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Summary

The UK has seen a significant increase in wind energy generation from the 1990s onwards, but the upward trend has not been consistent. Different types of remuneration scheme have been used, with the Renewable Obligation (tradeable certificates and quantity-based obligation) being most significant for onshore wind, albeit relatively expensive. Contracts for Difference have helped support major expansion of offshore wind, for which costs/megawatthour have fallen significantly. In general, governments in the UK have not made use of prescriptive, site-identification policies for locating on-shore wind. Part of the planning policy framework for onshore wind can involve the drawing up of areas where wind energy would be preferred and those where it would be virtually prohibited, but this functions simply as extra advice to the planning process when making decisions on projects. Offshore, UK Government bodies have sought to organise development opportunities by drawing up potential development zones, within which prospective developers make bids. But this is for the process of allocating site leases, and does not confer full planning permission on specific projects.

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1. Introduction

UK is an interesting and educative case study in the design of policies for wind energy. By the end of 2016, the UK had 10,923 MW of installed capacity onshore and 5,293MW offshore. In the second quarter of 2017, renewable sources supplied 29.8% of electricity, of which almost half (13%) came from wind.[i] However, this outcome reflects over 25 years of government action, with relatively frequent revision to policies and policy instruments. Wind energy expansion has also experienced periods of political support and opposition, especially affecting onshore wind, in which investment as begun to slow markedly. Since 2015 the major sphere of expansion has been in offshore wind, which is increasingly being viewed as a UK success story. The UK still faces significant challenges in designing institutions and infrastructure to better handle the intermittent output from wind power, a problem magnified by persistent high-level political commitment to building new nuclear stations.

Although this paper refers mainly to 'the UK', political devolution means that the governments of Northern Ireland, Scotland and Wales have significant powers in the energy field, especially in relation to planning, but also in relation to aspects of industrial support.

2. Remuneration systems

The UK has operated a number of remuneration schemes to support the expansion of renewable energy, including wind, as detailed in Table 1 below.

Non-fossil Fuel Obligation

The UK's first remuneration system for renewable energy was the Non-fossil Fuel Obligation (NFFO), which began operating in 1990. This was created principally to provide a system of financial support for nuclear power, but a small proportion of funding went to support renewables. It was a tender-based system, driven by quantities of capacity. The basic features of the NFFO are as follows:

- The NFFO process begins with the government announcing an order covering specific technology bands. Five orders were carried out during the programme's life.
- Renewable energy generators competed in a tender process. Each scheme that passed a "will-secure" test submitted a final bid and the government then selected the cheapest schemes to secure the required capacity within each band of the order.
- The renewables capacity was secured through contracts with generators at premium prices. The guaranteed contractual price was made up of the electricity market price and a technology-specific premium.
- Additional costs incurred by the electricity suppliers under these contracts were funded by all final electricity consumers through a levy on electricity bills, but subject to overall caps. The levy is paid to a specific agency, the Non-fossil Fuel Purchasing Agency.
- The 'obligation' falls on distribution network operators to purchase power from non-fossil sources.

The NFFO system evolved over time in a number of ways (Mitchell and Connor 2004). Competition through the tendering process only began to emerge with NFFO-2. From NFFO-3, the government allowed five years after the contract was awarded for bidders to obtain planning permission for their project. Steps were taken to split wind energy into smaller and larger bands to enable community projects

The NFFO made a relatively small contribution to wind energy expansion. Proponents point to success in driving down costs, from over 10p/kWh in the first round in 1990, to around 4p/kWh by 1998, but the design of the NFFO clearly had side effects. Its competitive nature encouraged bidders to put forward projects on the windiest, most exposed sites, increasing visual impacts, provoking public opposition and raising risks that planning permission would be difficult to obtain. Overall cost caps were set too low, which also encouraged under-bidding i.e. tendering of projects with costs that were unviable (Mitchell and Connor 2004).

The weaknesses of the NFFO helps explain why the UK was not an early leader in wind power through the 1990s. By the time the scheme was superseded, only 170MW of NFFO-contracted wind power was in operation (just 70 projects, and a small % of the 1153MW of renewable energy contracted in total under the NFFO).[ii] Mitchell and Connor (2004) suggest

governments were keener to show that competition was driving down costs than with delivery. A higher cost cap and penalty for not taking up contracts (encouraging more realistic bids) would have improved the scheme.

Renewables Obligation

In 2002, a new system was introduced for the remuneration of renewable energy, designed to address key problems with the NFFO, especially around delivery. Called the Renewables Obligation (RO), it is in effect a quantity-driven quota system using tradable certificates, with three key elements.

- An obligation is placed on energy supply companies to purchase a certain amount of electricity from renewable sources. This target rose through the operation of the programme from 3 % in 2002-3 to 15.4 % in 2015-16 (though see Woodman and Mitchell 2011 for technical details).
- Generators of renewable electricity can sell their output, but also receive a certificate (a Renewable Obligation Certificate, or ROC) for each unit produced that they can sell to suppliers or auction online (on a platform called e-ROC). Energy suppliers must purchase ROCs to prove that they are meeting their obligation.
- Should energy suppliers not meet their obligation they are required to make a buy-out payment (a penalty) per MWh under-performed. The premium from these payments is collected by the regulator and returned to energy suppliers in proportion to the degree to which they have met their obligation.
- Like the NFFO, the additional costs are paid for through customers' electricity bills.

As initially designed, the RO exhibited the preferences of the governments of the day for technology-neutral systems of support in which significant allocative roles were given to market processes. Government did not 'pick winners'. Rather, competition was sought between technologies and projects in order to drive down costs. Renewable electricity generators receive revenues from the energy sold plus the price of the ROCs, but electricity prices are subject to market pressures and the uncertainty that brings (Woodman and Mitchell 2011). The RO is also a relatively complex scheme of remuneration.

In terms of outcomes, the RO came to offer higher prices for generators (6-7p/kWh) than later phases of the NFFO but it did stimulate a significant upturn in RE investment compared to previous levels in the UK (see Section 5). But the scheme also had weaknesses.

- The RO exhibited problems characteristic of quota systems of 'exaggerated producer rents' (Ragwitz and Steinhilber 2014; Keay 2016). Remuneration levels were clearly above cost and it is unclear, for example, whether prices for renewable electricity have proven lower than those delivered by Feed-in-Tariffs (FITs) in Germany (Mitchell and Connor 2004). This is partly because the risks and uncertainties of the RO translate into higher costs for finance.
- Other acknowledged problems are the tendency to favour major extant, integrated energy businesses, as they are better able to take on the various risks and uncertainties of the RO. Major integrated utilities could fund projects 'on balance sheet' and address

uncertainties around contracts for supply. In general, independent and emerging companies proved largely unable to obtain finance, take on the risks or navigate the complexities of the RO themselves. This reduced competition.

- The RO also did little, initially, to foster dynamic efficiency, as it tended to favour mature, least cost technologies and did little to help emergent technologies. This situation proved to be a major advantage for on-shore wind, which was the technology most widely supported under the RO. Nevertheless the inherent risks translated into a need to secure a high rate of return, which encouraged developers to focus on large projects, and on sites with the highest wind resource rather than areas that might be more feasible in terms of landscape impacts and grid capacity (Woodman and Mitchell 2011).

From autumn 2010, cost control became a more consistent theme of policy and the Treasury instituted the Levy Control Framework to control the total amount of market support being given to low carbon energy. From 2009, the Government also began altering the technology-neutral basis of the scheme by adjusting the ROCs/MW for different technologies. It gave 1.5 ROCs/MW for offshore wind, subsequently upping this to 2 ROCs/MWh, then reducing it to 1.8 by 2016-17 as the CfD emerged as an alternative source of funding. RO support to onshore wind was reduced to 0.9 ROCs/MW from 2013-14.

A further facet of the RO is that as energy suppliers come closer to meeting the target for renewable that they are obliged to meet, so the price of ROCs falls. Governments have dealt with this by building in 'headroom' i.e. regularly raising the % obligation to underpin ROC prices.

With the introduction of Contracts for Difference (CfDs), the RO was closed for new entrants on 31st March 2017, but the closure date for onshore wind was brought forward to April 2016, a step that attracted criticism from the sector.

Feed-in Tariffs

In addition to RO support, a system of Feed-in Tariffs became operational in 2010 (set up by the Energy Act 2008). This targeted smaller energy projects, below 5MW, but it meant that for a period smaller wind projects were able to consider support under the RO or under the FIT. The Tariff on offer differs between technologies and project sizes and includes two separate payments. Generators receive a tariff for every kWh of electricity generated, whether used onsite or exported. This payment is subject to annual degression for new entrants to reflect falling technology costs. All generators also receive an export tariff for electricity exported, or can opt out and sell their electricity on the open market. In contrast to the RO, suppliers are obliged to buy all the output from a project, so removing market risks. FIT contracts last for 20 years.

The FIT has the advantages of simplicity and low risk that are attractive to smaller generators. The FIT in the UK has successfully supported very large volumes of new renewable energy capacity, especially solar PV. Small, single turbine, farm-scale schemes were relatively rare under the RO but massively increased in number with the FIT. With

solar PV, many observe that the FIT rates were excessively attractive because they did not sufficiently estimate the falling costs for solar PV.

However, the upsurge in demand has precipitated some major and near-terminal changes to FIT support. The enormous level of demand led to the FIT rates being decreased in 2012 and again in 2016. The steepness of the falls, the speed at which some of them were introduced, some affecting projects that had not been commissioned, has been seen as threatening investor confidence in renewable energy in the UK.

Contracts for Difference

The 2013 programme of electricity market reform brought in a new series of remuneration called 'contracts for difference' (CfDs). Like FITs, these were designed to give guaranteed, index-linked prices for electricity over specified time periods but avoid the problem of excess producer rents experienced by the RO. Each CfD includes a 'strike price': if electricity prices exceed the strike price, the difference will be returned to consumers; if it falls below this, the producer will receive funding to bridge the gap, sourced from a levy on consumers' electricity bills. The certainty offered by the scheme, and reduced risks, is also seen as lowering the cost of finance. Contracts are underpinned by a government-owned company, the Low Carbon Contracts Company.

For wind power, the CfD has a number of important features:

- CfDs were designed to support 'low carbon' energy sources in general, and thus nuclear power is also eligible (indeed, some would say that supporting nuclear is main goal).
- The reforms heralded a major increase in direct political control over energy technology choices, justified by concerns around carbon reduction and security of supply.
- Although there is more government direction, a basic design feature of the CfD and part of the initial policy intention is that CfDs would be issued by auctions in which different technologies would compete. This would allow the market to determine the mix of technologies and secure downward cost pressures.
- In practice, nuclear power CfDs have been excluded from auctions, with strike prices being negotiated bilaterally between the government and prospective development consortiums. Only for renewable have auctions been held. Nuclear power also gets much longer contracts than renewables: 35 as opposed to 15 years.

The first CfD auction round (completed February 2015) issued contracts for a new onshore and offshore wind energy projects. Onshore wind projects bidded into 'Pot 1', for 'established technologies', whereas offshore wind projects were bidded into 'Pot 2' for 'less established technologies'. For each pot, the government set maximum guaranteed prices against which bids could be gauged and established an overall available some of money. To the extent that bids prices clear significantly below the maximum, this allows more capacity to be supported.

However, the second CfD auction has only made money available for 'Pot 2' technologies, effectively excluding new onshore wind from this remuneration scheme and, thereby, from

public remuneration schemes in general, despite being one of the cheapest low carbon energy technologies.

The costs contracted price for some offshore wind projects approved under the second CfD round in September 2017 was just £57.50/MWh, less than half of the costs for projects supported under the first CfD round. Analysts are unclear whether this fall in costs is attributable to the design of the CfD and the use of auctions or simply falling costs of offshore wind arising from bigger turbines and improved, more efficient technology and delivery processes (Toke 2017).

It should be noted that offshore wind has also benefited from other, sector-specific forms of financial support. The first phase of development was facilitated by the Offshore Wind Capital Grants Scheme (see below). Prior to the introduction of the CfD, five offshore wind decisions were awarded final investment decision enabling contracts by government.

An overall and comparative assessment

Through a succession of remuneration schemes, the UK has greatly increased investment in wind power and secured a position in the World's top ten places to invest in renewables. However, its policy approach has been subject to relatively frequent changes. This has arisen from UK Governments shifting position on a series of dilemmas: how to balance market processes and 'technology neutrality' with direct political intervention; what is the appropriate scale of renewable energy investment vis a vis nuclear and gas technologies; ongoing concerns about cost control. This has tended to cause peaks and troughs in investment, and dent investor confidence. Onshore wind has been much more affected by these cycles than offshore, for which policy and political support has been relatively consistent.

International comparative analyses of UK systems of remuneration for wind energy generally concur that the UK approaches have been more expensive than those based wholly on Feed-in Tariffs, because of the risks and uncertainties involved (Ragwitz and Steinhilber 2014). It should also be borne in mind that wind energy, and other low carbon sources, are aided by other measures designed to raise the costs of fossil fuel generation e.g. the UK's Carbon Floor Price, designed to offset the low prices of carbon within the EU ETS.

Table 1: UK remuneration systems for wind energy

Scheme	Founding legislation	Type	Main period of operation (i.e. open to applicants)
NFFO (Non-fossil fuel obligation)	Electricity Act 1989	Auction-based: prospective generators offered tenders, cheapest chosen	1990-1998 (with five tendering rounds [orders] in this period)
RO (Renewable Obligation)	Utilities Act 2000	Tradeable certificates (Renewable Obligation Certificates) and quantity-based obligation	2002-2017
FIT (Feed-in Tariff)	Electricity Act 2008	Specifies returns for successful applicants that meet relevant criteria	2010 to present, but much reduced in scope from 2016.
CfD (Contracts for Difference)	Energy Act 2013	Echoes feed-in-tariff but with cost control for fluctuating electricity prices and auctions for projects.	Auction round 1 (2014), auction round 2 (2017)

3. Grid connection regulations

In almost all cases, developers of wind energy projects in the UK have needed to connect to the wider electricity grid. In the case of very small schemes, these can connect into the domestic (or farm or business) networks and thereby into the distribution network, with few cost or technical implications. All new connections need to meet certain engineering safety requirements (G83, G59). However, where schemes require more significant adjustments or additions to the network, then two further issues arise.

The first issue is that any major new overhead grid lines will need planning consent, which is a process administered by central government (see Section 3). In association with this, wayleaves to construct and operate the connections must also be set up with landowners. Wayleaves are bundles of legal rights and associated payments to the landowner.

The second issue is that a connection agreement will need to be reached with a network operator (a distribution company for smaller projects, one of the major grid companies for larger projects) before any connection to the network is made. Both generators and network companies have been privatised, and procedures of regulated third party access are in operation. Some elements of the new connection work must be conducted by the network companies but some (such as laying a new line) could be completed by an independent body and then, once approved, adopted by the network operators.

Network companies are obliged to offer a connection to new generators which also states the charge. However, a key issue is the extent to which adding a new wind energy project to the network creates the need for wider changes to reinforce the capacity of the network. If wider capacity increases are needed, the question then becomes one of working out the fair distribution of costs between new generation projects and other users of the enhanced grid. Network companies issue guidance on likely charges and offer estimates for particular applications. It may be that the offer to connect applies years into the future, once wider reinforcement capacity has been completed.

In the UK, the predominantly rural geography of onshore wind has needed to confront the uneven availability of grid capacity. In certain parts of the country, this has stalled the addition of smaller, especially community-driven energy projects because the costs of contributing to grid reinforcements would be prohibitive i.e. because the addition of more generation capacity, even quite small in scale, triggers a need for more system-wide reinforcement. For larger projects by major developers, affordability of new connections and reinforcement may be less an issue than the likely controversy of constructing major new overhead grid lines through rural areas.

4. Permission procedures, including environmental impact assessments

In the UK, the developers of wind projects always have freedom to choose where to site their project. Government policy does not mandate where wind farms must be located. This reflects the fact that the legal basis of the land use planning system is relatively discretionary in nature. This means that there is always scope to consider whether a specific application, for a given site is acceptable. This contrasts with countries in most of Europe or the USA, where land use zoning has a firm legal status.

However, almost all proposals for new wind turbines would need some kind of planning permission and some (especially offshore) need other licenses, too. Judging whether an application should be given planning permission gives the Government (national and/or local) significant scope to steer the way in which decisions are made about projects, and especially how the requirements for renewable energy are balanced against other social, environmental and economic impacts. On certain occasions, this has included making policies that identify areas (or 'zones') in which wind energy projects would be especially acceptable or unacceptable. But it is important to note that developers retain freedom about whether to sitetheir windfarms within these zones. In most cases, being located within (or outside) an area designated as preferred for wind energy development would not be enough, on its own, to determine whether an application should be given consent. Moreover, there is no connection between obtaining planning permission and obtaining financial support under government remuneration schemes (one does not trigger the other); indeed, the disconnection between the two has sometimes been a problem.

Most wind farm projects of any size will undergo Environmental Impact Assessment (EIA). The format is governed by European Union Directives, but the basic purpose is to ensure that decision-makers have adequate information about possible environmental effects on which to base a decision. One key element of the process is the submission of and Environmental Impact Statement, detailing the proposed project, the baseline environment, possible changes to that baseline and an assessment of their significance, potential mitigation and monitoring measures. The EIS is usually submitted by the developer at the same time as the planning application, such that the EIA process is closely linked to the process of attaining planning permission.

Not all wind projects need an EIA. The EU regulations require that any project involving two or more turbines or which have a hub height of 15 metres or more fall within Annex II, which means that an EIA may be necessary. Developers may produce an EIA voluntarily or request a screening opinion on whether EIA is required for their project, which may depend on its scale, location and thus potential impacts. In practice, therefore, EIA is likely to be required for projects (i) with more than five turbines, (ii) able to produce more than 5MW, (iii) or if it is near to or likely to affect a protected area. Key topics are landscape and visual impacts, effects on

terrestrial ecology (including birds and bats), noise, and the social and economic effects of construction.

Because the land use planning system of the UK already makes provision for public consultation and environmental impact information, the *additional* effect of EIA on decision-making is less than in countries with a less developed planning system.

Onshore wind

The procedure for gaining consent ('planning permission') for onshore wind developments has three main levels.

Small wind turbines

Small wind turbines are treated as 'permitted development', which means that planning permission is not required (and nor is EIA). This is subject to detailed criteria, for which important parameters are height (the highest part of the turbine must not exceed 11.1m) and location. For example, permitted development rights are not available for turbines in designated areas like National Parks, so all turbine applications could need planning permission.[iii]

Wind turbines or wind farms up to 50MW capacity

For wind energy projects that are too big to be considered permitted development, planning permission must be attained. For most projects up to 50MW in capacity, this is obtained from the municipality in its role as local planning authority. Most applications for wind turbines or wind farms also require EIA, as above. The local planning authority assesses the application and consults relevant technical bodies within the municipality (e.g. on highways, conservation) and other public bodies (e.g. for nature conservation, pollution, perhaps heritage). The process also makes provision for public consultation. The local planning authority reviews the consultation responses and the environmental impact statement. A key element of the review involves considering the application against the policies of the local development plan. This sets down the criteria against which applications are assessed, and this can include spatial policies that indicate areas where wind projects would be especially acceptable or unacceptable, though this varies between the different nations of the UK (see below).

The technical officers of the authority use all this material to make a report on the application with a recommended decision, either to grant planning permission, refuse planning permission or grant subject to conditions. These recommendations are considered by a committee of councillors (who are elected representatives) who may support officers' recommendations and usually do so, but are not obliged to do so. If the local planning authority takes more than 16 weeks in coming to a decision, or the developer is unhappy with the decision (because it is a refusal, or conditions are seen as too onerous), then they may appeal the decision. Appeals are dealt with by an independent public body, the Planning Inspectorate, though central

government may get involved. Only developers can appeal in the UK planning system, not third parties.

Large projects

Consent for power stations over 50MW capacity is issued by central government, because new generation projects of such scale are seen as having implications for the wider security and efficiency of the energy system. Central government consent effectively delivers planning permission for the project. All schemes of this scale are very likely to require EIA. There is still provision for public consultation and for seeking the views of statutory bodies before consent is determined.

Until 2008, a special unit of central government managed the process (under Section 36 of the Electricity Act 1989) but since 2011 – after a brief period when an independent body issued consents - the process has been managed by a team within the Planning Inspectorate. The Planning Inspectorate is a publicly funded executive agency that provides inspectors and support services for handling particular decisions within the planning system. The present position is that the Planning Inspectorate run the decision-making process and issue a final report and recommended decision, but the final decision is taken by the relevant government minister.

Applications for significant new grid connections are also consented by central government. Since 2008 legislation has made provision for new power stations and related grid connections to be considered for consent together, though this has not happened where high-capacity connections to the transmission network are required.

This basic three-level framework has been subject to a number of government interventions and changes since the early 1990s, to align planning policy with energy policy and climate change goals. A key means for doing this is the power of central government to produce or revise statements of national planning policy guidance. These give developers and local planning authorities a firm view on how applications and potential impacts should be assessed. While some elements will be instructions, others are advice on criteria to consider and the weight to be attached to different factors.

Central government has also made procedural changes to 'speed up' decisions on 'national significant infrastructure projects' (including electricity generating stations over 50MW) but this has not necessarily benefited wind energy. Until 2010, governments took the view that planning was a 'barrier' to the delivery of renewable energy, with a particular concern being that local planning authorities too often refused consent for wind energy projects, slowing deployment, and UK governments acted to improve consent rates[iv]. However, since 2010, in England, the UK government has sought instead to respond to public and political opposition to onshore wind, by giving local planning authorities more power over wind applications, making it easier to refuse consent.

Because planning in the UK is a devolved responsibility, it is important to recognise that the four nations (England, Northern Ireland, Scotland and Wales) have been able to take different approaches to planning for wind energy (Power and Cowell 2012; Cowell et al 2016). Here they are, outlined in more detail.

England

In England, consent rates for wind have generally been the lowest in the UK, often below 50%. Until 2010, government sought to encourage more positive decisions through national planning policy guidance, advising local planning authorities of the importance of renewable energy and advising them against drawing up spatial zones that would restrict wind energy development. Because of the population density of England, wind energy sites tend to be smaller so fewer projects exceed the 50MW threshold for determination by central government. Nevertheless, from 2008, wind energy generation projects above 50MW were brought into the new 'fast track' decision-making processes for 'nationally significant infrastructure projects'. This instituted National Policy Statements stating the need for renewable energy, including wind, and debarring the 'need' issue from being discussed with individual applications. The legislation also set strict time schedules for the decision-making processes. At the same time, new requirements were placed on developers to conduct adequate pre-application consultation with local communities and statutory bodies before a proposal could go forward for determination.

However, in the face of mounting public protest and political conflict, the Conservative Governments of 2010 and 2015 sought to use planning to deliver on manifesto pledges to reduce on-shore wind. All projects, even those over 50MW, were passed to local planning authorities for determination. Ironically, the Government does now require that all applications need to be within an area identified in a neighbourhood or local plan for wind energy development and to show community backing, but there is no obligation on local planning authorities to draw up any areas. The industry expects this to lead to the rapid curtailing of new onshore projects, and to create problems for repowering.

Northern Ireland

In Northern Ireland, consent rates for onshore wind are the highest in the UK, regularly reaching 80%, but this reflects two unusual contextual features. First, because of the history of sectarian conflict all planning consents are issued centrally, by the (since 2016) Department for Infrastructure of the Northern Ireland Assembly. Second, historically, there has been relatively little environmental opposition compared to the rest of the UK.

Scotland

In Scotland, consent rates have been the highest in the UK outside Northern Ireland, at 60-70%, which can be attributed to a number of factors. Firstly, Scotland has sizeable areas with relatively low population density, in agricultural and ex-mining landscapes that are outside the most highly protected landscapes, creating relatively unconstrained sites suitable for larger

wind energy schemes. Moreover, because of this, more schemes exceed 50MW and so are determined centrally by the Scottish Government rather than local planning authorities, and the Scottish Government has maintained a consistently pro-wind energy policy. Unlike England, the decision-making process for larger schemes is still managed centrally by the Scottish Government, with ministers making decisions, without the Planning Inspectorate[v] taking a regular role.

Local planning authorities have been encouraged to use their local plans to indicate areas where wind farms would be more acceptable or unacceptable, and most of them have done so, often informed by analyses of 'landscape capacity' and cumulative impacts. This has allowed a modicum of local spatial control over development but not adversely affected development rates, partly because a proportion of schemes have proceeded outside the identified preferred areas, often gaining permission on appeal. Over time, the Scottish Government has sought to standardise the methodology that local planning authorities use to draw up their spatial strategies for wind.

Wales

In Wales, consent rates have often dipped as low as those in England. From 2002-03, the Welsh Government took steps to address local planning opposition by drawing up a national spatial strategy that indicated seven 'strategic search areas' (SSAs) for on-shore wind development . Appendix 1 summarises the criteria used to draw up the Strategic Search Areas, which combined 'absolute constraints' with more flexible factors. Appendix 2 gives a map which shows the SSAs. A key strategy was to facilitate wind energy development, but also to avoid a situation in which wind farms were sprinkled across the whole of the Welsh landscape. Concentrating them in particular areas was considered preferable.

In governance terms, the SSAs do not function as mandatory zones, dictating where windfarm applications must be made. Rather, they serve as part of the Welsh Government's national planning guidance on renewable energy, indicating that within the SSAs larger-scale wind energy applications (25MW or above) should be viewed positively, and are thus more likely to gain planning consent. The same guidance also supports a restrictive stance on the scale of on-shore wind energy development outside the SSAs, where smaller projects (below 5MW) or schemes sited on 'brownfield' land are preferred. A whole suite of other impact criteria still remain relevant, whether a projects is within an SSA or not.

The spatial zoning strategy has had mixed success (Power and Cowell 2012). In parts of Wales, where the strategic search areas overlap with large areas of former industrial forestry, where publics are relatively acquiescent and the existing grid network has spare capacity, then the SSAs have encouraged and facilitated the consent of significant new wind farm projects, notably the 256MW Pen y Cymoedd scheme. However, in mid-Wales, where the strategic search areas overlapped with valued upland landscapes, with significant local public interest in landscape conservation and tourism, and wind energy projects needed major new intrusive high voltage grid lines to be built, the result has been major public protest and, ultimately, the refusal of

most projects. Indeed the scale of the protests arising in mid-Wales combined with those in England to destabilise UK-level political support for onshore wind.

In Wales, in addition to the SSA approach, a preferred bidder scheme was set up for prospective developers of wind farms in 'strategic search areas' that overlapped with land owned by the national forest estate. This tendering process was created primarily to simplify development processes and to secure some public control over the projects coming forward and the flows of royalties and other community benefits. It focused on the allocation of land rights; winning bidders still needed to obtain planning permission for their specific projects.

It is hard to judge whether different ways of organising planning in the UK could have delivered more on-shore wind energy. Generally speaking, the changes to and curtailment of financial remuneration is more of a problem today, though conflicts over the landscape impacts of onshore wind in the planning process arguably contributed to that policy and political shift. It is worth adding that the most important landscapes and wildlife sites have been largely protected from onshore wind. In international comparisons, UK planning is always seen as fairly and effectively implemented (Ragwitz and Steinhilber 2014). It does allow for political oversight and, at various times and in different parts of the UK, this has both helped and hindered wind energy. Arguably, however, expanding the large-scale development of on-shore wind, in a country where social attachments to rural environments can be powerful, often well-organised, and with links to the political process, was always going to be a challenge. The issue of whether more attention could have been given to other aspects of social acceptance such as community ownership is discussed below.

Offshore wind

Offshore wind farms also require planning consent, but applications have always gone through special, centralised procedures rather than local planning authorities. This is partly because the remit of local authorities ends at the coast. Another distinctive feature of the development process for offshore wind concerns how rights to exploit areas of the sea are allocated. As this precedes the seeking of planning consent, it will be outlined first.

Because the seabed under UK coastal and offshore waters is vested in the ownership of the Crown (i.e. the state), Central government has scope to steer how this is exploited, including by offshore wind. For offshore wind, this has involved the

UK government – in the form of the energy ministry and Crown Estates – identifying areas of the UK sea bed that would be made open for offshore wind energy construction and taking steps to give them a degree of authorisation for the leasing process. This process involved negotiating with and attaining some approval from key stakeholders with competing interests, such as fisheries, shipping routes and the military, thus streamlining permitting for developers.

To be more detailed, the allocation of exploitation rights has proceeded in a number of phases (Rounds 1, 2 and 3).

- With Round 1, the government issued guidelines on potential offshore development and developers chose sites. Some were located relatively close to shore and encountered difficulties gaining planning consent. Round 1 was considered a 'learning phase'.
- With Round 2, the government specified three larger areas for development, and required that no development took place in the areas nearest the shore. These areas were tendered to developers through a competitive bid process.
- Rounds 1 and 2 together allocated 8GW of sites but Round 3 was much bigger in scale, with nine offshore zones identified. A competitive tendering process was held in 2009 by Crown Estates. The bidding round differered from Rounds 1 and 2, in that tenders were requested from consortiums or developers, for each of the nine zones, within which multiple windfarm projects could fit. Bidders in Round 3 had to demonstrate their financial strength, development capability and resources to be able to deliver the scale of projects required. Licenses to develop windfarms within the nine zones were issued to successful bidders, totalliing over 26GW. The Crown Estate is also involved as a co-development partner in each of the Round 3 zones, shouldering some of the development costs.

For the larger Rounds 2 and 3, the process of identifying suitable areas was subjected to more detailed Strategic Environmental Assessment of the potential impacts. In selecting suitable areas a trade-off was made between likely levelised cost of energy (reduced by offering larger areas in which to develop) and environmental impacts (potentially increased by offering larger areas). In the end, it was agreed that some softer constraints could be relaxed in the identification of potential development areas, in order to make larger areas available, meaning that some key impacts were deferred to be assessed and addressed as specific projects came forward (Beyer 2014).

Acquiring the license to exploit a development zone is only part of the process; offshore wind farms also need to attain planning consent. The process of attaining planning consent for wind farm projects on specific sites remains the responsibility of the developer. Different processes are followed in different parts of the UK because of devolution. In the territorial waters off England and Wales (and in the Renewable Energy Zone[vi]) any offshore energy project between 1 to 100MW is consented by a special public agency, the Marine Management Organisation.

Any applications for projects over 100MW are processed by the Planning Inspectorate under the regime for Nationally Significant Infrastructure Projects, following the same process as for onshore wind, as discussed above. As with onshore wind farms that fall within these procedures, the Planning Inspectorate evaluate the application and issue a recommended decision, but the ultimate decision is taken by Government ministers. Welsh Ministers make the decisions onprojects in inshore waters (i.e. up to 12 nautical miles offshore) around Wales.

In Scotland, consents for inshore and territorial waters are administered by Marine Scotland (an independent public body) on behalf of the Scottish Government. In Northern Ireland, the Department of the Environment is responsible for marine licensing.

In general, planning for offshore wind has been more facilitative than that for onshore. The industry had expressed concerns about the multiplicity of consents that are required for offshore developments, but steps have been taken to bring most (if not all) consents together into 'one stop shops'. So, the consent issued by the NSIPs process can combine other relevant licenses and consents. The creation of singular marine agencies has also helped to integrate decision-making. All offshore projects require environmental impact assessment. The timeline for offshore wind energy projects is illustrated in Table 2, below, using the example of Rampion wind farm off the English south coast:

Table 2: Key stages in development of Rampion offshore wind farm (400MW dnc)

Stage	**Date**
Project development by developer begins	2008
Developer acquired exclusive rights to develop a wind farm in that offshore area granted by Crown Estates	2010
Survey, consultation and impact assessment work	2010-2013
Application for planning consent submitted	2013
Planning consent from central government attained	2014, July
Construction expected to be fully complete	2018

The major factor affecting the progress of individual offshore projects has been economics, dictated by such things as wind energy resource, water depth and sea bed condition, rather than planning consent. Offshore wind farms do attract opposition, especially where the site is nearer the shore, is visible from popular seaside resorts or attractive coastal landscapes, and where uninterrupted marine landscape are popular. A small number of offshore wind farms have been refused consent, mainly on landscape grounds, but the vast majority have been consented.

Meeting the requirements and concerns of organised stakeholders has often been more important than dealing with public or political concerns e.g. fishing, navigation and nature conservation interests. To some extent, potentially conflicting concerns have been managed through the identification of areas of UK seas suitable for exploitation, as above. However, the poorer knowledge of wildlife interests offshore has meant that project development and impact assessment has often co-evolved with new knowledge about the wildlife of the seas, such that some project have been identified as having quite significant risks to bird populations and will require careful monitoring.

5. Social aspects: acceptance & benefits, including support for community ownership

Social acceptance has been an issue for wind energy development in the UK and, as noted above, opposition to onshore wind energy development has underpinned the closer focus on offshore, even though the latter has been more expensive. Although surveys indicate high levels of general public support for wind energy in the UK, research shows that this support is often conditional e.g. it depends on the choice of location, as well as other concerns about cost, equity and the fairness of decision-making processes.

By and large, changes to the planning system – although they may have assisted schemes in gaining consent – have probably not helped to foster social acceptance, given that they have tended to promote more centralised, swifter decisions that seek to contain the scope for public engagement and challenge. The UK government has, however, evolved a series of other measures hoped to encourage greater societal support.

Community ownership

The main effect of the UK's systems of remuneration for wind energy has been to encourage very high levels of ownership and control by a very small number of multi-national companies, accountable to shareholders, which deliver relatively few economic benefits to host communities beyond initial construction-related employment and a small number of operational maintenance jobs. The absence of major UK manufacturers of onshore turbines has meant that regional economic benefits are few (compared to Spain etc; see Munday et al 2011). As a result, projects are readily seen as exploitative by local communities.

Nothing that the UK government has done has altered this main development model, but it has undertaken a number of steps to assist and facilitate the development and ownership of renewable energy projects by communities, including wind energy. These have taken the form of:

- grant and loan schemes for community energy initiatives, to address the difficulties of gaining finance. A large number of schemes have been introduced in different parts of the UK over the last twenty years. Schemes often have to focus on loans because EU 'State Aid rules' prevent schemes receiving both capital grants and revenue support.
- advice to prospective community energy developers.
- steps to make FITs more accessible to community energy projects through provisions for pre-registration and a relaxation of the energy efficiency requirement.

As a result of the above actions, and of the considerable voluntary interest in sustainability across the country, the UK now has many hundreds of community energy schemes in place, albeit that wind is just one of the technologies adopted. However, schemes are generally small (very few exceed 5MW), and the total contribution to renewable energy output is modest. This can be attributed to:

- The difficulties and complexity of developing and operating an energy project, such that few communities have the capacity to realise schemes. Following Mitchell and Connor (2004), government support specifically to community energy is in tension with remuneration schemes that, FITs aside, tend to be complex and work decisively against small new entrants.
- The planning system, generally, has given no weight to whether wind energy projects are community owned, and many wind-based projects have taken a very long time to get planning permission.
- Community energy projects are not free from local opposition, especially where wind is the chosen technology.
- Changes to remuneration schemes have caused instability, and the virtual end of FIT support has been a major barrier.
- Generally speaking, the UK government has been reluctant to coerce commercial developers to make a share of the ownership of their projects available to communities. The Infrastructure Act 2015 did create a policy on mandatory community share ownership for renewable but it has not been implemented.

Another problem is that, compared to Germany, banks in the UK have not been keen to loan money to underpin small-scale renewable energy initiatives. Also, municipalities in the UK have not been major actors in the energy sector until recently and there remain relatively few projects with high levels of municipal engagement, though this is certainly beginning to change. The introduction of the Feed-in Tariff made community engagement in renewable energy easier, but most new entrants have been individuals and, in the case of wind, farmers. This is mostly investment by individual farmers developing single turbines rather than cooperatives.

Because of the late development and modest size of the community energy sector in the UK, it has done little to affect the overall climate of opinion about wind energy. Scotland represents something of an exception to this picture. In Scotland, ambitious targets have been set for ‘community and locally-owned energy schemes’. The 500MW by 2020 target was met three years early, and new targets have been issued of 1GW by 2020 and 2GW by 2030. In many instances in Scotland, communities that have pursued community energy schemes have previously benefited from the Scottish Government’s policies to assist community land purchase, enabling them to control the land and resource rights necessary to deliver and benefit from renewable energy development. The inclusion of ‘locally’ as well as ‘community-owned’ enables farmers, councils and other groups to be seen as contributing to the target. However,

the nature of the devolution settlement means that the Scottish Government, at present, cannot shape remuneration systems.

Community benefits

Because major commercial projects remain the dominant mode of wind energy development, more attention has been given to the provision of 'community benefits'. This means flows of financial benefits or in-kind assistance granted by developers/owners to host communities. Such practices emerged spontaneously in the late 1990s, with many developers agreeing to give benefits of around £1000/MW of installed capacity/year, usually placed in a special fund that was managed by local people, and spent on environmental and social measures (Cowell et al 2011). Sometimes money was directed to be spent on local energy efficiency measures or other facilities that benefited local stakeholders.

From 2005 onwards, UK governments became increasingly keen to encourage the provision of community benefits, working with the industry to create 'good practice guides' for community benefits, and pushing them to provide benefit sums of £5000/MW/annum as the norm. Note that this is only about 5% of the revenue stream that wind energy generates, so is less remunerative to communities than full ownership, though of course it is risk free. In Scotland, registers of community benefits were created, so that communities could see what was being provided and to aid transparency.

Despite government pressure, community benefits have remained largely voluntary in the wind energy sector. There is resistance to attaching them to the award of planning permission, because of the probity concerns that planning consent is being bought and sold.

Other community benefit streams come out of wider public revenues. From 2010, the Government took steps to direct more tax revenues to municipalities that accepted wind farms. From April 2012, government has channelled money into its Coastal Communities Fund, equivalent to 50% of the revenue derived from its marine activities, including royalties from offshore wind farms (HM Treasury 2011).

It is far from clear that the provision of community benefits has improved social acceptance of wind energy or altered planning decisions. Where payments lack transparency, are offered late in the consenting process or are seen as about 'buying planning permission', then they can be viewed negatively, as a 'bribe'. Perhaps as a result, UK governments have presented community benefits as less about generating social acceptance and more about fostering justice i.e. allowing communities to share in the benefits of wind energy development, without any implication that this should change opinions.

6. Available wind data

Wind data in the UK is available from a number of sources.

Information on installed capacity, levels of generation and load factor, per annum and also broken down by region, are produced by the UK government, with updates on a quarterly basis:

https://www.gov.uk/government/collections/renewables-statistics

Data on renewable energy schemes that are progressing through the planning system is also made available, viz.:

https://www.gov.uk/government/collections/renewable-energy-planning-data

For offshore wind, the Crown Estate (a public body) has produced some analyses of the offshore wind energy resource at 4.4km resolution, viz.:

https://www.thecrownestate.co.uk/media/476245/ei-uk-offshore-wind-resource-dataset-2015.pdf

With onshore wind, detailed data is mainly provided commercially and/or by developers installing measurement equipment on prospective wind farm sites.

7. Domestic industrial capacities

Compared to European leaders like Denmark, Germany and Spain, the UK has relatively little domestic industrial capacity in the wind industry. Most of the manufacturing of turbines and related components installed in the UK has taken place overseas. There are UK specialisms in small-scale turbines, consultancy and, increasingly, offshore wind, but onshore wind projects have been completed mainly with imported technology.

Back in the 1990s, there were indigenous turbine manufacturers but a combination of design issues, competition with Danish and German products that increasingly became the industry standard, and the up-and-down nature of domestic policy support meant that UK onshore turbine manufacturing has not developed significantly. Branch plants set up by overseas companies (such as Vestas on the Isle of Wight) have also faltered.

The offshore sector represents a slightly different picture. Siemens developed a major facility for manufacturing turbine blades for offshore wind farms in eastern England, now employing close to 1000 people, and the stability of the UK investment pipeline for such projects is a major factor. Estimates of direct employment in the wind industry vary depending on how ‘direct’ and ‘indirect’ are defined, but probably now exceeds 20,000, with offshore employing more than onshore. Vestas on the Isle of Wight has reopened to produce components for offshore turbines.

The fact that the UK does not retain all of the economic benefits of wind energy development is one factor explaining its difficulties in maintaining consistent political support and the dynamics of opposition. The remoter rural areas in which onshore wind farms tend to be build secure only

a fraction of the economic income streams (Munday et al 2011). For offshore, the levels of employment created in operations and maintenance hubs in smaller seaside towns with higher unemployment has often been locally attractive.

8. Institutions in the area of R&D, training & education

The UK government has supported a number of activities in the fields of R & D, training and education around renewable energy, though much less than has been channelled towards nuclear power. Most of this has been directed towards novel technologies that have yet to be able to supply commercial levels of power.

In the past, the UK has supported research and demonstration into wind energy technologies. Much of this took place while the UK electricity sector was still in public hands. However, it is reasonable to say that the development and commercialisation of onshore wind technologies is not a sphere in which UK-based research and development played a very significant role.

The story is different for offshore wind. Offshore wind has been subjected to a much clearer, more sustained programme of government funded research and development, much more closely integrated with the domestic maturation of the technologies. The first phase of development was facilitated by the Offshore Wind Capital Grants Scheme, set up in 2001 and designed to incentivise a set of proposals that could be used to gather data on sites and project costs and thereby inform future remuneration schemes (Beyer 2014). Projects were able to receive grant funding of up to 40% of eligible costs per project. In total £107 million was made available, disbursed to projects over 2002-2012, but £50 million was voluntarily paid back so that developers could access the revenue support available under the RO. The five pilot sites developed 2003-2008 had a total capacity of 390MW.

Public money has also helped support the work of the National Renewable Energy Centre at Blyth, Northumberland (England), which began work in 2002 focused on the development, commercialisation and risk reduction for offshore/marine renewables. It conducts development and testing for offshore turbine blades and power trains, as well as offering facilities for training offshore wind technicians. It merged with the ORE (Offshore Renewable Energy) Catapult in 2014.

9. Export promotion policies

The UK government spends significant sums of money each year in the promotion of energy interests, both conventional and renewable. Within the sphere of wind energy specifically, efforts to support exports are more significant for offshore wind, where the UK has more distinctive technological and economic expertise to project and enhance. The support covers promoting the UK supply chain, making links to new international partners and various forms of finance (see https://www.gov.uk/government/collections/offshore-wind-sector-export-help).

That said, given that the wind sector in the UK at present depends heavily on imported equipment and expertise, important substitution through more domestic control of the supply chain is arguably a more important agenda than export promotion.

10. Conclusions

At the time of writing, one can say the following about wind energy's prospects in the UK, based on current policies.

In the short-term, levels of new development of offshore wind are likely to become minimal, so long as no supportive remuneration regimes are made available. In England, the pro-local planning policy arrangements may even see older wind farms be removed as the original 25-year planning consents require renewals but do not receive them. Further expansion of offshore wind will occur, as Round 3 schemes compete with increasing success for CfD funding, and lower costs allow more capacity to be funded.

In the medium term, the prospects for further expansion of wind energy depend on potential policy shifts. The UK government has made positive noises about giving some form of market support for on-shore wind, where projects have local support, but it is hard to see that this will be major. Moreover, the UK government has sought to 'cap' overall expenditure on remuneration for low carbon energy. Arguably, as costs/MW reduce, high levels of financial support matter less than the way that, say, CfDs give some solidity to prospective income streams. Were there to be moves to devolve power over remuneration resources for renewable energy to Scotland, this might alter the picture. It also remains a problem that the UK government remains wedded to a very large programme of new build nuclear power.

What would help the economics of wind energy into the medium-long term, and enable more efficient use of wind resources, is progress with infrastructure for the storage and conversion of wind energy, balancing intermittency and helping to regularise income streams (Hvelplund and Djørup, 2017). This is occurring without policy support, with wind farm operators being a major source of new investment in battery storage. Further progress would arguably require much more action by municipalities and cities, which is occurring only patchily.

As above, the UK government's apparent determination to see more nuclear capacity installed is a limitation – political, economic and technical – to the creation of a more decentralised, in which more wind power, more diversely owned, plays an even larger role. It also matters what happens with the costs and performance of solar power, as these technologies have proven swifter and more straightforward to install than wind turbines.

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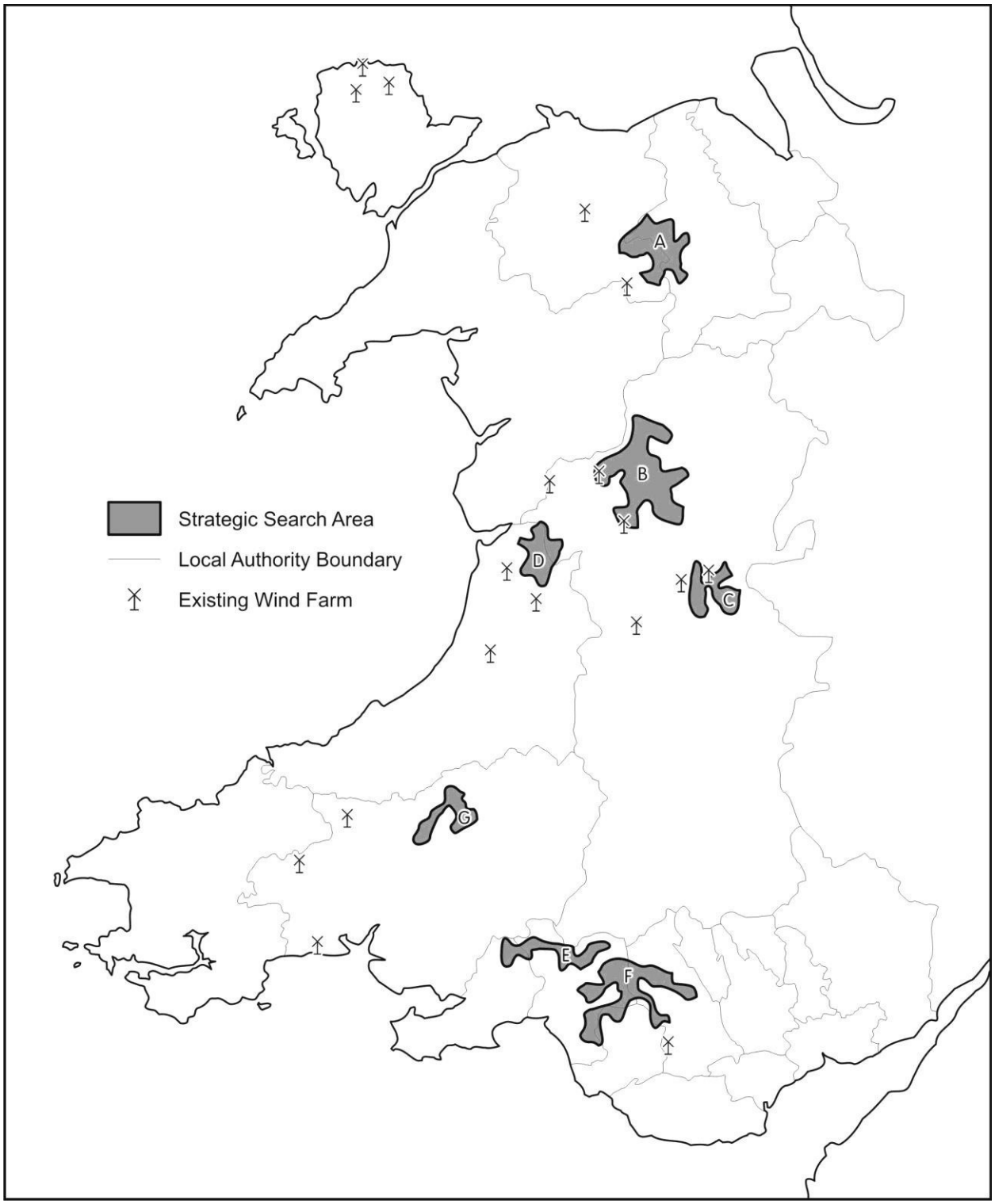
12. Appendix 1: Methodology for the strategic assessment of opportunities for major wind power capacity in Wales

Absolute constraints **i.e. affecting exclusion of an area from SSA**	Landscape designations: National Parks: Areas of Outstanding Natural Beauty National and international wildlife conservation designations: sites protected under EU wildlife legislation; Ramsar Sites; National Nature Reserves; Dyfi Valley Biosphere site; World Heritage Sites Residential areas: land within 500m of cities, towns and villages Minimum average wind speed below 6m/sec Ministry of Defence Tactical Training Areas and other installations Lakes and reservoirs
Localised constraints (within wind farm site but not affecting inclusion/exclusion from SSA)	Civil airports and airfields Meteorological Office radar Sites of Special Scientific Interest, Scheduled Ancient Monuments, registered historic parks and gardens and their settings Country Parks and Heritage Coastlines
Electricity distribution issues	Availability of spare grid capacity Likelihood of additional capacity coming forward
Additional criteria for area selection	Each area should have capacity for at least 100MW of onshore wind Contains at least two separate prospective wind farm sites; encompasses and/or is close to an existing wind farm 'Positive siting factors' – in single ownership, open access land Avoids National Park boundaries by 4km or more Significant areas with few, isolated dwellings
	Source: based on Welsh Assembly Government 2004; Cowell 2010

13. Appendix 2: Strategic Search Areas for Large-scale On-shore wind development



Source: after Welsh Assembly Government 2005.

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[ii]http://webarchive.nationalarchives.gov.uk/tna/+/http:/www.dti.gov.uk/renewables/publications/pdfs/windfs6.pdf/

[iii] See the following for more information - https://www.planningportal.co.uk/info/200130/common_projects/57/wind_turbines, accessed 21st October 2017.

[iv] The 'consent rate' is the percentage of applications that gain planning consent, usually measured as the percentage that gain consent at first attempt.

[v] In Scotland, Planning Inspectors are referred to as Reporters.

[vi] This was established in 2004 as an area beyond the UK's territorial waters that can be exploited for energy production. It is co-extensive with a previously defined area over which the UK exercised jurisdiction over marine environmental matters.

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