing country would not benefit from the export opportunity, and the exporting country would experience incrementally higher wholesale power prices. However, whether importing or exporting, interconnection's beneficial impact on security of supply can lead to Europe-wide macro-economic benefits through reduced price volatility and enhanced system stability, ultimately reducing wholesale electricity prices for all consumers.

New interconnector projects would also catalyse a range of additional economic benefits. First, new jobs would be created from the need to plan, build and maintain the new links. Second, inward investment would be boosted in order to deliver the multi-billion pound projects. Thirdly, this inward investment could reach a critical mass requiring new industries in the UK e.g. to manufacture the substantial quantities of sub-sea cabling required.

04. Now is the time to act and deliver new interconnection

Britain faces a compelling opportunity as a country to deliver new interconnector projects and access the considerable benefits available to consumers and the wider economy. Positive progress has already been made in preparing for this investment and many of the building blocks are already in place.

As well as establishing the proposed 10% interconnection benchmark by country, the European Commission, supported by the Council and Parliament, have afforded interconnectors special status through inclusion in the 'Projects of Common Interest' process, enabling accelerated planning, approval and implementation. This scheme is supported by a Europe-wide ten year network development plan (TYNDP) to facilitate decision making across the electricity transmission network. The Commission has also recognised the specific role of interconnectors in its draft Guidelines on Environmental and Energy Aid and has sought evidence that greater interconnection has been pursued ahead of Member States being granted approval for State Aid schemes supporting new electricity generation or generation adequacy measures.

DECC's support, seen through their recent policy statement¹⁷ on interconnection, has been underpinned by public statements from the Secretary of State. In turn, a growing list of developers has come forward with proposed projects. More work is needed to agree the details of how the longer and more costly interconnectors can access additional support (e.g. from the 'Capacity Mechanism') to be viable, and to put in place country-to-country agreements to facilitate cross-border renewable energy trading. Ofgem, in collaboration with the Belgian energy

regulator (CREG), have been developing a new and innovative regulatory regime to offer prospective investors the certainty they need. The design of this 'Cap and Floor' regime is nearing completion and includes in-built flexibility enabling it to be used for multiple new projects of different lengths, costs and complexity.

Elia, the Belgian national transmission operator, and National Grid, have put forward the first project (NEMO, a new interconnector link between Britain and Belgium) to pilot this new regime and much of the planning, consenting and engineering design work has already been completed.

Britain is therefore poised to complete the final design elements of the new regulatory regime, enabling developers to secure the considerable capital required to deliver these complex and technically challenging projects. Through continuing to work together, the above stakeholders are now well placed to build on the successful momentum developed to date, to secure the necessary regulatory and investment decisions for a 4-5 GW portfolio of new links in 2014/5 and unlock the benefits including a £1 billion wholesale electricity price reduction per year by 2020¹⁸.

17. Source: DECC report of December 2013 'More interconnection: improving energy security and lowering bills'

18. Source: based on analysis prepared by Baringa / Redpoint for Should be National Grid Interconnector Holdings Ltd.

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interconnection



Background: This paper has been prepared by National Grid Interconnector Holdings Limited (NGIH Limited), which pursues European business development opportunities alongside National Grid's RIIO regulated businesses. NGIH Limited is a wholly owned subsidiary of National Grid Plc.

We're connecting energy systems in partnerships across Europe, making our energy supply at home more secure, and using our skills and expertise to help other countries build energy systems for the future, designing the best, most affordable, long term solutions for consumers and the environment.

Our operational businesses are the Interconnexion France-Angleterre interconnector between Great Britain and France and the BritNed interconnector which runs beneath the North Sea between the Isle of Grain in Kent and Maasvlakte, near Rotterdam.

Interconnexion France-Angleterre has been operational since 1986 through our joint operation with Réseau de Transport d'Electricité (RTE). BritNed has been operational since 2011 through our joint operation with TenneT.

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

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A dramatic seascape with a cloudy sky and waves crashing onto a sandy beach. The sky is filled with heavy, grey clouds, and the water is a deep, dark green. The waves are white and foamy as they break onto the shore. The beach is a mix of dark sand and white foam.

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