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# Transmission planning and regional power market integration

# The opportunities for UK Energy Policy[1]

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## Executive Summary

The UK Government is currently considering how to reduce the costs associated with decarbonising the UK energy system and maintaining security of supply. The Committee for Climate Change has indicated that significant volumes of offshore wind and/or CCS will need to be deployed if carbon budgets are to be met. Whilst significant uncertainty remains over the cost and deployment potential of CCS, it is important to retain the option to exploit the vast offshore wind resources in the North Sea.

A large proportion of the costs of offshore wind deployment relate to new grid infrastructure and the need to manage system balance in light of the variable nature of offshore wind production. Numerous studies have now been undertaken which highlight the huge cost savings that are available from more effective planning of grid investments and the integration the UK power system with those in neighbouring countries. In particular, this analysis shows that:

- More co-ordinated and strategic grid planning across onshore, offshore and cross-border regimes could save between £1.5bn and £10bn in the period out to 2030,
- Whilst sharing of system balancing resources with neighbouring countries can save a further £3bn each year by creating a more flexible system that has the effect of 'firming' the output from variable renewables and reducing the need for investment in low carbon generation capacity.

Moreover, significant savings can also be achieved through reducing the cost of meeting carbon budgets by importing cheap surplus renewable resources from neighbouring countries (e.g. onshore wind from Ireland) and offsetting the need for direct renewable investment in the UK. In this regard, it is important to recognise that the UK offshore wind resource is itself far cheaper than that being deployed in many other EU countries (e.g. 15% load factor offshore wind in Italy) and establishing an interconnected North Seas grid creates the opportunity to promote investment in the UK offshore wind industry and export

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the power produced. Studies have shown that EU countries can achieve a combined saving of up to €300bn in the period out to 2030 by sharing renewable resources in this way.

Realising these benefits requires the Government to take a number of actions:

- *Institutional:* Establish an Independent System Operator (ISO) as the institution responsible for coordinating network development requirements and evaluating the implications and opportunities of market integration. These tasks would be in addition to the core functionality of least cost and secure operation of the power system and other policy delivery functions currently undertaken by National Grid and DECC. It would, therefore, help to rationalise the overall industry institutional structure.
- *Political:* Re-focus political engagement with neighbouring countries to explore opportunities to co-operate on energy system planning and low carbon resource sharing. This should include bi-lateral discussions with key neighbouring countries and placing a strong mandate on the North Seas Countries Offshore Grid Initiative to exploit the opportunities associated with developing an offshore network.
- *Regulatory:*
    - Require Ofgem to reform the regulatory system for onshore and offshore networks and interconnections to ensure effective co-ordination across the regimes as well as realising the full value of creating options to manage future uncertainty.
    - Ensure that the Internal Energy Market reform process currently being undertaken by the EU Commission focuses on two key issues of significant potential benefit to the UK. Firstly, a system of financial transmission rights trading should be introduced, since this will enable the UK to fund renewable energy projects in other countries and directly benefit from the energy produced. Secondly, a mechanism for the inter-state trading of flexibility products and corresponding allocation of interconnection capacity, since this will create a more flexible power system and reduce the quantity of low carbon generation that is required to meet decarbonisation targets.

## Context

The UK Government faces some important energy policy challenges as it seeks to decarbonise the energy system in line with statutory targets whilst maintaining security of supply and minimising the short term cost burden on consumers and taxpayers. Decarbonisation of the power sector has long been viewed as a critical initial step since it achieves early emissions reductions whilst creating options for the longer term decarbonisation of other energy sectors. Recent evidence from the Committee for Climate Change[4] suggests that this strategy remains valid given that good progress is being made with the decarbonisation of the power sector whilst early progress in other sectors has been slow.

However, continued decarbonisation of the power sector over the next decade requires that a number of key issues are addressed. The current fleet of coal-fired power plant will need to close and be replaced by a mix of flexible and lower carbon resources in sufficient quantities to maintain security of supply. Moreover, investment in large volumes of low carbon generation must continue. This, in turn, is projected to involve significant deployment of offshore wind and/or carbon capture and storage[5], both of which have cost and technical challenges.

Whilst offshore wind remains relatively expensive, the UK has proved its ability to deploy this resource at scale and costs are continuing to reduce. On the other hand, the potential to deploy CCS at scale and in the near future remains highly uncertain. It is, therefore, important to retain the option to exploit the large UK offshore wind resource, particularly in the North Sea.

Much of the cost associated with offshore wind deployment arises from the requirement to develop expensive offshore grid infrastructure and to manage the variable nature of offshore wind production through creating a more flexible power system. Indeed, it is envisaged that the UK will need to embark on the largest grid investment program since the current integrated network was established after World War II. It is expected that investment in onshore, offshore and cross-border transmission capacity will reach £23bn–£50bn by 2030[6], which is considerably greater than the entire current Regulated Asset Value

[4] 'Reducing emissions and preparing for climate change: 2015 Progress Report to Parliament', Committee for Climate Change, June 30, 2015

[5] 'Power sector scenarios for the fifth carbon budget', Committee for Climate Change, October 22, 2015

[6] The expected investment ranges have been established by considering minimum and maximum investment scenarios from a number of sources. These include the RIIO-T1 final proposals (available at: http://www.ofgem.gov.uk/Networks/Trans/PriceControls/RIIO-T1/Pages/RIIO-T1.aspx ), the National Grid Electricity Ten Year Statement and Imperial College analysis (Imperial College and NERA Consulting, 2012, Understanding the Balancing Challenge, Analysis conducted for DECC, available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48553/5767-understanding-the-balancing-challenge.pdf

of existing GB transmission assets (< £13bn). Any improvements in the network planning process therefore have the potential to deliver considerable savings in the cost of the network infrastructure as well as significantly reducing the costs of a major offshore wind deployment program. Moreover, more integrated operation of the power system with neighbouring countries has the potential to deliver further savings. Not only would wholesale prices in the UK reduce to converge with those on the continent, but fewer flexible resources would be required to meet fluctuating demand and to offset the variable production from offshore wind and, moreover, fewer low carbon resources would be required to meet decarbonisation targets.

Many studies have now been undertaken to quantify the potential savings available (see Box 1 for list of relevant studies). This paper discusses the body of evidence emerging from this analysis and suggests the policy steps that are necessary to realise the benefits for the UK power system and consumers.

**Box 1: Recent studies exploring benefits of more co-ordinated and strategic grid planning and market integration**

1. "Strategic Development of North Sea Grid Infrastructure to Facilitate Least-Cost Decarbonisation", study for E3G (July 2014)
2. "Study of the Benefits of a Meshed Offshore Grid in Northern Seas Region", study for EU Commission (July 2013)
3. "Benefits of an Integrated European Energy Market", study by Booz & Co for EU Commission (July 2013)
4. "More interconnection: improving energy security and lowering bills" DECC (Dec 2013)
5. "Impacts of further electricity interconnection on Great Britain", report for DECC (Nov 2013)
6. "Impact Assessment on European Electricity Balancing Market" report for EU Commission (March 2013)
7. "Integrated Transmission Planning and Regulation Project: Review of System Planning and Delivery" report to Ofgem (June 2013)
8. "Physical and Financial Capacity Rights for Cross-Border Trade", report for EU Commission (Sept 2011)
9. "Understanding the Balancing Challenge" report for DECC (July 2012)

## Transmission network development

Ofgem is responsible for regulating the transmission network and ensuring that the needs of current and future consumers are met at least cost. There are two features of the current regulatory framework that are particularly significant given the huge investment program described above and the challenge of decarbonising the power system.

Firstly, Ofgem currently regulates transmission network development through three separate processes covering on-shore, off-shore and cross-border assets, despite the fact that they all perform the same underlying function of transmitting power at high voltage. Whilst amounts of offshore and interconnection assets remain limited, there is modest interaction between the regimes and relatively little to gain from more co-ordinated transmission planning, delivery and operation. Indeed, this differentiated approach has made it easier for Ofgem to introduce competition in the provision of off-shore and interconnection assets. However, as levels of interconnection and offshore investment increase, the interactions across the regimes will become significant and there is already growing evidence of benefits in transmission projects that cut across regimes (multi-purpose projects)[7]. The current regulatory framework is not well-placed to access these benefits.

The second issue relates to the requirement for network investments to be justified on the basis of firm user commitment, particularly from known new generation projects. However, anticipatory transmission investment, in which full firm user commitment is not obtained in advance, are likely to be more efficient in the future when there will be material economies of scale in transmission investment, constraints associated with establishing new transmission corridors or developing new rights-of-way, and environmental constraints associated with the number of shore landing points that may be needed to connect offshore and onshore network assets. Furthermore, the increasing uncertainty about future transmission needs, coupled with the irreversible nature of transmission investment, means that the optimum investments should not be identified solely on the basis of net benefit, but also on the option value that they provide. The concept of option value is well-established in welfare economics, referring to the value placed on the ability to utilise an asset in the future, and is recognised as an important element of the total economic value of a project. However, it is often ignored due to the inability to charge potential users who currently value this future option.

Study number 1 from Box 1 explored the benefits of both anticipatory investment and the potential savings from integrating the planning of interconnection and the offshore grid network by considering the future development of North Sea Grid Infrastructure in four different offshore wind generation deployment scenarios. The results indicated that coordination in connecting offshore wind farms could deliver significant savings of between £1.5bn and £10bn in the period out to 2030 when compared to a 'point to point' radial

[7] Examples include offshore wind farms connecting to interconnectors and the development of meshed offshore grids that would also potentially increase onshore boundary capacities.

configuration and the total volume of onshore-to-offshore connections in the UK reduced from 68.1GW (radial/hub) to 58.7GW (integrated)[8].

This study also demonstrated that it would be preferable to build excess grid capacity in the first stages of offshore grid development in anticipation of a potentially large rollout of offshore wind rather than taking a conservative stance in anticipation of a low-offshore wind future. This is because there are significant economies of scale in developing offshore networks infrastructure and the delays in connecting offshore wind farms could be very costly. In other words, it may be preferable to marginally over-invest and run the risk of stranded costs than under-invest and then need to reinvest into the network and delay the connections. For the scenarios considered, the benefits for the UK were estimated to be between £0.5bn and £3.5bn in the period out to 2030.

## Power market integration

The EU Commission has been seeking to develop a competitive and integrated European energy market for a number of years and has implemented a variety of measures in pursuit of this goal. However, the EU is still some way from achieving a unified single energy market and the Commission has recently consulted on the need for yet further regulatory and market reform[9].

The idealised vision of market integration aims to ensure that resources can be exploited from a wide geographic area such that consumer needs and policy objectives are met at least overall cost. This, in turn, requires consistent policy goals and operational requirements along with institutions capable of planning networks and deploying resources across Member States.

In practise, the situation in the EU falls short of this idealised vision in a number or ways. Member States have different objectives with regard to energy mix and security of supply and it is common for Governments to aim for self-sufficiency[10] in delivery of key policy objectives. Institutions, such as economic regulators and system operators, are national in scope and collaborate through EU-level associations (ACER and ENSTO-E) that have little executive authority.

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[8] This reduction in infrastructure arose since the integration of the offshore network with neighbouring power systems allowed offshore wind generation to be exported when cost effective rather than needing to accommodate all generation in the UK system – see section on power market integration.

[9] Communication for the EU Commission: 'Public consultation process on a new energy market design', COM(2015) 340 final, July 15, 2015

[10] Self-sufficiency can mean either self-security, whereby sufficient indigenous capacity is in place to meet resource adequacy targets at system peak, or energy neutrality, whereby overall energy demand is met by indigenous production and annual net transfers across interconnectors are broadly zero.

Nevertheless, there remains considerable political support across the EU for increased interconnection of national energy markets and mechanisms have been implemented to help finance new interconnectors[11]. All Member States are currently obliged to achieve interconnection of at least 10% of their installed electricity production capacity by 2020 and there is the ambition to increase this to 15% by 2030. Significant progress is being made in increasing the level of interconnection between the UK and other EU Member States as summarised in Box 2.

**Box 2: Current and planned interconnection to the UK system**

Existing interconnectors: total 4GW

•2GW to France (IFA)
•1GW to the Netherlands (BritNed)
•500MW to Northern Ireland (Moyle)
•500MW to the Republic of Ireland (East West).

Planned interconnectors: Total ~ 10GW

- 1GW to Belgium (Nemo) – Expected completion 2019
- 1GW to France (IFA2) – Expected completion 2020
- 1-1.4GW to Denmark (Viking) – Expected completion 2020
- 1.4GW to Norway (NSM link)
- 0.8-1.2GW to Iceland (Ice Link)
- 0.7GW to Ireland (East West 1 & 2)
- 0.8GW to France (Channel Cable)
- 1GW to Belgium (Belbrit)
- 1.2GW to 2GW Norway (Vattenfall et al)
- 1GW to France (Eleclink)

The total installed electricity production capacity as at the end of 2014 was 85GW[12] and this is likely to increase by 2020 as more renewable capacity is commissioned. This suggests that the EU interconnection target of 10% installed production capacity will require around 9GW of interconnectors.

Whilst there are a number projects in the development pipeline, some of these remain at an early concept stage or are on-hold and only three projects are publically committed to be operational before the end of 2020. The combined total of current interconnector capacity plus those expected to commission before the end of 2020 is around 7GW. This suggests that, although the UK is making good progress in increasing the level of cross-border interconnection, there remains a risk that the UK will fall short of meeting the 2020 EU interconnection target.

[11] See http://ec.europa.eu/energy/en/topics/infrastructure/projects-common-interest
[12] DUKES 2015 Chapter 5

Moreover, EU-level regulatory codes are being developed to ensure the optimal use of interconnection capacity to exploit energy arbitrage opportunities and allow trading of capacity resources – so-called 'market coupling'. Therefore, increases in interconnection capacity, along with implementation of market coupling provisions, should go some way to reduce UK wholesale prices in line with those on the continent and improve the operational efficiency of the UK power system.

However, the current approach is still constrained in its ability to reduce costs for UK consumers in two key regards. Firstly, whilst energy and capacity can be traded cross-border, ancillary services cannot[13] and, as the proportion of variable renewables increases, this can have significant cost implications (Appendix 1 explains the system balancing challenges and why trading of ancillary services has the potential to further reduce costs). Study number 9 from Box 1 considered the benefits associated with regional sharing of frequency regulation and reserve services using cross-border capacity. This was found to reduce operating costs by about €3bn/annum when compared with a policy of each Member State providing the services to meet their own requirements and many of these benefits accrue to the UK. This is an important change that would have the effect of 'firming' the output from variable renewable resources such as offshore wind and the bulk of the cost savings would be derived from significantly reducing the volume of low carbon generation that is required to meet decarbonisation targets.

Secondly, whilst the Renewable Energy Directive does contain 'flexibility mechanisms' to provide incentives for investments in renewable power generation to be located in places of highest renewable resource potential[14], Member States have failed to take advantage of these opportunities. In part, this is due to the fact that a Member State that invests in renewable generation in another Member State is unable to access the energy that this renewable generation produces, even if these two states are connected via cross-border interconnection. Correcting this anomaly requires changes to the EU Internal Energy Market rules (see Appendix 2) but could open up a number of important opportunities for the UK. Study number 3 from Box 1 explored the benefits available from the efficient location of renewable generation across the EU. This analysis suggested that overall costs may be reduced by up to €300bn by 2030 and this creates significant opportunities for the UK. The

[13] Other than through bi-lateral agreements between TSOs

[14] The Renewable Energy Directive sets out a methodology for allocating the EU renewables targets between individual Member States. The Directive's 'flexibility mechanisms' are designed to allow those Member States with lower renewable generation potential or higher costs to partially fulfil their renewables targets in or with other countries through (i) Statistical Transfers whereby one member state with an expected surplus of renewable energy can trade it statistically to another member state; (ii) Joint Projects: whereby a new renewable energy project in one Member State can be co-financed by another Member State; or (iii) Joint Support Schemes: whereby two or more Member States agree to cooperate on all or part of their support schemes for developing renewable energy and share out the renewable value by agreement between them.

increasing amount of interconnection with neighbouring Member States creates the opportunity to import low cost renewable resources to meet carbon reduction targets (e.g. cheap surplus onshore wind generation from Ireland or solar generation from southern Europe). This is in addition to the opportunity to export offshore wind generation produced in the North Sea.

## Policy steps needed to realise the benefits

It is unrealistic to expect the EU energy system to move to a single and fully integrated market in one step – even if this is the desired long term vision. Nevertheless, the analysis presented in the previous section demonstrates that there are a series of benefits that could be realised for the UK over the next 5-10 years through a adopting a more co-ordinated and strategic approach to grid planning and exploring opportunities for more integration with neighbouring power systems. The potential benefits are significant and arise from:

- Creating the opportunity to exploit the significant offshore wind resource in the North Sea at least cost through efficient investment in transmission network infrastructure and reducing the cost of system balancing and delivering short term security of supply.
- Reducing the cost of meeting carbon budgets – through, for example, importing surplus renewable energy from neighbouring countries and creating a more flexible power system that can be decarbonised with less low carbon generation capacity.
- Promoting investment – through, for example, exporting offshore wind generation to neighbouring countries that do not have the same quality of resource.

A number of changes are required if the UK is going to be able to take advantage of these opportunities. Most importantly, it is necessary to establish an independent institution that is capable of evaluating the various costs and benefits involved, including the impact on UK energy prices and the requirements for network development. Such analysis requires a detailed understanding of the system and market operation – expertise that currently resides within National Grid. However, it would be inappropriate for National Grid to undertake this responsibility given its business interests in interconnection and transmission. Instead, there is the opportunity to establish an Independent System Operator (ISO) to fulfil this function. This is a common feature of energy markets worldwide and there is considerable evidence on how to create a governance and regulatory structure to effectively steer an ISO. The core functionality would be the least cost and secure operation of the power system and the ISO would be obliged to pursue more effective ways of sharing balancing resources with neighbouring countries. This institutional change would have the added advantage of creating an independent expert body capable of supporting the broader delivery of Government energy policy objectives without the potential conflicts of interests that exist with National Grid's current responsibilities as the electricity market reform delivery body. A recent Policy Exchange report[15] highlighted how an ISO could form a key element of a more rationalised industry institutional structure.

However, an ISO by itself cannot exploit the full benefits of resource sharing alone and the Government must take the political initiative to re-focuses engagement with neighbouring countries to explore opportunities to work together to reduce energy system costs. This engagement should be informed by the wealth of analysis that already exists and there should be clear objectives to exploit the opportunities to reduce costs and promote investment. For example, dialogue should be re-opened with the Irish Government to explore the benefits of sharing renewable resources and the North Sea Countries Offshore Grid Initiative should be given a strong mandate to identify how to exploit the opportunities available.

In addition to these institutional and political initiatives, there are a number of more technical issues relating to regulation and market design that need to be addressed. Firstly, the current regulatory regime for planning and regulating the offshore transmission network, including interconnection capacity, is based on previous paradigms of limited integration and low probability of major offshore development. This system is no longer appropriate if the UK is to maximise the benefits of system integration and ensure a co-ordinated development of onshore, offshore and cross-border assets. An ISO would be in a position to propose strategic developments of the offshore and cross-border network that aligns with onshore developments and minimises overall costs and these could be approved by Ofgem through a revised and internally coherent regulatory regime. Ofgem should, therefore, be required to identify and implement a new regime that is more appropriate to support the cost-effective development of the offshore and cross-border network.

The second technical issue involves the development of the EU Internal Energy Market. It is necessary to develop a system of Financial Transmission Rights since this will enable the UK to fund renewable energy projects in other countries and directly benefit from the energy produced (or, conversely, encourage other Member States to invest in the UK). Indeed, the EU Commission is currently looking to revise inter-state co-operation mechanisms as part of a review of the Renewables Directive and it would be highly beneficial for the UK to see progress in this area[16]. Another important aspect of EU Internal Energy Market development is that new mechanisms must be developed for the inter-state trading of flexibility products that are not currently addressed through energy arbitrage and capacity markets. The Government should ensure that these issues are addressed as part of the current review of

[15] http://www.policyexchange.org.uk/publications/category/item/governing-power-improving-the-administration-of-the-energy-industry-in-great-britain
[16] See http://ec.europa.eu/smart-regulation/roadmaps/docs/2016_ener_025_cwp_renewable_energy_package_en.pdf

market arrangements being undertaken by the EU Commission given the huge potential value to the UK.

This package of institutional, political and regulatory reforms represents practical steps that have the potential to deliver significant benefits in the near future. They should, therefore, be pursued as a matter of priority by the UK Government.

## Appendix 1: The UK system balancing challenge

Operating reserve requirements and the need for system flexibility increases significantly at high levels variable renewable generation. Traditionally operating reserves have been delivered through conventional plant operating at reduced output (i.e. less efficiently). The need for additional reserves and lack of system flexibility has the potential to be costly and increase the amount of $CO_2$ emitted and, ultimately, constrain the ability of the system to accommodate variable renewable generation. Therefore, integration of significant volumes of variable renewable generation (and inflexible nuclear) in the UK electricity system in future presents a challenge for cost-effective system balancing.

Study number 9 from Box 1 demonstrated that the continued reliance on synchronised conventional generation to deliver increased levels of balancing services presents a key barrier to the cost-effective integration of variable renewables. Provision of real time balancing services by conventional plants is inevitably accompanied with delivery of energy that is unwanted, particularly during night periods when demand is low. In these circumstances, the only means to balance the system is to curtail renewable output, which is economically and environmentally undesirable. The chart below demonstrates how the flexibility of conventional generation in the future UK electricity system was shown to affect its ability to cope with variable renewables. The extent of the problem is measured in terms of the level of wind energy curtailment arising from the lack of system flexibility. For 30GW of wind generation, the curtailment could exceed 25% of annually available wind energy, in the situation in which the system has less flexible conventional generators.

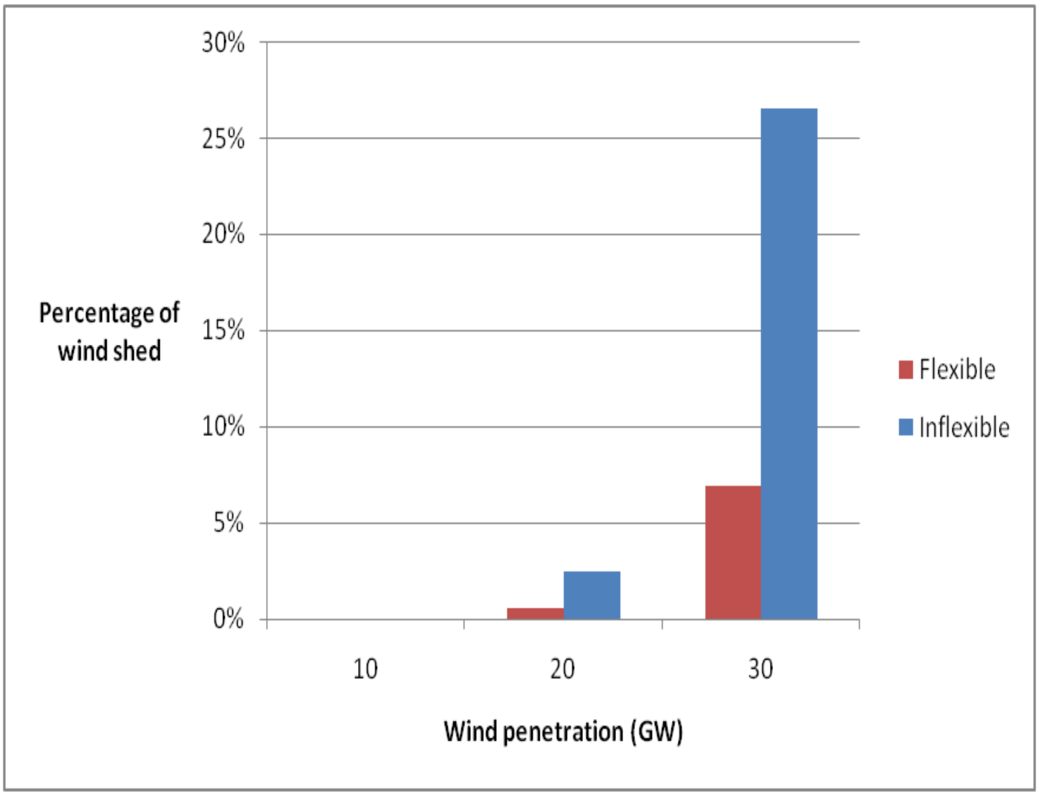


*Figure 1: Amount of wind generation curtailed as function of penetration and flexibility of the system*

The allocation of the reserve portfolio between part-loaded conventional generation and alternative sources is, therefore, vital to the efficient operation of the system – particularly in a congested network with significant wind generation. In such situations, the commitment of alternative sources of reserves will generally be preferred. This is even the case if these are located in neighbouring states and may require reduction in energy transfers across interconnectors. The allocation of interconnection capacity between energy and reserve services is, therefore, important for overall system efficiency and the current market coupling arrangements would not facilitate this optimisation.

This point was investigated in study number 6 in Box1 and is illustrated in the chart below which considers two energy systems – Area A with significant penetration variable of renewables (e.g. UK) and Area B with significant penetration of low marginal cost generation, such as nuclear, but also flexible standing generation (e.g. France). If the reserve requirement is ignored, the interconnector capacity will be used solely to transport energy from Area B to Area A. However, if the capacity of interconnector is optimised between energy and reserve, the flows between the two areas change significantly.

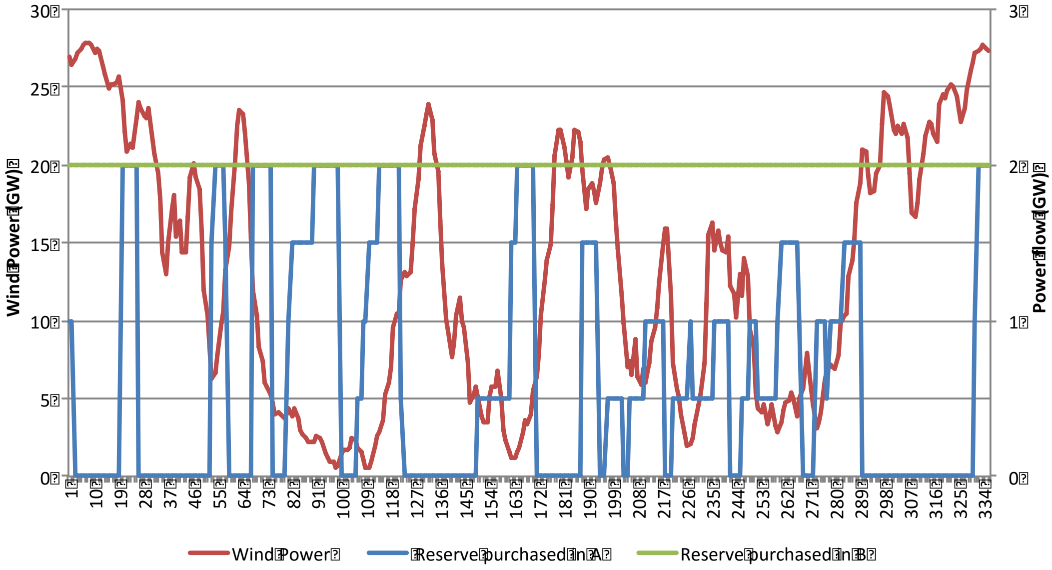


*Figure 2: It is efficient to constrain energy flow in order to facilitate cross-border access to flexible generation*

The development of new trading arrangements for sharing reserve between Member States has the potential to bring significant benefits. In particular, this will involve shifting the requirements to provide reserve from areas with high renewable production (exporting areas) to areas with low production or demand-dominated areas (importing areas) by making use of cross-border transmission.

Furthermore, given the increased diversity in demand and renewable output across interconnected areas, when reserve is shared across Member States, as opposed to every Member State providing reserve services for its own needs, this would have a very significant impact on the overall reserve requirements. Moreover, it would have the effect of reducing the capacity of low carbon generation that is required to meet decarbonisation targets and this would save significant costs. Addressing this issue should, therefore, be a key priority of the current review of market design currently being undertaken by the EU Commission.

## Appendix 2: Creating the opportunity for renewable resource sharing

At present, a Member State that invests (directly or indirectly though the renewable certificates) in renewable generation in another Member State is unable to access the energy that this renewable generation produces, even if these two states are connected via cross-border interconnection (or via multiple cross-border interconnectors). Renewable energy production will be accessed by, and traded in, the host Member State only and will not contribute to meeting the energy needs of the Member State that actually invested in the renewable generation project.

If there is interconnection between the two states (which could be direct or indirect via other states), it should be possible for the Member State making the investment into renewable generation project to also access the renewable energy production of the plant installed in the host Member State. Creating this change would provide an important additional incentive for sharing renewable resources and allowing the EU to efficiently exploit renewable resources.

One potential solution to this problem would be to establish long-term transmission access regimes that would enable Member States to access this energy generated elsewhere via the cross-border interconnection. Financial Transmission Rights (FTRs), which would specify the source/generation zone and sink/load zone of the electricity trade, would present an appropriate obligation between trading parties[17]. In fact, the Member State that provides investment (or access to renewable certificates) may require the renewable energy generator to secure cross-border access from the host state and trade the energy within the market of the Member State that made the investment. This would also facilitate cost-effective investment in cross-border transmission capacity and interconnection that could be funded by the parties that benefit from the interconnection, e.g. renewable generators.

[17] Currently, in line with the cross-border European market design (i.e. Target Model), countries that exchange renewable energy are required to specify individual cross-border interconnectors along a "hypothetical" route of the electricity flow between country of export and country of import. Then, the appropriate capacity on all the interconnectors specified would need to be reserved for this trade to be firm, through purchasing Physical Transmission Rights (PTRs). It is well recognised that this approach is inherently inefficient and will create barriers for market integration, particularity in the context of renewable energy exchange. As argued in a recent report for the European Union ("Physical and Financial Capacity Rights for Cross-Border Trade", report for EU Commission, Sept 2011), Financial Transmission Rights (FTRs) could provide a solution to this problem, as they present an obligation between trading parties which would only specify the source/generation zone and sink/load zone of the electricity trade, but not all multiple interconnectors that might link these zones together. One of the key advantages of FTRs over PTRs is that contracts for exchange of power in different directions can be netted, so that the absolute value of the total volume of contracts from one country to the other can greatly exceed the actual cross-border network capacity, considerably enhancing competition in each market.

Finally, it is important to stress that there is a very considerable experience with FTRs as these have been very successfully used for efficiently managing transmission access in congested networks, particularly in the US.