Peatland vulnerability to energy-related developments from climate change policy in Ireland: the case of wind farms

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SUMMARY

Ireland enjoys a wet and windy climate which is highly suitable for both peatlands and wind farms. There are currently 73 wind farms in Ireland, 39 of which are located on upland peatland - the oldest one on an industrially extracted blanket bog. The national and local (county level) policy in relation to wind farms is to promote renewable energy in order to decrease dependence on imported fossil fuels and to mitigate climate change by reducing carbon emissions from non-renewable energy sources, whilst taking account of statutory obligations for planning and sustainable development. Lessons learned from past developments and ongoing monitoring have been applied in adapting guidelines for planning authorities and environmental impact assessment. However, although the vulnerability of peatland habitats is emphasised in the guideline documents, wind farm proposals for sensitive upland peatland sites continue to appear. Any development that involves drainage and fragmentation of peatlands has irreversible impacts on these ecosystems. Furthermore, the perceived 'green profile' of wind farms means that they tend to be viewed in a different light from other developments. It is proposed that any development on the nationally and internationally significant peatland resource of Ireland should undergo rigorous examination and impact assessment, and that degraded peatlands such as the industrial peat extraction areas in the Irish Midlands be selected as alternative locations for wind farm development.

KEY WORDS: blanket bogs, industrial cutaway peatlands, renewable energy policy, wind turbines.

INTRODUCTION

Ireland has extensive oceanic peatlands of three different types, namely fens, raised bogs and blanket bogs. Around 17% of the country is covered by peatland with some parts having very high percentages, e.g. 62% for West Donegal (Hammond 1981). There are two sub-types of blanket bog, one (montane blanket bog) occurring in mountain ranges throughout the country and the other at low altitude in the west of Ireland (Atlantic blanket bog). The western areas are also the most exposed to the strong Atlantic winds. Indeed, Ireland's wet and windy climate is ideally suited for both peatlands and wind farms.

In the course of history, peatlands have shaped parts of Ireland very strongly, influencing rural economy and culture, settlement distribution and communications. On the other hand peatlands are themselves deeply humanised landscapes which have evolved, indeed sometimes originated, in close association with land use systems (e.g. tree clearance and the development of western blanket bogs). Human activities since prehistoric times have contributed to the current situation whereby only a relatively small amount of peatland remains in an *intact* or undamaged condition (Douglas *et al.* 2008) and most peatlands exhibit some level of degradation, from near-intact sites with marginal drainage to those that have been severely damaged by industrial peat extraction. The problems of peatland utilisation and degradation have far-reaching implications for Ireland's environment and socio-economic well-being. It is therefore extremely important that the best remaining examples are preserved and protected. These are issues that have been fully recognised by the Irish government who, *via* the Environment Protection Agency, is currently funding the BOGLAND project (2006–2009). The principal aim of the project is to generate a range of appropriate measures that the government will need to put in place in order to promote the sustainable management of the remaining peatland resource, in a manner which respects the positions of all stakeholders. In seeking to draw up effective management options, it is necessary to assess the different types of development that occur on peatlands in terms of the nature and magnitude of ecosystem impacts. Some types of development have caused serious degradation in the past, some are causing degradation at present (e.g. turf (peat) cutting, Wilson 2008), and others threaten to cause severe damage in the future (Jones *et al.* 2006). However, the most obvious pressures on Irish

peatlands have been linked to agricultural policy (overgrazing by sheep), forest policy (afforestation) and energy policy.

In view of recent European Union (EU) and national commitments to reducing emissions of greenhouse gases, a component of the BOGLAND project focuses in particular on developments that relate to new energy policy. Because there is a strong correlation between suitable areas for *climate-change alternative energy development* and vulnerable sensitive landscapes such as peatlands, this study seeks to assess both the benefits of renewable energy development, in particular wind farms, and the associated negative impacts on these ecosystems.

The first part of this paper presents an overview of policy relating to renewable energy (mainly wind) in Ireland and considers, using case studies, whether the location of wind farm developments on peatland is a potential environmental problem. It then outlines the current guidelines for planning and developing wind farms, and concludes with possible scenarios for the future of wind farms on peatland.

IRISH ENERGY POLICY

The EU is committed to reducing carbon emissions across the Member States by 20% on 1990 levels by the year 2020. It is also committed to a 30% reduction in the event of an International Agreement on Climate Change to follow on from the Kyoto protocol. The government confirmed the objective of the national energy policy (based on the Energy White Paper of 2007) as "an energy policy based on secure sources of supply that promotes competitiveness and is environmentally sustainable". This policy is being informed by a number of very significant developments in the policy environment, amongst which are: (1) the end of the era of cheap fossil fuels, especially oil; (2) a finite fossil fuel supply and (3) the need for action on climate change.

Ireland's Greenhouse Gas (GHG) emissions were 25.4% higher in 2005 than in 1990 (EPA 2008). In the same 15-year period, the Irish economy grew by some 150%. Currently, 91% of the country's energy sources are imported fossil fuels (the average import figure for other EU countries is closer to 65%). Nuclear energy is currently not a popular option in the Republic of Ireland, even though 0.17% of the country's electricity supply is nuclear generated and imported *via* an interconnector from Northern Ireland. The most important energy sources for electricity generation are gas (40%), coal (24%), oil (12%) and peat (9%). Dependence on imported energy will remain a feature of the Irish energy situation, despite the strong emphasis on self-sustainable targets and ideals.

In 2006, renewable energy generation in Ireland contributed 5% (on a primary energy equivalent basis) to the country's total energy requirements for the year. Wind energy experienced the highest growth, increasing by 46%. It is expected that, by 2020, 50% of the electricity supply will come from gas, 30% from wind, 8% from coal, 2% from peat, and the remainder from imported hydro-power. Carbon dioxide (CO_2) emissions *avoided* through renewable energy generation reached 2,188 kt CO_2 in 2006. The most significant contribution to this total was from wind energy (1,042 kt CO_2), followed by solid biomass (582 kt CO_2) and hydro-power (465 kt CO_2) (Howley *et al.* 2006).

The peak demand for electricity in Ireland is about 5,000 MW (SEI 2008). The 2007 *Policy Consideration for Renewable Electricity to 2010* of the Irish Government has an ultimate target to get 42% of its electricity from renewable sources by 2020, with an interim goal of 24% by 2010. To meet this target, about 800 MW of wind turbines have already been installed, and developers have or are expected to file applications to generate a further 3,700 MW of electricity from wind.

It is calculated that there is enough onshore-accessible wind to provide all of Ireland's electricity requirements (Graham Brennan, SEI, pers.comm. 2008). The island is one of the first landfalls for winds crossing the Atlantic, so wind hits harder and more constantly than in most other locations in continental Europe. The capacity factor for onshore wind turbines - the measure of how much of the time the turbine is actually generating power - is 35% in Ireland compared with 25% elsewhere in Europe. This means that electricity from wind costs about 6.2 euro cents per kilowatt hour which, when adjusted for risk, is less than the cost of gas-fired electricity (JCCNMR 2006). The cost of electricity generated by offshore turbines is about double this amount due to higher construction and maintenance costs. However, up to 30% more output can be obtained from offshore than from onshore developments due to the higher density of moisture-laden offshore air. Nevertheless, despite the apparently favourable wind regime, back-up power supplies are required to compensate when wind is not available.

Apart from providing electricity and reducing our dependence on imported fossil fuels, the main benefit from wind farms is to reduce carbon emissions in a bid to mitigate climate change. Reduction of carbon emissions cannot be achieved by a reduction in energy consumption alone and

shifting from non-renewable to renewable sources of energy is a key to addressing climate change concern.

WIND FARMS AND PEATLANDS

Ireland's exceptional wind resource is almost paralleled by its peatland resource. Both are often found in the same location as wind hits harder and more constantly in the west of Ireland and in the uplands where peatlands are situated.

The government-backed drive towards cleaner energy alternatives to fossil fuels has jump-started the country's wind power industry, and by January 2008, 73 wind farms had been constructed and connected to the grid since the first turbines began generating at an industrially cutover peatland site in Bellacorick (Co. Mayo) in 1992. Using the new peatland map of Ireland (Connolly *et al.* 2007), it has been estimated that 39 (53%) of these wind farms are located partly or entirely on peatlands (Figure 1). This proportion is likely to increase in the future as wind energy projects are targeted towards various types of peatlands on account of the following factors:

1. *Location*. Upland areas have higher wind speeds and most upland areas in Ireland contain significant portions of peatlands.
2. *Holding size/ownership***.** As the size of turbines increases (typically 100–150m in height), the size of an 'array' (the grid pattern of a large-scale wind farm) requires a very large area of contiguous land, ideally with as few owners as possible. Two ideal regions are: *uplands*, which are not subdivided for grazing, often on account of the presence of peatlands which are often jointly held as 'commonage' by a small number of farmers; and *lowland bogs*, which were acquired by the State during the early years of its existence and during World War II for industrial peat extraction to secure self-sufficiency in energy. In due time, up to 80,000 ha of industrial cutaway peatlands (mainly in large units) will be available for after-use options. Outside these two land types, it is a difficult task to assemble land holdings of sufficient size for large projects. This is because Ireland has a significantly larger proportion of very small land holdings than other EU member states and the pattern is generally most intensive (i.e. the greatest number of the smallest holdings) in those areas with the highest wind speeds.
3. *Land Cover*: Peatlands typically support the lowest-growing (generally less than 0.5 m tall) type of vegetation in Ireland. Such areas are generally characterised by low topographical variation. These conditions create little turbulence, which increases the potential energy capture by wind turbines.

The potential for wind farms and the added value of renewable energy generation has led to increased pressure on the peatland resource. The threat of wind farms to peatlands and hence to the Irish natural heritage must be placed in a national context of inadequate peatland protection and enforcement. Ireland is home to approximately 8% of the global resource of blanket bogs, and therefore has an important international role in conserving these habitats. Peatlands are designated under Annex I of the EU Habitats Directive, and a number of regulatory measures have been introduced by the Irish Government to control and limit further degradation. Of the original 1,177,670 ha of peatland in the Republic of Ireland, an estimated 21,519 ha of raised bogs (128 sites), 182,063 ha of blanket bogs (123 sites) and 20,000 ha of fens are currently included within Special Areas of Conservation (SACs) and statutory Natural Heritage Areas (NHAs) (Douglas *et al.* 2008). This total of approximately 220,000 ha of conserved peatland is less than 20% of the original peatland area. Monitoring of habitat condition has been initiated by the National Parks and Wildlife Service (NPWS) and the results indicate that despite designation and legal protection, there has been a significant decline in the area of active raised bog in Ireland in the last ten years (Fernandez *et al.* 2005).

A key conservation issue that affects the siting and layout of wind farms is the presence of designated nature conservation sites within sensitive peatland habitats. Wind farm developments have added pressure on sensitive upland areas which, due to gaps and inconsistencies in the designations of SACs and NHAs, may not have been surveyed or designated under the current list given to the European Commission. Evidence for such pressure can be found amongst the various recent planning applications for wind farm developments. For example, Leckanarainey Wind Farm was proposed for a location on intact montane heath and blanket bog on Arroo Mountain, Co Leitrim, an area designated not only as a SAC but also as an Area of Outstanding Natural Beauty (AONB) in the Leitrim County Development Plan 2003–2009. Nonetheless, Leitrim County Council's refusal of planning permission is currently being appealed. Similarly, Knocknagown Wind Farm is proposed for a location within Killarney National Park and MacGillycuddy's Reeks and Caragh River SACs. Thus wind farm developments on peatland illustrate the potential for inconsistencies and clashes between

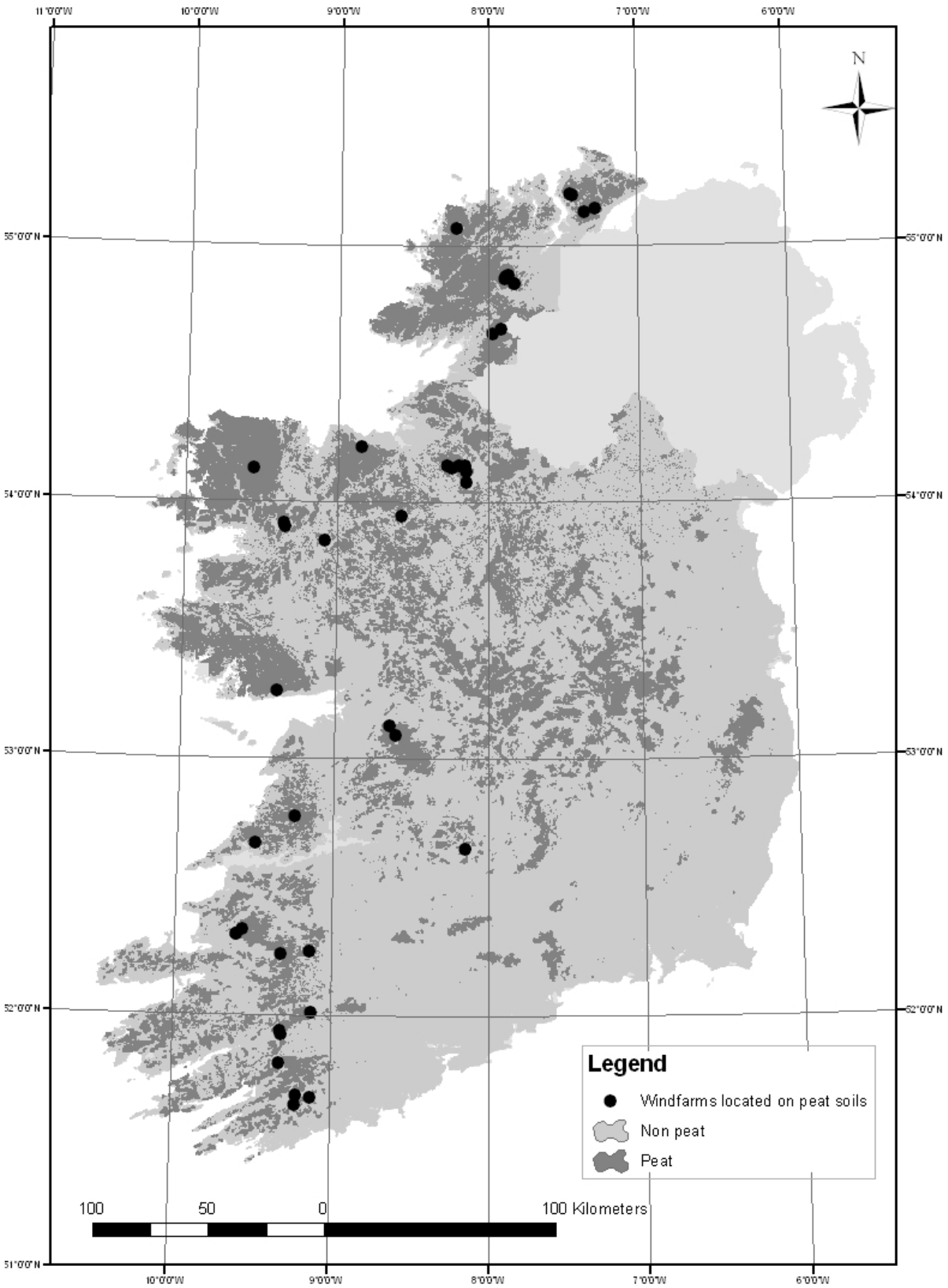

Figure 1. Distribution of *working* wind farms located on peat soils in Ireland in 2008

law (protection given to sites by EU legislation) and *policy* (government policy on rapid expansion of the renewables industry). There is a sense that the perceived green nature of wind farms allows them to be treated in a different manner from other developments, so that loss of peatland and peat-forming ecosystems may be overlooked in the greater scheme of the developer, planners and planning authority.

A review of the current guidelines for wind farm developments in Europe shows that the most significant impacts are those affecting the landscape (visual), noise effects, loss of habitat and impacts on breeding birds. In general, intensive developments such as wind farms in sensitive environments result in significant effects such as drainage, loss of habitat, fragmentation, loss of peat-forming function and soil erosion. Peatlands are vulnerable ecosystems that may be impacted significantly by wind energy developments due to disturbance and/or loss of habitat, resulting in the reduction or loss of biodiversity from ecosystem to species level. Relatively intact peatland sites are particularly vulnerable due to their dependence on high water tables. Degradation of the habitat will in turn affect the occurrence of species - not only flora but also, for example, birds which visit peatlands to breed, feed or roost (Bracken *et al.* 2008).

The area designated for peatland conservation mentioned above is a fraction of the original peatland area, and wind farm development on peatlands must be considered in the context of the continuing loss of peatlands in Ireland. The main causes of peatland degradation in Ireland are industrial and domestic peat extraction (for energy and horticulture), afforestation and agriculture (reclamation and over-grazing). Wind farms are an added threat to one of the most vulnerable habitats, namely upland bogs. These are already the most threatened by both overgrazing (Foss & O'Connell 1998) and afforestation - the latest inventory has shown that forests now cover 218,850 ha of blanket bog, and 29% of the total afforested area was on peat soils in 2006 (Twomey 2005).

Planning and siting of wind farms should not be overlooked simply because other threats to peatlands are of relatively greater significance. However, it must be noted that impacts from wind farm developments are relatively small-scale in the Irish context. Based on the megawatt outputs and average turbine rating, the current 39 wind farm sites that are located entirely or partially on peatland cover roughly 2,200 ha. It is generally acknowledged that the land area directly used and modified by wind farms is rarely more than 4% of the total site area, so that infrastructure for the 39 wind farms will occupy an area of around 88 ha. However, once a peatland is fragmented and drained, the effects often result in a larger impacted footprint and can be irreversible. But it is unwise to generalise about impacts without considering each particular site. There is a range of peatland types in Ireland, and each peatland has its own site-specific features and status. There is a scale of condition and thus sensitivity of peatland habitats, ranging from near pristine to heavily degraded. Intensive developments on degraded sites may have less significant effects with regard to some functions of the peatlands. Thus, the industrial cutaways where the peat has been largely removed could present a more robust receiving environment in terms of wind farms, or any development for that matter (see 'Future wind farm developments' below).

LESSONS LEARNED FROM ESTABLISHED WIND FARM DEVELOPMENTS

Since the early years of wind farm development in Ireland, their environmental impacts have been assessed and monitored. In 1996/7, a large wind farm (25 wind turbines, 7.5 km of new roadways) was developed at Barnesmore, Co. Donegal. The site is a blanket bog mountain plateau (300–400m a.s.l.), with high winds and high rainfall (>2000 mm per year), which was used prior to development for low-density sheep grazing and hand cutting of peat for fuel. The surrounding low-lying land had been drained and planted with conifers. After completion of the wind farm, a study was commissioned to investigate its effects on the general character of the land, addressing specifically the impacts of the construction on soil, hydrology and vegetation (Collins *et al.* 2000). The wind farm was located on a wet heath - blanket bog mosaic with a variety of types and thicknesses of peat. With the exception of very stony surfaces including vertical rock cuts, most of the newly-made and disturbed surfaces have weathered well and begun to merge and grow into their surroundings. Revegetation ensured early protection against erosion, but some erosion-sensitive areas remain at the turbine sites, where sheep were observed to congregate. Inadequate appreciation of the hydrological characteristics of water-saturated blanket peat in such a high-rainfall area has led to some problems and necessitated corrective actions. Some original culverts were inadequately sized, especially where roads crossed waterways or streams. In many locations at Barnesmore, water has failed to penetrate laterally through the broken-stone foundations of roads. Recommendations following this development

included the need for the developers to be aware of the botanical and hydrological composition of the peat and to involve soil drainage and ecological experts. It was also recommended that techniques for conservation and restoration involving careful retention of the surface layer of living vegetation as 'seed' material should be planned ahead (this was not done at this site); and that sheep grazing should be excluded from restored areas for at least three years after completion of works and controlled at no more than 0.2 ewe equivalent per ha for a further three years. The authors concluded that co-operation between the developers, planning and government agencies and other interested parties was successful at Barnesmore. This study and lessons learnt from it acted as a base from which suggestions and recommendations were incorporated into future developments in similar ecologically sensitive areas.

Despite the best efforts of NGOs and other parties, the number of monitoring programmes associated with either proposed or already built wind farms have probably been insufficient to ascertain the full impacts over a range of habitats, including different peatland types. While each new wind farm development provided deeper understanding of the issues concerned and potential difficulties, recommendations were not keeping pace with the rate of arrival of wind farms in the Irish landscape. However, many of these have now been fast-tracked in the aftermath of the massive bog slide at Derrybrien, Co. Galway, which occurred during construction of a 60 megawatt wind farm on forested blanket bog. The bog slide was initiated on 16 October 2003 on Cashlaundrumlahan Mountain (Slieve Aughty, Co. Galway) near Derrybrien and was reactivated following heavy rainfall on 28 October 2003. This was one of the biggest peat slides recorded, involving and estimated 450,000 m^3 of peat. A small landslide (3,000 m^3) had occurred at Derrybrien a few weeks prior to the *big* bog slide. On the same day, a small peat failure (15,000 m^3) occurred 4 km north of Cashlaundrumlahan in Sonnagh Old bog, a site where 9 wind-turbines had recently been established (Lindsay & Bragg 2004). In August 2008, a bog slide occurred after heavy rainfall in the area of Ballincollig Hill, in the Stacks Mountains, Co. Kerry. Investigations are on-going, but it seems likely that this is the fourth bog slide attributable to wind farm development on upland blanket bogs in Ireland.

Despite the relatively benign landscape in terms of geo-hazards, several people have died in Ireland due to landslides, the majority of which involved peat as the principal material (Creighton 2006). Indeed, bog bursts had been reported historically in the Slieve Aughty region prior to the 2003 events. The majority of bog slides have occurred on blanket bogs in the west of Ireland and in mountainous areas due to their particular topography, geology and hydrology together with high rainfall. They have been mostly associated with recent rainfall or melting snow with an increased likelihood of failure where the peatland has been disturbed, for example by burning, opening peat banks (Sollas *et al.* 1897, Tomlinson 1981) and installing drains parallel to the edge of the bog, or where natural internal peat pipes were present (Dykes & Warburton 2007, Long & Jennings 2006); and arise typically where a break of slope occurs at the edge of a blanket peat upland plateau (Boylan *et al.* 2008).

While a zone of weak peat and proximity of a natural drainage channel were contributory physical factors at Derrybrien, it was concluded that the activity associated with the construction of the wind farm was also a major contributory factor (AGEC 2004). While there were no human fatalities, the bog slide devastated located infrastructure and watercourses (it was estimated that 50,000 fish died as a consequence) and the event has received considerable media attention. The Derrybrien bog slide heightened public awareness of the potential danger of disturbing upland blanket bog and reminded the government of its duty to apply the precautionary principle and adopt new guidelines to prevent the recurrence of such an event. The precautionary principle is enshrined in the European Impact Assessment Directive (85/337/EEC, amended by 97/11/EC), which has been implemented in Ireland through its integration into the land-use planning consent system and other development consent systems. It provides for the Environmental Impact Assessment (EIA) process, whose primary objective is to ensure any project likely to have significant effects on the environment is subject to an assessment of the likely impacts. The European Commission brought an action against Ireland in May 2006, claiming that the government had failed to comply with its EIA obligations and alleging that "particular deficiencies" in relation to EIA at Derrybrien amounted to "a manifest breach of the Directive". The lessons learnt at Derrybrien initiated the development of comprehensive guidelines for the development of wind farms in Ireland.

DEVELOPMENT OF GUIDELINES AND POLICY FRAMEWORK

In June 2006, the Department of the Environment, Heritage and Local Government published its Wind

Energy Development Guidelines (DOEHLG 2006), which supersede the 1996 Guidelines. These new guidelines are designed to 'ensure a consistency of approach throughout the country in the identification of suitable locations for wind farm development and the treatment of planning applications for wind farm developments.' The relevant European and national documents that the guidelines draw on include: *The National Development Plan (2000-2006), Sustainable Development: A Strategy for Ireland (1997),* the EU *White Paper on Renewable Energy (1997),* the *Green Paper on Sustainable Energy (1999),* the *Electricity Regulation Act of 1999* and the *National Climate Change Strategy (2000)*. These new guidelines are now used by all County Council Planning Authorities who are required to produce their own County Wind Strategy whereby suitable areas for wind farm development are identified. The trend remains to locate wind farms on upland sites where the wind regime is naturally better and where there are only a small number of registered owners. Planning applications for wind farms generally involve pre-planning consultation in addition to Environmental Impact Assessment (EIA). This procedure is required for wind energy developments that contain more than five turbines or output more than 5MW. However, the Planning Authority retains the option to request an EIA for smaller wind farms if they believe significant environmental impacts may result. The content of EIA documents *generally* follows the guidelines developed by the Environmental Protection Agency (EPA 2003). The 2006 Planning Guidelines contain an Appendix 4 on 'Best Practice for Wind Energy Development in Peatlands'. This gives additional special construction guidelines developed from monitoring of past projects and lessons learnt from others. These include the requirement to carry out an assessment of peat stability, the methods for which have been comprehensively researched in Ireland in the last three years (Boylan *et al*. 2008). Further changes in legislation should ensure that wind farm schemes fully integrate environmental concerns into their planning and operation ensuring their sustainability and harmonisation into the National Biodiversity Plan being developed for Ireland. Further plans should be assessed using the EIA/SEA model.

Interestingly, off-shore wind farms (*and all off-shore developments*) are excluded from the provisions of the Planning and Development Act 2000. They are subject only to the Foreshore Acts of 1933 which ultimately give full power to the Minister of Marine to award foreshore leases for construction off Ireland's coasts without statutory involvement of local authorities and with no right of appeal. Reformation of the Act will be required to safeguard marine ecology before new price supports for off-shore are introduced for wind farm developers so that EU levels of protection for the marine and coastal environment are observed.

Wind farm developments on afforested peatlands remain questionable. While restoration works have been carried out to bring back several bog ecosystems from past afforestation, it is recognised that some sites have gone *beyond* the point of restoration because all characteristic 'bog' features have disappeared (Coillte 2008). On the other hand, these new peatland forests have created new habitats in the Irish landscape with their own associated biodiversity (Feehan *et al.* 2008). In some cases, their demise (i.e. removal of the trees) would involve a second generation of habitat loss and would also threaten protected species, for example hen harriers. It is also well acknowledged that removing forests from peatlands can lead to several ecological impacts, for example water quality issues from leaching of nutrients and impacts on salmonid habitats (Farrell 2007, Renou & Farrell 2005).

FUTURE WIND FARM DEVELOPMENTS ON PEATLANDS: INCREASE THE BENEFITS AND REDUCE THE RISKS

The case of wind farm developments goes beyond the simplistic development/conservation binary argument so often invoked in environmental debate because it is hoped that the generation of renewable energy will help avoid some of the effects of climate change. Planning Authorities are asked to consider the development of wind energy projects, including those proposed for designated areas, in view of their strategic importance in contributing significantly to the achievement of targets set out in the National Climate Change Strategy. In all cases the environmental benefits of utilising a natural resource are stressed to outweigh potential negative impacts, once best planning practices have been employed.

It should be reiterated that the main benefits from these wind farm endeavours are (1) a reduction of Ireland's dependence on imported fossil fuels and (2) carbon emissions savings. Wind farm developments should be expected to save carbon emissions by offsetting fossil energy sources. Therefore, these savings should be greater than the carbon lost by (1) the elimination of the natural functions of peatland (carbon sequestration and storage) and (2) the building and maintaining of the wind farm. Opinions differ as to how degraded a

peatland will become and how much carbon will be lost depending on location, management practices and timescale; whereas carbon lost through the production and running of the wind farm are more easily estimated. So far, calculations show that carbon losses do not exceed the carbon savings except in worst-case scenarios involving extreme erosion and landslides (Couwenberg & Joosten 2007). Models have been created showing that good management practices can be used to minimise the carbon loss (for example by restoring the site) and even ameliorate carbon stores (by improvement of habitat) (Nayak *et al.* 2008). This *carbon saving* benefit could also be augmented if the development takes place on degraded peatlands (for example hand-cut cutovers and industrial cutaways) which have been found to release carbon already (Wilson 2008, Wilson *et al.* 2007). Industrial cutaway bogs in particular may provide a welcome option for wind farm developers. These areas are heavily exploited and present intensively managed sites that cover extensive areas and are also generally located in relatively remote areas. Bord na Móna (the Irish Peat Board) is developing a number of applications for wind farms on industrial cutaways in the Irish Midlands. Even though the wind regime is not as favourable as on the uplands or west coast, improving turbine technology should make the proposed wind farms viable. Planning permission has already been granted for one of the 'largest land based' wind farm in Ireland on the former Bord na Móna Oweninny Works in Co. Mayo. This will supply up to 320 MW to the National Grid. The planning application was developed to take cognisance of the rehabilitation programme developed on the cutaway to promote the re-establishment of semi-natural wetland and peatland habitats (poor fen and rudimentary peat-forming communities) (Farrell 2004). This rehabilitation could further contribute to carbon savings by increasing carbon sequestration (Wilson 2009) while improving other functions of peatlands that had been lost through past disturbance.

Energy generation is a complex issue and while a series of targets and ideals have been set by the Irish Government, these will continue to be influenced as the realities of climate change and the responsibilities of individual nations in terms of carbon become more apparent. Carbon politics and penalties along with growing and developing economies will have a considerable effect on the future. The implementation of a global trading mechanism for carbon credits means that peatlands (a huge carbon store) have now been identified as a valuable economic resource. Wind energy is seen as a key element in providing environmentally friendly energy for the Irish nation, particularly as there is such a favourable wind regime in Ireland, both land based and more particularly off-shore.

However, wind farms are and will remain highly controversial and divisive, especially on vulnerable sites such as peatlands. Wind farms on peatlands have neither been properly investigated at a wider physical scale nor monitored long enough to assess their full impacts. Wise planning and knowledge based assessments can mitigate harmful effects, however. The avoidance of large scale peat erosion and bog slides by adequate assessment methods, which are being continuously developed, is critical to future careful planning. The use of larger turbines has also been advocated: they are much more widely spaced - typically on 300 to 500m grids - and capture energy with a much smaller spatial 'footprint' than smaller ones. Furthermore, developments that utilise existing roads, substations and transmission lines give rise to less new or additional environmental disturbance than those that require new infrastructure. Avoiding deep peat areas should also reduce risks. Much of the potential for environmental effects also rests with the quality of the detailed design, specification and project supervision during both construction and installation. In the case of peatlands, the developer should retain the services of a peat soil and a peat ecology expert for the duration of the project. In general terms larger organisations are more likely to have the technical and personnel resources to achieve the necessary standards than smaller development companies. This does not, however, preclude the development of small scale community energy producing schemes managed at a county level which may encourage more far-reaching environmental and political sustainability.

There is a need to ensure that potential pressure is differentiated from likely or significant pressure by careful discrimination between different types of peatland environments. Hence the need for an assessment and identification of exclusion zones that safeguard conservation and protection of sensitive peatland habitats. The assessment should reflect the work and recommendations of the National Parks and Wildlife Service in habitat assessment surveys for Natura 2000 sites. It should also reflect the recommendations of the *Wise Use Guidelines* of Joosten & Clarke (2002). In summary, the main issues to be considered for any peatland site are:

1. *Significance*: type of peatland, extent/scale of the habitat on its own or as part of a complex or corridor; scarcity of species or conditions (e.g. iron fens); role as a resource for species; role in other beneficial uses such as scenery and water

quality protection.
2. *Condition*: condition assessment; degree of degradation and the potential for rehabilitation and/or restoration.
3. *Location:* proximity to existing infrastructure such as roads, power lines and substations.
4. *Socio-economic*: the role of the peat resource in economically sustaining human communities.

CONCLUSION

This article has examined wind farms as one of the energy-related developments with potential to facilitate delivery of our obligations under climate change policy in Ireland, in the context of their interactions with peatland ecosystems. Our main conclusions are as follows:

- Wind farms have been proposed for upland sites in Ireland because of the more favourable wind regime, the remoteness of the sites and the opportunity to deal with extensive landscapes whose ownership is in the hands of relatively few individuals.
- Wind farms on relatively intact and vulnerable upland sites have irreversible ecological effects. Even though the infrastructure footprint can be relatively small, drainage and fragmentation effects can affect a much larger area.
- Wind farms in Ireland are perceived as environmentally friendly and this perception has often contributed to conflicts in the appraisal of the type and nature of their impact.
- An assessment of peatland habitats, and a value rating system to highlight potentially suitable (and unsuitable) areas is required. Peatlands such as industrial cutaways are less vulnerable to development effects.
- Guidelines for wind farm developments should be continuously reviewed and developed as monitoring projects provide information from the most critical sites.
- Vulnerable peatland ecosystems (intact, near intact and designated areas) should be excluded from proposed developments. Industrial peat extraction areas, on the other hand, are probably relatively suitable. They are generally already close to established high voltage lines and key areas within the national electricity supply grid. The rehabilitation of these industrial sites could, with a perceived green energy option, provide a dual benefit in terms of biodiversity and so-called 'climate friendly' energy generation.

Wind farms provide renewable energy and so should help alleviate climate change. However, developments on peatland may interfere with important peatland values, and this is one of many issues that need to be considered in formulating a management policy for Irish peatlands. This study complements the reviews of other developments on Irish peatlands that need to be considered critically if a framework for a national peatland policy is to be proposed as part of the BOGLAND project.

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