GP WIND

Thematic Case Studies

18 November 2011

Case Study theme 1 - Species impact offshore and onshore

The main barrier
Legislation in all EU countries protects most animal species or regulates their harvesting; usually provides special protection for rare species and for important elements in the ecology of species such as migration routes; and requires assessment of potential environmental impacts of developments. At EU level the main relevant legislation is the Strategic Environmental Assessment (SEA) Directive, the Habitats Directive and the Birds Directive, and regulations regarding Natura 2000 sites; see official EU Guidance on wind energy development in accordance with EU nature legislation. These make reference to the IUCN Red List of Threatened Species.

Public concern on this issue is often considerable. As a result of these factors, concerns about species impacts are among the commonest causes of delays to or refusal of planning consents for wind turbines.

Case study purpose
In this case study we examine the ways in which wind farms impact on species, provide selected examples of good practice, and discuss lessons that can be learned from earlier wind power developments. We also outline some common misconceptions. The purpose is to reduce the potential for conflicts from this cause, which in turn will save time and money through reducing or preventing delays and planning refusals.

Case study research methodology
The case study was based on a review of the scientific and technical literature, and consultations with stakeholders on key issues, examples of good practice, and lessons learned.

Key issues identified – Wind turbines can affect species in several ways, most usually:

Adult white tailed eagle killed in collision with wind turbine

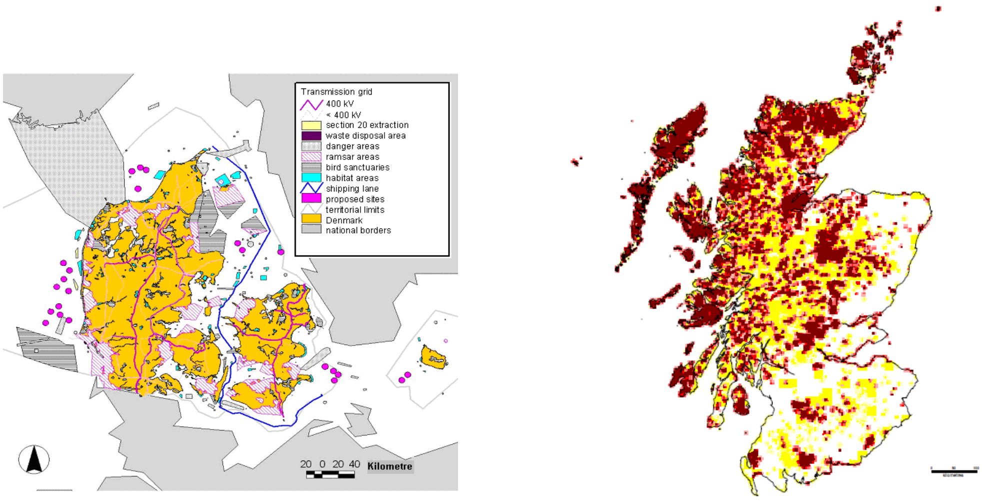
- Direct mortality of birds and bats through impact with turbines, or the effects of air turbulence behind turbines. This has proved to be particularly significant for some species of large birds of prey (Camina 2011; Nygård et al 2011; Munõz 2011), which can be very vulnerable to collisions, breed only slowly, and are often uncommon or rare. There is also concern for certain species of seabird based on their ecology and flight patterns.
- Damaging, destroying, creating, or significantly modifying habitat used by certain species, e.g fish and benthic communities; see also (here; theme 2)
- Complete or partial avoidance of wind turbine arrays and their vicinity by certain species, e.g of seabird, upland birds, and sea mammals making the habitat unsuitable, or less so; and/or forming a barrier to migration.

The existence and scale of collision and displacement effects are highly variable depending on the location of the wind turbine development and the species involved. Recent research indicates EIA methodology currently applied is a poor predictor of actual mortality from this cause and that the exact siting of individual turbines, as well as of the whole wind farm, is an important factor (Ferrer et al 2011; see also below). Wind turbine developments in urban areas do not usually have significant problems, while developments near to or within concentrations of vulnerable species frequently experience real negative impacts on wildlife, causing significant problems in the planning process and/or with the operation of the turbines. These can significantly raise the cost and time required for the planning process, increase the running costs of a completed wind farm, and negatively affect the general level of acceptance for further wind power development.

Examples of good practice

Red-throated diver. Data from Denmark indicates that this species avoids offshore wind farms almost completely, though the same areas were favoured habitat before construction. Certain species of seabird are, however, unaffected by or attracted to the wind farm areas.

- Indicative advice and/or planning – Considerable experience indicates that the planning process can be made more rapid, and less expensive for all concerned, if areas of potential conflict, and those where conflict potential is low, are mapped at a regional or national scale. This allows developers to target at an early stage areas with good wind resources, but which are unlikely to encounter major species impact objections. Examples include indicative planning for Denmark offshore (Danish Energy Agency); advisory work for Britain offshore produced by the COWRIE project; the Irish offshore SEA (currently in preparation); and the advisory map of bird sensitivity, Scotland onshore, produced by an RSPB/SNH/Scottish Government joint project.

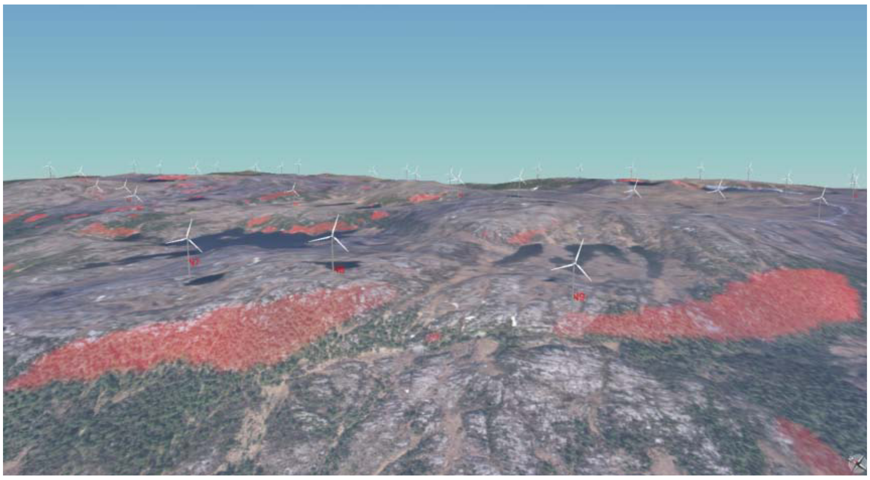


Danish indicative planning map for offshore wind power development; RSPB bird sensitivity advisory map for onshore wind power development in Scotland

- Clear and good quality Environmental Impact Assessment (EIA) standards. Clarity is important so that developers and other stakeholders know what must be assessed. Quality is important so that the results are less likely to be challenged during the planning process, causing delays, costs, and possible refusal of consent. Examples of such standards are the Danish and Scottish EIA standards
- Guidelines from expert organisations to assist with assessment of particular species groups, such as the UNEP guidelines for bats (Rodriguez et al 2008)
- The mitigation hierarchy is widely regarded as best practice; its application is required in some legal jurisdictions. Efforts should first be made to prevent or avoid impacts; then to

minimise and reduce any unavoidable impacts; and then to repair or restore any unavoidable adverse effects. Any significant residual effects should where possible be addressed via 'offset' in order to achieve 'no net loss'. If an offset is not possible, some other form of mitigation may be required. N.B. The Habitats Directive *prohibits* causing negative impacts to the species and habitats listed in the Directive except in certain exceptional circumstances of overriding public interest, which must be clearly demonstrated (Article 6.4).

- Potential for conflict by bird strikes and by habitat loss may in some cases be mitigated by creating attractive habitat for the vulnerable species nearby, to compensate for habitat loss and/or to reduce use of the wind farm area through providing an attractive alternative. A good example, with initially promising results, is the Beinn an Tuirc golden eagle habitat offset
- Micrositing. Small adjustments to the siting of individual turbines may have a large impact on the incidence of, e.g. bird strikes (Ferrer et al 2011). Many large birds, for example, use 'hangwind' areas where air rises over a ridge, to gain height. Avoiding the immediate area of such hangwind sites by micrositing, even by a few tens of metres, as proposed for the Hitra windfarm extension in Norway (see English summary and Figure 31), may reduce considerably the degree to which flight paths of these species and wind turbines overlap.



Example of micrositing planning. 'Hangwind' areas likely to be used by birds, especially birds of prey, for soaring are marked in red, and the original planned position of turbines indicated.

- Habitat management. Intelligent management of the habitat in and near windfarms can reduce bird strike risk. For example, in Germany the uncommon Montagu's harrier hunts on farmland and prefers short grass for hunting. By harvesting grass in fields with turbines last (the fields are cropped for hay anyway), the birds are in the early part of harvesting concentrated away from turbines, and the wind farm is never especially attractive.
- Minimization and real-time monitoring procedures at the Barão de S. João wind farm in Portugal. This coastal wind farm lies on a major international migration route for a number of species of large soaring birds, including the griffon vulture (*Gyps fulvus*), which is known to be very vulnerable to turbine collision mortality on migration (as at Tarifa in Spain, see Munõz 2011). Radar and observation are used to temporarily shut down turbines when migration flows at turbine blade heights are high (typically in light winds, <5m/s). In the first full year of implementation (2010) the total equivalent shutdown period was 4.3 turbine days, corresponding to production losses of *ca* 2%. There was zero mortality of soaring birds despite >30 000 recorded movements through the wind farm area.

Part of a griffon vulture flock migrating past a temporarily shut down wind turbine at Barão de S. João wind farm, Portugal Photo: Alexandre H. Leitão /STRIX

Example of lessons learnt

- Smøla, Hitra and Frøya are three large islands lying off the coast of mid-Norway. Norway's first large scale wind farm was constructed on Smøla, in an area with a high density of breeding white-tailed eagles. Collisions with turbines were soon noted and between 4 and 11 eagles have been confirmed killed each year since the wind farm opened in 2005. Deaths of the Smøla subspecies of willow grouse and a variety of other birds in collisions have also been a concern. Statkraft (the developers) and the authorities instituted a major research programme which has informed the placement and planned expansion of the Hitra wind farm, and the authorities have placed a moratorium on development at Frøya, an island very similar to Smøla, pending the results of the research programme. Major wind power developments currently in the planning process in the region are at sites of similar power generation potential, but away from the immediate coastline in areas much less vulnerable to bird strike dangers (and not visible from major tourist routes along the coast). Impacts on birds have not therefore been significant in the formal planning process at these sites.

Smøla wind farm

Implications for policy and practice

- Attention to potential species impacts before the formal planning process is begun, and appropriate siting based on such knowledge, is clearly the most important method by which conflicts can be avoided or reduced and the planning process speeded up. Developers also benefit by avoiding long, costly, and possibly unsuccessful planning inquiries if otherwise similar sites in wind energy yield terms are available. Early scoping on a regional or national scale is the primary method by which this can be achieved. The factors involved are often species specific; for example the apparent considerable differences in avoidance behaviour by golden eagles and white tailed eagles indicate the need to avoid generalising too easily across species. The degree to which a given measure is replicable in a different situation also needs to be carefully assessed.

- Further research on collision vulnerabilities, findings of which are translated into EIA methodology requirements, is required. It appears that there is potential for micrositing to strongly affect collision vulnerability, and so by good micrositing to reduce potential for collisions, and so the planning delays and/or consents refusal from this cause.

- Political will to provide clear and credible indicative planning guidelines to developers and other stakeholders is the most important factor in reducing the potential for concerns about wildlife impacts to affect wind energy development. EIA requirements for assessing species impacts need to be clear, transparent, and credible, for example the German Standard for Investigation of the Impacts of Offshore Wind Turbines on the Marine Environment (Bundesamt für Seeschifffahrt und Hydrographie 2007). Mitigation schemes should be carefully planned and species-specific, employing specialised knowledge of the behaviour of the species in question and should be assessed after they are implemented to check whether they have been effective. These measures also reduce costs of, time required for, and the potential for refusal of, planning consents in the formal planning process.

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EU Directives

Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (Habitats Directive)

Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (Birds Directive)

Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment (SEA Directive)

Case Study theme 2 – Impact on habitats

The main barrier
The EU Habitats Directive protects over 200 habitat types of European importance, and national/regional law often also protects certain habitats. Wind farms may produce short, medium and long-term negative impacts on environments, habitats, biotic communities and species which can impact the consenting process. It is possible to distinguish two types of impact:

- Direct: habitat loss and destruction; soil erosion. Indirect: Loss of available habitat due to fragmentation and disturbance-displacement of (species) individuals.

When assessing the suitability of a potential site it is important to identify the direct and indirect impacts on the habitat which may be caused by the project both during construction and during operation. Examples of impacts during construction phase include:

- Permanent destruction of vegetation in the area of the foundations, assembly area, underground services and roads.
- Cutting, felling and moving of tree species, with the associated risk of destruction of nests or nesting sites or the diversion of trophic (nutritional) sources;
- Removal of deadwood substrate trophic for protected invertebrates (e.g. *Lucanus cervus, Cerambyx cerdo*);
- Disturbance or destruction of sensitive habitat types such a peat.

Examples of impacts during the operational phase include:

- Ongoing loss of food sources that would have been produced by plants that have been destroyed
- Drying of peat and resultant habitat degradation arising from hard infrastructure – access roads and turbine foundations.

The areas identified as suitable for wind energy installations are often undeveloped and difficult to access. Therefore all kinds of associated works such as road and tracks construction, grid connection, may occur, that represent a potential impact on the habitat. This motivates the development of measures to overcome, minimise and mitigate adverse effects.

Case study purpose
This thematic case study's main objectives are to ensure a sharing of knowledge, to identify good practice and identify lessons learnt in relation to impacts on habitats and underline the attempts already made to overcome the barriers presented by such impacts.
The examples of successful cases represent an important point of reference to overcome barriers across Europe. On the other hand the lessons learnt identified below will present examples where the approach to the issue was not appropriate in the hope that others may learn from them.

Case study research methodology
The case study was based on a review of the scientific and technical literature, and consultations with stakeholders on key issues, examples of good practice, and lessons learned.

Key issues identified
Given the widespread deployment of onshore wind, often in sites of great aesthetic value and environmental sensitivity, there is concern regarding the potential environmental impact from construction and operation of wind turbines on habitats.
The type and scale of impact is very much dependant on the habitats involved, and their ecology and state of conservation; as well as the location, size and design of the wind farm plan or project.

Impacts may not be confined to *habitat loss,* but may also include *habitat degradation.* The scale of direct habitat loss resulting from constructing a wind farm and associated infrastructure depends on the size, location and design of the project. Whilst the actual land take may be comparatively limited, the effects may be more widespread where developments interfere with hydrological patterns or geomorphological processes. The significance of loss depends on the rarity and vulnerability of the habitats affected (e.g. blanket bogs or sand dunes) and/or of their importance as a feeding, breeding or hibernating place for species, especially for species of European conservation concern. Peatlands in particular can be damaged by the inappropriate siting of wind farms or their associated infrastructures, such as new or improved access roads. The damage is often caused because developments have not taken sufficient account of the underlying hydrology of the peatland. So, whilst the actual amount of peat lost may be small, the damage caused to the natural drainage system of the peat (for instance through drainage ditches etc.) may have repercussions over a much wider area and can ultimately lead to the deterioration of a more significant area of peatland and other related habitats, such as streams and other water courses located down-stream.

Examples of good practice

1) *The 1.7 MW "Pian dei Corsi" windfarm in the municipality of Calice Ligure (Savona, Italy)* has been in operation since 2004. Extending an existing well-sited windfarm may in some circumstances be more acceptable environmentally, as well as more economic, than developing a new site. The protection of habitat was guaranteed primarily by the adherence to a methodology used for the site selection. In the Region of Liguria it is necessary to verify the consistency of the wind farm with a two-level Planning Reference Framework.

Some of the precautions taken during the implementation process of this project include:

- Preventing damage to roots and foliage of trees by means of a solid fence to demarcate working area;
- Restoration of existing vegetation through temporary removal and later replacement of turf and shrub and tree planting. Removed vegetation was conserved in a nursery site prior to transplantation. Nursery stock was also grown to integrate with the vegetable material removed temporarily from the site
- Removal of grassy earth balls from the area before the start of the works which was then conserved in the nursery and then laid for another naturalistic engineering project restoring the scarps (cliff);
- *Leucojum Vernum* bulbs (snowflake) were used for the regeneration of excavated areas
- Such mitigation measures help safeguard and preserve rare and protected species such as *Aquilegia atrata*, *Leucojum vernum, Erythronium dens-canis, Orchis (Dactylorhiza) maculata.*

Nevertheless, the principal habitat impact during the operational phase was:

- Durable habitat loss, including removal of mature beech trees during construction of services and turbine foundations.

Measures taken to overcome identified potential adverse effects at Pian dei Corsi include:

- Use of wind turbines at low rotational speed settings: the generator OptiSpeedR allows a variation of the turbine rotor speed between 14 and 31 revolution per minute;
- Burying cables, following line of existing road and, elsewhere, selecting shortest possible route to connect to the electricity grid to minimize impact;
- Close tower spacing (as consistent with power generation considerations) to reduce windfarm area;
- Reuse of the existing access road from phase 1 of the project;
- Recovery of removed or damaged plants during the construction work and returning them to their original position at the site.

2) *Wind energy development on peatland habitat in Scotland.* Often the ideal location for onshore windfarm development in Scotland, in energy terms, is on upland peatland blanket bog or carbon-rich soils but the installation of turbines and service tracks can degrade the peat resources leading to habitat damage and carbon losses. Efforts have been focussed on designing, locating and

constructing windfarms in ways that avoid sensitive areas of peatland habitat as well as ensuring that peat carbon losses are minimised. In addition to this, wind energy developers have played a major role restoring previously damaged peatland habitat.

Guidance such as the 'Windfarm and peatland good practice principles ' and 'Environmental good practice during windfarm construction' are important in ensuring that standards of best practice are adhered to during windfarm construction and management. The Scottish Government has also developed a carbon calculator (see also Thematic Case Study 6) to assist developers in calculating the impact of wind farm developments on the soil carbon stocks held in peats.
There is a significant landslide risk when developing on peat slopes. The Scottish Government's Peat Stability Guidance is widely regarded as best practice in preventing landslides, which can cause major ecological damage with attendant financial risk to developers (see below).

4) *Scotland: Sectoral Marine Plan for Offshore Wind in Scottish Territorial Waters – Habitats Regulations Appraisal.*
Marine Scotland, under the Conservation (Natural Habitats, &c.) Regulations, was required to undertake a Habitats Regulations Appraisal (HRA) of the Sectoral Marine Plan for Offshore Wind to determine whether it would have a 'likely significant effect' on sites designated for their nature conservation interest at an international level. This requirement extended to Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Ramsar sites. The HRA was carried out for the short and medium term options identified within the Plan.

The HRA process can most easily be summarised as following three steps:
Step 1: Identifying (screening) the relevant species and habitat features of theEuropean/Ramsar sites that need to be considered in the assessment;
Step 2: Identifying which of these species, habitats and European/Ramsar sites can be excluded based on the 'initial' mitigation measures that are proposed in the Offshore Wind Energy SEA Environmental Report. It is worth noting that throughout this HRA there was a presumption in favour of including not excluding sites, in keeping with the precautionary principle;
Step 3: Undertaking an Appropriate Assessment (AA) to determine whether the draft Plan will affect the integrity of these sites and what additional mitigation measures are required to avoid any such effects.

5) *"Terpandros" and "Antissa" Wind Parks in Lesvos Island, Greece*
The construction works were launched in October 2002 and the development became operational in February 2003. The produced electricity amounts to 24.000 GWh per annum with 9.0 m/sec average annual wind speed.

Factors that have led to success:
- Harmonious integration of wind parks into the local natural environment
- Compliance to legislation
- Developer's proactive approach towards preserving and enhancing the local ecosystem: As fossils were revealed during the construction works, extensive excavations took place and led to the discovery of further fossils, which constitute a new core of the Petrified Forest.

Example of lesson learnt

Derrybrien peat slide (Ireland, ECJ C-215/06)

In 2003 a landslide occurred during the construction of a wind farm in Ireland. An estimated 450,000 cubic metres of peat was dislodged and 50,000 fish died from the resultant river pollution. The European Commission brought a case against Ireland and the European Court of Justice (ECJ) made a judgment against the defendant. Two further landslides occurred in 2008 resulting in further prosecutions.

Ireland was found to have failed in its environmental obligations as a proper environmental impact assessment should have been carried out before this wind farm was consented. The Irish Government argued that the peat slide was caused by poor construction work as a contractor had been prosecuted and convicted by the District Court for a practice adopted during construction. However, the court determined that the slide occurred because a proper Environmental Impact Assessment (EIA) had not been required in Irish planning processes at the time. It was possible for developments being carried out without full planning consent to apply for retrospective permission after or during completion, even in cases where an Environmental Impact Assessment should have been carried out beforehand. The court ruled that retrospective permission can be granted only in exceptional circumstances and argued that the application of Irish law was too loose. Consenting guidelines specifically for wind energy in Ireland were published in 2006, two years prior to the judgment in this case.

The case demonstrates that is important to identify the direct and indirect impacts on the habitat which may be caused by the project during construction and operation phase.

Implications for policy and practice

- In view of the potential impacts of wind farms, and the unique characteristics of each potential site location, it is recommended that the Applicant, prior to commencing the Environmental Impact Assessment (EIA) procedure, considers and screens the critical relevant habitat impacts. In fact, the identification or presence of critical environmental conditions on the site suggests the necessity of a procedure for special assessment or a more detailed focus. It is important also to take in consideration similar approaches by other windfarm developers. In some cases this may conclude that the area may be considered inappropriate for the installation of wind turbines. In others it may conclude that impacts will be minimal or can be mitigated satisfactorily.
- Governments should work with the renewables industry to improve understanding of the impact of windfarms on habitats and recommend the development of Government or EU good practice guidelines on windfarm construction, particularly in relation to sensitive habitat types.
- The adoption of these guidelines by windfarm developers and every reasonable effort should be made to avoid significant adverse environmental effects on sensitive habitats. Agreements should also be reached through full and open stakeholder engagement to ensure habitat restoration is properly planned and managed.
- Technical guidance on landslide hazard risk assessment, particularly but not only on peatlands; and clear guidance on how conclusions of risk level should be arrived at, is needed

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http://www.scotland.gov.uk/Publications/2006/12/21162303/1

Thematic Case Study 3 – Biodiversity

The main barrier
Although evidence shows that in general wind energy does not represent a serious threat to biodiversity, poorly designed wind farms or those sited in the wrong place can pose a potential threat to vulnerable species and habitats. Failure to properly consider impacts on wildlife and biodiversity within an environmental impact assessment will cause delays in the planning and decision-making process and could slow, or even prevent, a proposed development. Issues which may arise around belatedly identified impacts on biodiversity could affect the viability of operational windfarms.

The most relevant EU Legislation and advice is that which concerns Natura 2000 sites, including the Habitats Directive and the Birds Directive - for advice see Wind energy development and Natura 2000. Wind farm proposals must consider impacts on European Natura sites, and planning authorities must undertake appropriate assessments to establish if the proposals significantly affect these. Where authorities fail to do so, or where a development goes ahead in contravention of Natura legislation future viability of the development could be at risk and the Member State could face infraction procedures.

Case study purpose
This thematic study examines the issue of biodiversity, i.e. the variety of life in the world or in particular habitats or ecosystems. It is likely to be of most use to regulating bodies and developers. The study identifies selected examples of good practice, lessons learned from existing wind power developments, and highlights studies and practices available on the subject. The purpose of the study is to identify guidance which can assist appropriate windfarm development, to collate evidence, and to make information broadly available in order to reduce the potential for future barriers to deployment, or negative effects on viability of developments after construction, arising from negative impacts on biodiversity being identified. By highlighting good practice the study can prevent delays in planning processes, save time and money and increase the likelihood of applications achieving consent.

Case study research methodology
This thematic study was undertaken by reviewing existing papers and case studies from stakeholders, and in consultation with Scottish Natural Heritage (SNH), with a view to drawing together the issues which Wind Energy presents for biodiversity and identifying areas of good practice and best advice.

Key issues identified
The main impacts from onshore windfarm developments on biodiversity are, for habitats, loss of habitat from construction of infrastructure either directly damaging vegetation, or by pollution from run-off from tracks, dust from vehicle movements etc. particularly in the aquatic environment but also into wetlands, or changes to hydrology as water courses are engineered or water-tables impacted; and for species, risk of collision for flying species, from vehicle movements (mainly for land animals),

habitat loss, and displacement / disturbance that can change behaviours and upset key stages in yearly cycles.

Offshore, the International Union for Conservation of Nature (IUCN) document "Greening Blue Energy: Identifying and managing the biodiversity risks and opportunities of off shore renewable energy" describes the impacts of windfarm developments on the marine environment as including "disturbance effects from noise, electromagnetic fields, changed hydrodynamic conditions and water quality, and altered habitat structure on benthic communities, fish, mammals and birds."

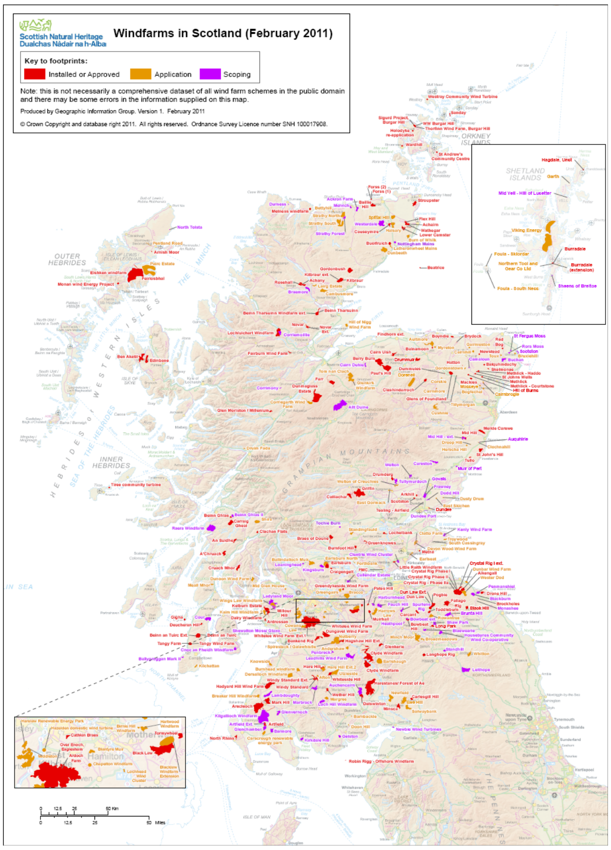
The IUCN project highlights that "Planning and development decisions made at this [early] stage of the development of off shore wind energy will be setting a precedent for future developments… so it is imperative that shortcomings in research and knowledge are addressed as a matter of urgency". A great deal of uncertainty still exists around impacts of offshore development. A lack of data limits the scope of EIAs and hinders the development of monitoring programmes, and the industry has some way to go before environmental risks and opportunities are comprehensively understood. A precautionary approach to protect biodiversity will clearly hamper the deployment of offshore wind and there is therefore an urgent need to bring forward research to fill knowledge gaps.

Examples of good practice

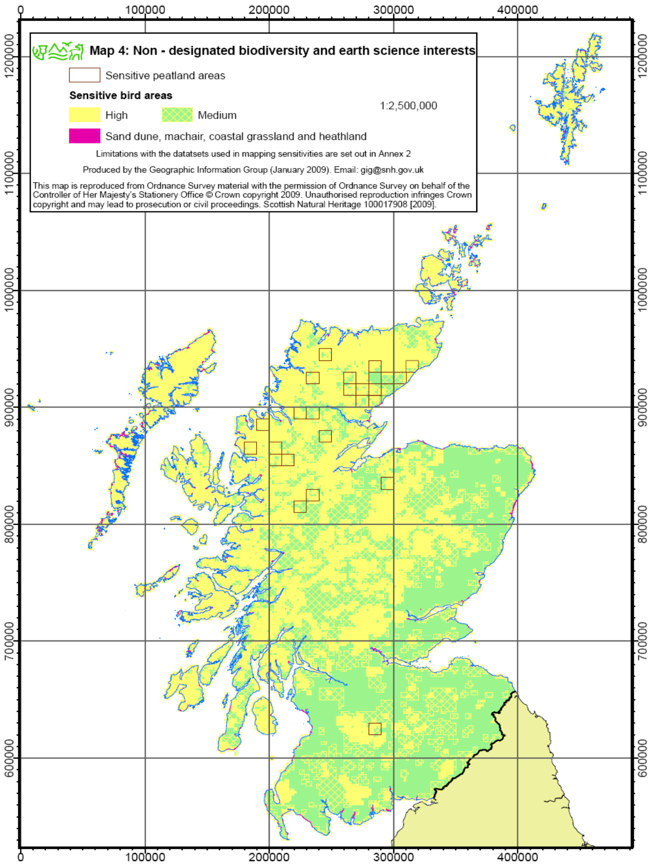
- The International Union for Conservation of Nature (IUCN) document "Greening Blue Energy: Identifying and managing the biodiversity risks and opportunities of off shore renewable energy" seeks to improve the environmental performance of offshore renewable energy projects and develop comprehensive guidance to promote best practice.
- The German federal government is undertaking research at the Alpha Ventus pilot offshore wind installation to improve the knowledge base for decision making in offshore EIAs, including development of radar technology to assess collision risks of night migrating birds and possible mitigation measures (Schmaljohann et al 2008; Dokter et al 2011)
- Bio3, a Portuguese company undertaking biodiversity consultancy and research, have developed a "biodiversity tracking system: a tool for monitoring biodiversity", an online tool to track fauna, which automates the collection, processing, optimization and loading of satellite transmitted data related to individual's movements. They have also developed the "Wildlife Fatality Estimator", a free online platform which helps users to properly apply existing methodologies and correctly estimate the mortality rate associated to human infrastructures such as wind farms. Two successful examples of how to reconcile wind projects and wildlife located in Portugal are the Malhanito and Prados wind farms, which lie inside a Natura 2000 Site of Community Importance (SCI). During the development of the project, baseline studies were conducted in order to identify areas and/or habitats of ecological relevance. Based on this information, sensitivity maps were developed and taken into account during the definition of the final layout. The potential impacts on two endangered species, the Bonelli's eagle on Malhanito wind farm and the Montagu's Harrier on Prados wind farm, triggered the development of mitigation plans for both species.
- In the USA, the National Wind Coordinating Collaborative (NWCC) have developed a "Comprehensive Guide to Studying Wind Energy/Wildlife Interactions", which is a guide to persons involved in designing, conducting, or requiring wind energy/wildlife interaction studies. The document follows a general framework for progressing through the decision process for a proposed wind project and a guide to methods and metrics for use in the necessary studies.
- Scottish Natural Heritage's (SNH) locational guidance approach offers information on which parts of Scotland are most suited to wind farm development in natural heritage terms, and in which parts significant adverse impacts on the natural heritage are most likely to arise. At a strategic level it identifies the natural heritage sensitivities which should be addressed by developers and by planning authorities in planning positively for wind energy.
- For offshore interests, the publication "Danish Offshore Wind – Key Environmental Issues" by the Danish Energy Authority usefully summarises the key research findings on the impacts on benthic communities, fish, marine mammals, birds and people's perception of offshore wind farms.

- SNH's windfarm development map (see Fig 1, below) - Provides a national overview of windfarm development in Scotland, based on SNH data and, although indicative, it provides an advisory overview to assist developers. Comparison with SNH's locational guidance maps (see Fig 2 below) broadly shows how natural heritage constraints have influenced the consenting pattern for windfarms, with windfarm development in Fig 1 following a pattern of less-sensitive areas depicted in green in Fig 2 (although availability of grid connection is relevant also).

Windfarm Location Map, Scotland



Natural Heritage Sensitivities Map, Scotland



The main biodiversity sensitivities identified are the potential impact of wind farms on habitats through disturbance and loss through construction, and impacts on birds. The habitats identified as most sensitive are those with legislative protection and where either the habitat is so rare that any loss is regarded as serious; or where turbine installation or access tracks might interfere with the functioning of the habitat.

Scottish Planning Policy places a duty on planning authorities to develop more detailed Locational guidance at the local authority level. SNH's Strategic Locational Guidance provides a starting point for this and SNH provides further guidance and support to individual authorities where required.

SNH's Scotland's biodiversity strategy indicators monitor changes in species, habitats and landscapes and reflect wider changes in the natural environment. They can be considered to be a kind of barometer of the health of the environment and are a useful tool to help detect potential problems early on.

Excerpt from consent for Black Law Windfarm, South Lanarkshire, Scotland.

> *"7.26 No later than 6 months from the commencement of development, a habitat management plan shall be submitted to and approved by the local planning authorities in consultation with Scottish Natural Heritage. The approved habitat management plan, amended as the case may be, shall thereafter be implemented in full, unless otherwise agreed by the planning authorities."*

Examples of lessons learnt

- In Scotland, locational guidance combined with nurturing a culture of comprehensive engagement between developers and government's environmental consultees and stakeholders, at the earliest possible stage in planning, has cemented consideration of factors affecting biodiversity into the planning system.
- Some of the natural heritage impacts are best avoided by locating away from areas of high natural heritage sensitivity. Others can be mitigated through sensitive detailed siting and design.
- As a strategic approach which gains the acceptance of industry, planning authorities, and the wider public can be of major assistance in facilitating wind farm development and in reducing to a minimum the time delays and financial losses involved in preparing, assessing and determining controversial and possibly ultimately rejected, schemes.
- In Italy, after the recent installation of 25 wind turbines in the Municipality of "Foiano Valfortore", failure to consider the impact on biodiversity has led to serious impacts on species and habitats and on the entire ecosystem. There have been calls for a radical reform of the regional environmental impact assessment (EIA) procedures, to overcome the lack of specific knowledge on these issues and to make compulsory the presence of an expert in the EIA Procedure.

Implications for policy and practice

Experience has shown that where developers have engaged with environmental consultees at an early stage, have undertaken rigorous EIA work, and have been prepared to develop mitigation and habitat management, developments have a better chance of achieving consent, and of moving through planning systems quickly and efficiently.

The advantages of a strategic, locational approach are also clear. However, it should be noted that locational guidance is not a substitute for a thorough EIA. The local presence or absence of important species and habitats which cannot be represented at larger scales may result in higher, or lower, sensitivity in some specific locations. Understanding of the impact of wind farms on biodiversity interests is incomplete. There will be a need to keep guidance under review as understanding develops.

For offshore developments in particular, the diverse nature of developments and of ecosystems in different regions, and the limited nature of the current knowledge base, means that data or research from one region or for one type or size of development may not be directly applicable elsewhere.

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Case Study theme 4 – Tackling Cumulative Impact Issues

The main barrier

Cumulative impacts (CI) encompass the combined effects of multiple developments or activities on a range of receptors. These include CI on landscape and visual amenity, cumulative effects on species and habitats, as well as social and economic effects such as impacts on the local economy and recreation. CI also includes other impacts such as construction, traffic, noise, military operations, air safety (radar, flight paths, seismological monitoring) and civil aviation. Defining CI is challenging but EC guidance suggests that indirect impacts, cumulative impacts and impact interactions can all be classed as CI.

It is the complex nature of these interactions their impacts and assessment which make CI a barrier to the deployment of wind energy both on- and off-shore. While an individual wind energy development may be acceptable in term of its impact on a receptor, the CI of several developments, or the 'in combination' effects of other developments within an area, may have a significant effect on the receptor, meaning the development is unacceptable in CI terms. CI may also arise from small-scale developments such as individual turbines. Importantly, whilst all individual projects or actions affect their environment, the combined effects of multiple actions can be greater than the sum of individual parts. CI can arise from different types of activity (for example, the CI of windfarms and forestry) and may arise from existing and approved development, and proposals awaiting determination.

The identification and assessment of CI is an integral part of all stages of the environmental assessment process and is crucial to the successful deployment of wind energy. CI assessment is intended to estimate the impact of a planned action (i.e. a development) on a receptor (e.g. landscape, habitat or species), *in combination* with other actions. Furthermore, there is a requirement under EU Environmental Impact Assessment (EIA) regulations for CI assessment to consider the direct impacts and indirect, secondary or cumulative effects of a project and the interactions between environmental factors.

Case study purpose

This case study attempts to determine how best to identify and assess CI and how to overcome residual CI issues by focusing on the policy implications of current research and practice. The purpose is to signpost relevant academic literature, reports and technical information to improve understanding of CI issues and assist in developing wind energy sustainably.

Case study research methodology

Key issues were identified and a series of recommendations made by reviewing scientific and technical literature and exploring issues with relevant stakeholders.

Key issues

- The CI of one windfarm development combined with the impact of other windfarms and other types of development and land use change (such as forestry, agriculture, urban development and other industries) means that CI can be significant and complex to assess.
- CIA (Cumulative Impact Assessment) is a legislative requirement of EIA, Birds and Habitats Directives but comprehensive assessment is challenging. This has resulted in a lack of understanding of how CI of windfarms affect receptors. Reasons for this are numerous but a recurring theme is a lack of clear definitions and guidance on how to perform CIA (Masden, et al. 2010; King et al. 2009; Bérubé, 2007).

- It is common for different activities such as forestry, agriculture and development to fall under different consenting regimes. This means that while CI may be significant, they are difficult to compare and hence difficult to assess within the decision making process.
- The impacts of large-scale windfarms can be far reaching, particularly if there are CI on mobile receptors such as migratory species, which raise transboundary issues. However, the regulatory decisions are often taken at a local level meaning these issues are difficult to assess.
- Current consenting regimes are set up primarily to consider an individual development, which often means CI are overlooked, or inadequate, particularly if there is a lack of strategic planning.
- Many small-scale developments such as single turbines or groups of turbines, do not require EIA and many fall outwith spatial planning exercises, but small-scale developments do contribute to CI.
- Our understanding of CI for offshore wind is less developed than for onshore. CIA for offshore wind must address CI in the marine environment, including other novel technologies such as marine renewables, industries such as fishing, and also consider the CI of onshore development.
- This is within the context of climate change where the environmental baseline is not static.

A number of factors can influence the existence and scale of CI effects, including the sensitivity of receptors (e.g. the sensitivity of a species in terms of conservation status, breeding ecology); the location (whether it is within a site sensitive for wildlife or landscape issues); the physical environment (e.g. the geography of the site, land use and other anthropomorphic factors). In addition, the intensity and nature of developments can influence the scale of CI depending on whether they are clustered or dispersed, as can the technology type and size.

Potential impacts on the development of wind energy

There is a legal requirement to assess CI in the EIA, Birds and Habitats Directives. There is also considerable reputational risk to the industry from developments where CI have not been assessed or considerably underestimated. Windfarms such as those in the Altamont Pass in California have led to large number of bird fatalities which has damaged industry reputation. In addition to these impacts, the perception of saturation of windfarms within a landscape can ultimately lead to the refusal of projects on cumulative landscape grounds. Minch Moor windfarm was refused by Scottish Borders Council, amongst other reasons on the basis of significant and unacceptable cumulative visual impacts when considered with schemes approved or proposed, including impacts on users of roads and paths in the area. An appeal of this decision by the developer was subsequently refused by Scottish Ministers.

Examples of good practice

The UK Committee on Climate Change suggest that higher approval rates in Scotland compared to the rest of UK, for both small- and large-scale projects (56% and 100% respectively in the year to September 2010, compared to 34% and 47% in England) are due to a strong policy lead and to following good practice:

- Clear guidance and scoping procedures to assist developers when making applications. This is supported by online Planning Advice Notes. Statutory nature conservation organisation, SNH, has produced guidance on the assessment of CI and 'good practice during windfarm construction'.
- Statutory consultees and NGOs are engaged, providing advice and guidance on site availability and suitability early on in the planning process. This includes a bird-windfarm sensitivity map to identify areas where windfarms may pose a risk for important bird populations so that the most sensitive sites are subject to more stringent assessment for compatibility with sustainable windfarm development or are avoided if sensitivities are considered too great. This has been incorporated along with other natural heritage constraints into national strategic locational guidance.
- Collaboration with stakeholders to overcome barriers to developments (e.g. technical solutions to radar issues, and the creation of a Scottish Renewable Energy Ornithological Steering Group to share environmental information) has enabled informed decisions to be made.

- Due to the proximity of several large offshore wind proposals on the East coast of Scotland, there is an urgent need to assess the potential CI. To address this, The Crown Estate established the Forth and Tay Offshore Wind Developers Group. This joint approach aims to help in the assessment of potential cumulative and in-combination impacts and where appropriate, to progress collaborative survey work and stakeholder consultation.
- Effective and positive engagement, as well as information and experience sharing, between authorities at local (Local Planning Authority) and national (Government) level.
- These measures have been supported by strong political will at all levels which has translated into real progress - Government has intervened where projects are considered of 'national interest'.

In 2005, the Welsh Assembly Government adopted a novel approach to planning for renewables by identifying seven Strategic Search Areas (SSAs), within which there is a general presumption in favour of major onshore wind development. The SSAs range from 50km^2 to 150km^2, and were generated using an approach which excluded certain strategic constraints, including internationally designated sites. This was developed in conjunction with environmental stakeholders, industry and local planning authorities and means that the most sensitive sites are protected from windfarm development at the strategic level.

The Scottish Planning Policy takes a different approach in that it requires local planning authorities to set out in their development plans a spatial framework for onshore windfarms of over 20MW (windfarms of less than 20MW may be included if considered appropriate). This is intended to guide developments to appropriate locations, to maximise renewable energy potential and minimise wasted effort and resources on inappropriately located proposals (see Fig 1).

Figure 1: Suggested Approach to Preparing Spatial Frameworks

Stage 1 – Identify areas requiring significant protection

- Sites designated for their national or international natural heritage value or green belt
- Where the cumulative impact of existing and consented wind farms limit further development

Stage 2 – Identify areas with potential constraints

- Consider matters relating to the historic environment; regional and local landscape and natural heritage designations; tourism and recreational interests; communities; aviation and defence interests; and broadcasting installations
- Where proposals will be considered on their individual merits against identified criteria

Stage 3 – Identify Broad Areas of Search (BAS)

- Where there are no significant constraints on development
- Appropriate proposals are likely to be supported subject to consideration against identified criteria

However, CI between two BAS could be heightened by poorly sited small schemes within the areas between BAS. In addition, the cumulative effect of inappropriately sited windfarm development could be to create the perception of a landscape dominated by windfarms, where the Landscape Character Assessment and Landscape Capacity Study indicate the landscape is unable to accept such a level of change. The approach also recommends that BAS should be planned with the existing pattern of development. This approach aims to protect a coherent pattern of development and reduce the potential for CI by encouraging clusters of windfarms, with the spaces between clusters as an essential element of the spatial framework.

Due to the developing nature of the offshore wind sector, it is recognised that some final design details may not be available for inclusion in the EIA at the time of application submission (e.g. final turbine size). Given this uncertainty it is accepted that a 'Rochdale envelope' can be defined, within which an EIA team can assess the variation in final design parameters in which the consenting body can constrain a developer. The EIA and Habitats Regulation Appraisal should be undertaken within the envelope, and this information used to progress the CIA. The development of offshore infrastructure (i.e. cables and onshore substations) will also contribute to the overall CI and should be considered within the CIA. While for a new area of research, the COWRIE guidance on assessment is recommended.

Examples of lessons learnt

Well-documented examples of where CI were overlooked or not addressed effectively, and have resulted in significant negative impacts, are limited. However, as the number of windfarm developments increases, the importance of CI will increase. It is therefore important that lessons are learnt to reduce the risk of adverse CI in the future. Poorly sited windfarms have caused major numbers of bird mortalities, sometimes of species conservationally sensitive to such losses (it is not appropriate to consider all bird species as forming an undifferentiated class). This reinforces the need to site windfarms appropriately in order to minimise impact. A more strategic approach to planning may have helped avoid some of these impacts, as would closer examination of the effects of interactions between windfarms and other forms of development.

In terms of landscape and visual amenity issues, some authorities have introduced a minimum distance between windfarms as a means of reducing CI. However, this may run contrary to the alternative policy of concentrating windfarms in areas with high wind potential. In the Walloon Region of Belgium, the Cadre de Référence (a framework for the development of windfarms) does not specify a minimum distance criterion and in the absence of regional spatial planning, there is nothing to prevent multiple projects being proposed in close proximity, raising cumulative landscape issues.

Implications for policy and practice

Policy level 1.

- More effective strategic spatial planning – using assessment tools such as mapping constraints and fieldwork to ascertain maximum capacity and areas of sensitivity for a given area.
- Explicit definitions of impacts, actions, significance levels, and scale of assessment can reduce uncertainty in the assessment process and improve stakeholder communication.
- Consistent, robust, up to date methodology and guidance for CI assessment
- Elevation of CI assessment to a strategic level, as a part of spatial planning and SEA.

Scoping 2.

- Early, effective engagement between developers, government and stakeholders.
- The development of an EU wide code of good practice between industry and environmental stakeholders for site selection and habitat management issues to prevent the least suitable sites reaching application stage.

Planning 3.

- As well as at a strategic level, CI issues need to be assessed at development management stage (e.g. site specific) as part of EIA.
- Strong mandate by relevant consenting body, whether local or national, to refuse inappropriate proposals where CI is deemed to be unacceptable.

Construction

- Guidance and joint working between government, industry and environmental bodies can be particularly effective in achieving high environmental standards.

Operation

- A coordinated approach to data collection, robust post-construction monitoring, case study research and publication, and data sharing can help inform our understanding of the CI.

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Case Study theme 5 - Systems and process for monitoring environmental impacts

Photo:K. Krijgsveld.(www.buwa.nl)

The main barrier

Applications for power stations, including wind power, and those for significant power lines, need to be accompanied by an Environmental Impact Assessment (EIA) which describes the effects the development is likely to have on the environment. To protect the environment, monitoring of environmental effects is often mandated by regulators and proposed in the EIA

BACI monitoring at Near Shore offshore wind farm, Netherlands.

If these activities are subsequently approached disingenuously, or not carried out properly or at all, this not only exposes the developer to legal challenges but may serve as a barrier to future developments by the wider industry, as decision makers would be reluctant to consent to similar schemes in future. However, wind energy projects which have been planned to minimize adverse environmental impacts, and where those plans have been implemented, have been shown to positively influence perceptions of wind energy once completed[1].

Case study purpose

In consenting a large scale wind farm the developer is given powers to construct and operate a wind energy development. However, it is important that the construction and operation of the facility is managed and controlled in a sustainable way which takes account of environmental effects and minimises impacts.

This effort is usually mandated by regulators through the use of a detailed suite of conditions that must be met by the developers in taking the scheme forward from consent, through to construction and eventually into operation. Appropriate measures are frequently proposed in the EIA conducted by the developer. The purpose of this case study is to show how these conditions can be used to manage complex post-consent work streams to the satisfaction of key stakeholders. In this way, this case study may be useful for developers, Governments, planning departments, statutory bodies, regulators and community groups.

This case study identifies key issues and good practice for monitoring impacts of wind farms on the environment.

Case study research methodology

The methodology adopted to develop this case study consists of presenting two kinds of collected evidence:

(i) information gathered from a selective review of the available literature in scientific journals, evaluation and follow-up studies, publicly available policy documents, industry guidance and the GP WIND Steering Group Advisors consultation documentation, and

(ii) evidence collected through in-person interviews with wind power developers, environmental organisations, local authorities, educational institutions and NGOs

The Scottish Government's website on Energy Consents[3] holds a database of all previous consent letters issued by the Scottish Government including all conditions required and is a good source or starting point for bodies interested in producing conditions for use in their own processes. Other sources of information on conditions can be obtained from local Planning Authority websites[4].

Key issues identified

The issues commonly covered by consent conditions requiring monitoring include the following:

- construction methods,
- roads and traffic,
- noise and dust,
- access,
- environmental effects
- Decommissioning and reinstatement of the site.

The main barrier identified in a number of regions has been the poor quality of many EIAs and in particular the lack of attention given in them to mitigation or monitoring of impacts. This commonly delays the consenting process very significantly or may result in refusal of consent.

Lack of clarity from regulators in EIA requirements, especially as regards expected standards for systems and processes for monitoring impacts, is frequently cited by developers as a major problem in carrying out satisfactory EIAs.

In some regions there can be difficulties with finding qualified staff to undertake monitoring requirements.

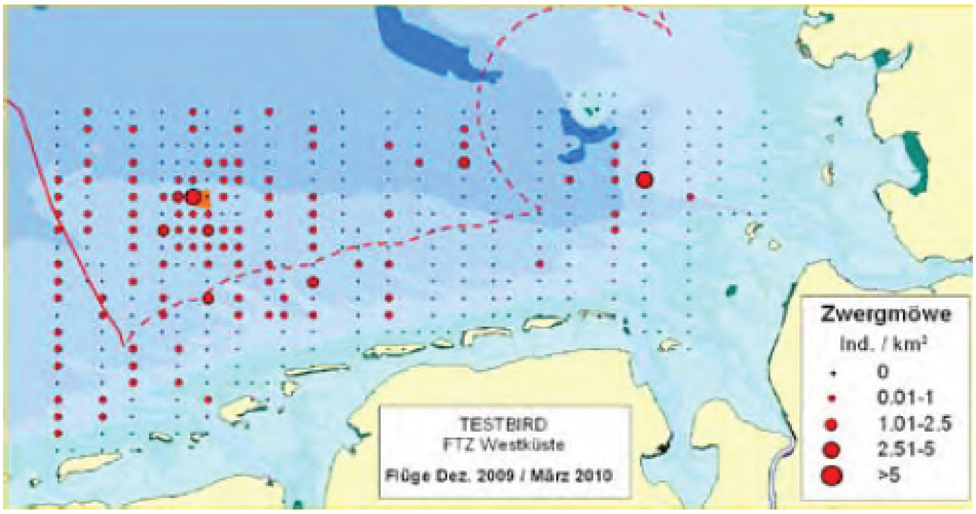
Examples of good practice

- The BACI (before/after-control/impact) approach to monitoring impacts is generally regarded as best practice in this field. This approach to monitoring is currently being implemented at the Near Shore offshore wind farm in the Netherlands. While results are not complete, as several years of data are required, the programme provides a detailed example of best practice in the planning and implementation of BACI monitoring techniques at a complex site in environmental monitoring terms.

- Scottish Natural Heritage provides detailed guidance on methods for monitoring bird populations at inshore wind farms (SNH 2009), which employs the BACI approach.

- The German Federal Government has mandated clear standards for monitoring environmental impact of offshore wind farms in its Standard for Investigation of the Impacts of Offshore Wind Turbines on the Marine Environment (Bundesamt für Seeschifffahrt und Hydrographie 2007). These require the approval holder to carry out ecological monitoring before, during, and after the erection of an offshore wind farm. A good example of the development and implementation of the practical application of these standards is given in the publication

Environmental Research at Alpha Ventus (offshore wind farm) – first results (Bundesamt für Seeschifffahrt und Hydrographie 2010)



Distribution of little gulls Hydrocoloelus minutus based on aerial surveys in December 2009 and March 2010. Orange area: Alpha Ventus wind farm. Source: Bundesamt für Seeschifffahrt und Hydrographie 2007

Implications for policy and practice

- Clear and credible EIA requirements, including the impact monitoring standards expected, are important for the avoidance of the confusion which leads to lengthy and costly consents processes
- The BACI approach is current best practice and should be adopted for environmental impact monitoring where practicable
- Guidance on detailed methodology from appropriate government bodies is useful to all parties involved in preparing and assessing monitoring plans

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Case Study theme 6 – Carbon accounting for wind farms

The main barrier

One of the main driving forces for the change towards renewable energy is the need to reduce greenhouse gas emissions, including carbon dioxide (CO_2), that are contributing to climate change. Wind electricity is regarded as sustainable as the overall level of emissions is thought to be low in particular as the operational emissions (those occurring during the production of electricity) are supposed to be close to zero. However wind energy can also exert some impact on the local and global environment, and we must avoid replacing one set of impacts with another. One concern raised about electricity generation using wind power is whether the expected saving in carbon emissions during the lifetime of the wind farm will be compensated by carbon losses associated with their development and installation. Studies indicate that good management practices can be used to minimise carbon losses, even where peat lands are involved. Nonetheless it remains important that the overall carbon emissions are known and considered at the planning stage.

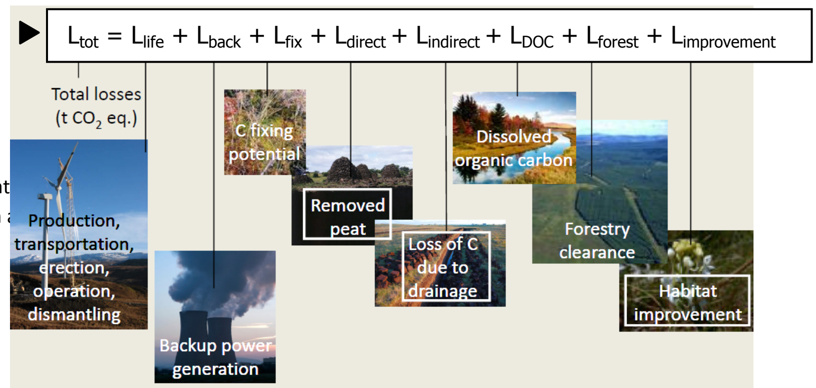
Consequently more planning authorities across the world are requiring that applicants with proposals for wind farm developments take account of the carbon impact occurring over the lifetime of the wind farm when applying for consent during the permitting process. Due to uncertainties involved in estimating the relevant CO_2 emissions, it is only possible to give a general indication of the likely balance. Nonetheless this final payback can have a significant bearing in the final decision-making by all stakeholders when assessing whether the project is justified on the basis of climate change benefits. Hence this requirement raises some concerns about the reliability of calculation methods used to estimate carbon losses and gains during the construction and lifetime of wind farm developments. To-date there is no unique methodology to measure carbon emissions from wind farms, and there is a need for consistent and robust methods for the evaluation of carbon savings.

Case Study purpose – wind farms and carbon savings

The implications for carbon emission assessments of an actual wind farm development are just one aspect of the suite of considerations that planning systems are starting to take account of. Various other considerations come into play when wind developments occur in sensitive areas that could lead to other sources of emissions - like the disturbance of bogs, peat, wetland and upland systems which act as vital "carbon banks" in many EU countries. This guide has been prepared to assist in the estimation of CO_2 gains or losses of a proposed wind farm when applying for a planning permit. It examines aspects of estimating the CO_2 emitted by wind farms during the construction phase, while also considering the longer-term emissions arising from the impact of that wind farm on its location, which can vary considerably from site to site. This paper is relevant to all the stakeholders involved in any wind energy development including developers, regulators, academics, planning departments and community groupings. This best practice is solely focused on onshore wind since this is a relatively new concept in wind energy permitting, and no concrete efforts for offshore wind carbon accounting were noted at the time of writing. This paper has made extensive use of work already undertaken by the Scottish Government.

Key issues identified

Several papers from the wind industry (like KTH, General Electric, Vestas) have addressed the estimation of emissions arising from the fabrication (steel smelting, forging of turbine columns, the manufacture of blades and the



electrical/mechanical components) and construction (transportation of components, quarrying, building foundations, access tracks and hard standings, commissioning) of wind farms. However this is only part of the carbon emissions potentially released, and the industry tends to rarely consider carefully conditions at the site itself when making claims for a farm's ability to reduce CO_2 emissions. This is a fundamental omission as certain impacts can have much greater implications to the overall CO_2 emissions than the actual construction phase. In fact the total carbon emission savings of an individual wind farm are estimated by accounting emissions from different power sources that will be replaced by wind power against loss of carbon due to production, transportation, erection, operation and dismantling of the wind farm, loss of carbon from backup power generation, loss of carbon-fixing potential of peat land, loss of carbon stored in peat land, carbon saving due to improvement of habitat and loss of carbon-fixing potential as a result of forestry clearance.

Example of good practice – calculating carbon savings from wind farms on Scottish peat lands

In 2008, the Scottish Government developed a methodology and tool for assessing carbon emissions from wind farms which provides a transparent and easy to follow method for estimating the impacts of wind farms on the carbon dynamics of organic soils like peat lands, as opposed to mineral soil, by also taking into account peat removal, drainage, habitat improvement and site restoration. This methodology is currently being revised further in order to improve the methodology. The following section will cover the various items that need to be taken into consideration when estimating the total carbon emission savings from a wind farm according to the Scottish Government best practice.

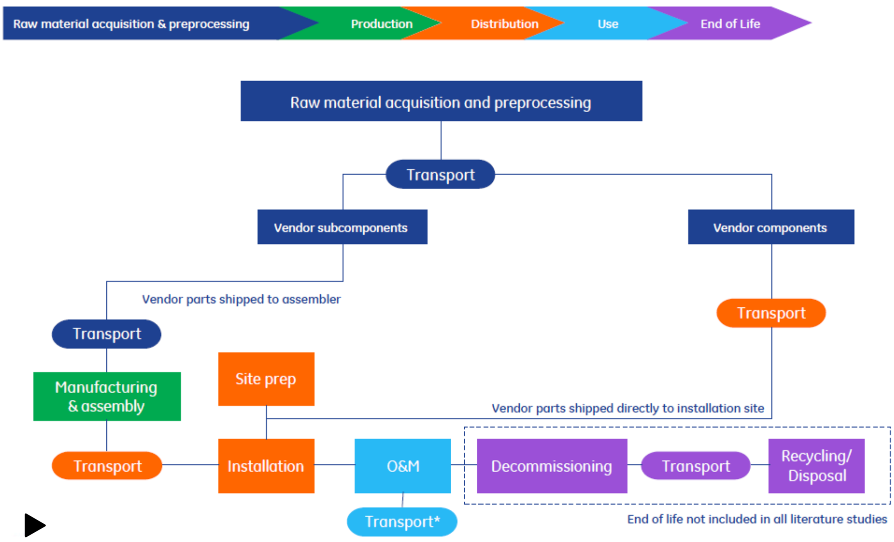
'Appendix 2' of the Scottish Government document presents a detailed method and workings to calculate the wider carbon emission losses and savings associated with wind farm developments on Scottish peat lands using a full life cycle analysis approach that also takes into account peat removal, drainage, habitat improvement and site restoration. It is supplemented by an EXCEL spreadsheet containing a full carbon calculator (version 2.0.0.). 'Appendix A16.6 – Carbon Payback Calculations' presented by the Viking Energy wind farm offers other concrete examples, but are also contested.

Estimating carbon emission savings from wind farms

CO_2e, or carbon dioxide equivalent, is a standard unit for measuring carbon emissions. The impact of each different greenhouse gas is expressed in terms of the CO_2 that would create the same amount of warming using standard ratios. Carbon emission savings are calculated using the emission factor for the type of fuel used for power generation; therefore the saving achieved by producing energy from wind depends on the type of fuel that is being replaced (termed the counterfactual case). However, in most circumstances it is not possible to define the electricity source which will be replaced by the renewable electricity project so calculations are done for three possible options: i.e. substitution for coal generated electricity, substitution for fossil fuel generated electricity and substitution for a grid mix. The emissions of carbon dioxide can vary by country and with improvements in technology; so updated and specific emission factors should be used in the calculations. The annual emission savings are estimated by multiplying the total annual energy output, by the emission factor for the counterfactual case (i.e. coal fired generation, fossil fuel mix generation and average country grid mix generation. Consequently the carbon '*payback*' time for a wind farm is calculated by comparing the net carbon losses from the wind farm, with the carbon savings achieved by the wind farm when replacing the same electricity generated from a coal fired capacity, fossil fuel mix and a grid mix. Payback is strongly correlated to the date of start of operation of the wind farm since two exactly similar wind farms built at different points in time will have a different carbon payback since the grid will have changed in the meantime. It is also crucial to ensure that the rated capacity of the wind farm is not entirely based only on "average output" figures and wind speeds in order to avoid controversy.

1. Loss of carbon due to production, transportation, erection, operation and dismantling of the wind farm components (the infrastructure overhead)

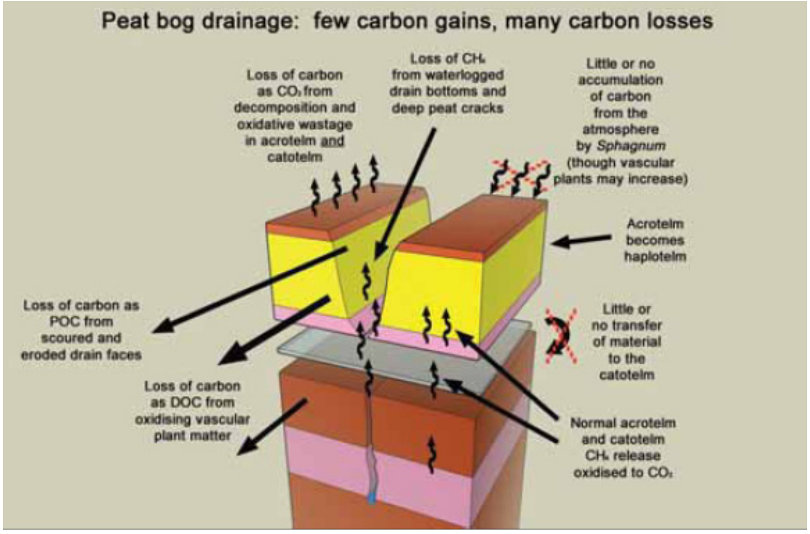
CO_2 emissions from wind farms include CO_2 emissions that occur during production, transportation, erection, operation, dismantling and removal of turbines, foundations and the transmission grid from the existing electricity grid. Emissions reported in peer-reviewed literature have a range of 0.006 to 0.034 t CO_2 MWh-1, with indications that the foundations are the component which most affects the environment, particularly the cement used. Assuming a wind farm lifetime of 25 years and a capacity factor of 30%, this equates to emissions of 394 to 8147 t CO_2 MW^{-1}. Defensible figures for the specific wind farm should be used wherever possible, but if these are unavailable carbon dioxide emissions due to the turbine life can be estimated from the turbine capacity.



2. Loss of carbon due to backup power generation

This refers to emissions losses due to any accompanying backup power that is necessary to stabilise electricity supply to the consumer because of the inherent variability of electricity generated by wind. The total loss of carbon emission savings due to backup power generation depends on the type of energy used to provide the backup. The total loss of carbon emission savings due to backup power generation is hence calculated as a product of the additional emissions, the reserve capacity required for backup, the backup fuel emission factor, and the life time of the wind farm. However calculations are not that straight forward and various other factors may complicate backup and grid displacement calculations, like the rated capacity of the wind farm and the extent to which future thermal generation will incorporate carbon capture technology and how that will impact on the emissions from fuel combustion.

3. Loss of carbon stored in peat



▲*Carbon-balance model of drainage for a standard cubic meter of peat*[29]

Peat is dead plant material, deposited in-situ, which has failed to decompose completely because waterlogging starves decomposer organisms of sufficient oxygen to enable them to function effectively. Peatlands in particular can be damaged by the inappropriate siting of wind farms or their associated infrastructures, such as access roads. Excavations and ditching associated with wind farm construction causes peat to dry out over time which releases its stored carbon content, including dissolved and particulate organic carbon (DOC/POC). Peat damage does not occur only at the site of turbine bases, borrow pits or access tracks, but may also affect water tables some distance from structures.

Consequently the loss of the carbon fixing potential of the peat land needs to be calculated for the area from which peat is removed, and also for the area affected due to drainage. The value of 0.25 t C ha^{-1} yr^{-1} = 0.92 t CO_2 ha^{-1} yr^{-1}) is used for the estimated global average of the apparent carbon accumulation rate in peat land, if site specific data is not available. Loss of carbon fixing potential of peat land is calculated from the area affected by wind farm development (both directly by removal of peat, and indirectly by drainage), the annual gains due to the carbon fixing potential of the peat land, and the time required for habitat restoration.

Loss of carbon stored in peat lands represents the greatest risk in terms of potential CO_2 loss since it can be lost directly from the excavated peat, and indirectly from the area affected by drainage during wind farm construction. Loss of carbon from the excavated peat is assumed to be 100%. In order to estimate the losses and gains stored in peat lands the following factors need to be considered:

- Loss of carbon from removed peat
- Loss of carbon from drained peat
- Loss of carbon dioxide due to leaching of dissolved and particulate organic carbon

Please note that loss of carbon due to peat slides is not considered here since it is assumed that required measures to avoid peat landslides have been taken.

4. Carbon savings due to improvement of peat lands habitat

Habitat improvement at disturbed sites can potentially prevent further carbon losses while increasing carbon stored in the improved habitat. These gains can also be estimated and accounted for by using IPCC default values and site specific equations. Emissions of nitrous oxide are assumed to be negligible in unfertilised peat lands. To calculate the carbon emissions attributable to improvement only, any emissions occurring if the soil had remained drained are subtracted from the emissions occurring after flooding; where a negative indicates a net reduction in emissions.

5. Loss of carbon-fixing potential as a result of forestry clearance

The presence of extensive areas of forestry in the vicinity of the wind farm site can significantly reduce the yield of wind energy, so it may be necessary to clear existing forestry. The amount of carbon loss from timber depends on the type of tree, the age of crop on felling, the end use of the timber and how quickly any stored carbon is returned to the atmosphere. Loss of carbon dioxide due to forestry clearance is obtained from the area of forestry to be felled, the average carbon sequestered per year, and the lifetime of the wind farm.

Suggested best practice to improve wind farm carbon savings

The extensive 'Good practice during windfarm construction" guidance document that was developed jointly by Scottish developers, Government and agencies provides an excellent example of stakeholders' collaboration. Suggested practices for improving carbon savings associated with wind farm developments, which can also benefit habitat and biodiversity, include:

- Consider the time of year and scheduling of wind farm construction to minimise emission impacts due to inclement weather, site drainage, flooding, dust, traffic, breeding seasons and waste considerations.
- Minimise impacts from the site compound, workers' welfare facilities, parking, laydown area and storage areas.
- Careful monitoring of construction for unnecessary emissions, and pollution prevention undertaken by a developer.
- Ensure good traffic management.
- Where possible site the wind farm on a mineral soil.
- Survey peat habitats during EIA if applicable to make informed and sound decisions on proposed workings in the peat environment.
- When excavating areas of peat, layer turfs should be kept as intact as possible by excavating in large turfs or clumps since they are less prone to drying out.
- Excavated peat should be prevented from drying out by minimizing disturbance or movement, and by spraying the peat to keep it moist in appropriate circumstances.
- Stockpiling of peat should be in large amounts, taking due regard to potential loading effects for peat slide risk, and bladed off at the side to minimise the available drying surface area.
- Peat should be restored as soon as possible after disturbance.
- Floating access roads should be used where appropriate (see document for details) to avoid cutting into peat and disturbing it, leading to drying out.
- Submerged foundations should be employed on deeper areas of peat, to maintain hydrology around the turbine base and avoid draining the peat area.
- Excavated tracks should not act as water channels or as barriers to water flow, and should be tackled organically according to geomorphologic characteristics during the construction stage.
- Cross drains should be laid in order to minimise the collection of water, and ensure overall catchment characteristics are maintained.
- Careful attention and enquiry should be dedicated to ensure turbine foundation and crane pad construction minimise waste and carbon emissions
- Ensure adequate woodland removal techniques are adopted, followed by open-ground habitat restoration.
- Keep in mind emissions when designing the wind farm electrical collection system, route and trenching method.

Further peat best practice guidelines can be found in the "The Politics of peat", the "Best Practice for Wind Energy Development in Peat lands" guidance document and "Windfarm developments on Blanket Bog".

Implications for policy and practice

It is becoming increasingly important to ensure clarity about the sources of emissions during a wind farm's life cycle, and comprehensive methodological approaches to carbon accounting are crucial in establishing credibility and ensuring reliable estimates. The current progress in methodological development still leaves scope for interpretation and improvements, which implies that methodologies need to be transparently documented and must remain open to scrutiny in order to be credible, generate trust and win acceptance. This is especially relevant in order to ensure that wind energy contribute to the objectives of the United Nations Framework Convention on Climate Change towards stabilizing greenhouse gas (GHG) concentrations in the atmosphere.

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Case Study theme 7 – Construction and operation of facilities in the marine environment

The main barrier

Legislation associated with the construction and operation of offshore wind farms in all EU Countries is regulated through governmental bodies who implement specific conditions on consents to ensure that the impact on the environment is minimised as far as possible. The experience that has been gained through the UK licensing of 'rounds 1 & 2' for offshore wind farm development has highlighted that alongside the often discussed risk to avifauna, two of the other particularly complex constraints surrounding the construction phase of the projects were: Underwater noise and issues associated with scour and scour protection. Both of these issues were routinely covered by specific consent conditions which must be complied with. Experience from the UK offshore wind farms suggests that these issues need to be considered further as the costs associated with gathering the data to comply with consent conditions can be substantial. This is also an EU-wide issue as more projects are being constructed further offshore and the cumulative impacts and uncertainties associated with underwater noise and scour issues get ever more involved.

Case study purpose

In this case study we draw from previous experiences of construction and operation of offshore wind farms and examine the consent conditions and resultant constraints applied to the construction and operation of wind farms in the marine environment. We also consider how we can better define and therefore mitigate against these constraints in order to reduce the impact on the environment and to reduce the need for a precautionary and restrictive approach to consenting and consent conditions. During this review we also highlight areas of good practice and instances where this has proven to be effective.

Case study research methodology

The case study was based on consultations with key stakeholders on good practice and lessons learned from existing offshore wind farms and a review of all scientific and technical literature of the key barriers identified.

Key Issue Identified No. 1: Underwater Noise

Many marine organisms including most mammals and many fish species use sound as a mechanism to navigate and communicate whether it be to locate mates, search for food or avoid predators. Anthropogenic sound emitted during the construction or operation of offshore windfarms can mask biologically relevant signals for marine organisms. Masking natural signals can lead to behavioural reactions; and at very high levels sound can injure or even kill marine life.
The principal source of underwater noise associated with offshore wind farm construction is from driven pile installation methodologies. The increasing larger sizes of offshore wind farms, and a move to jacket structures employing multiple piles may result in piling operations over several seasons and where several sites are in construction concurrently complex cumulative impacts.

The SEA Directive *inter alia* requires that regulators ensure that they comply with EU legislation such as The Habitats Directive, and The Birds Directive; and regulations regarding Natura 2000 sites which relate to nature conservation. The Habitats Directive builds on the Birds Directive by protecting natural habitats and other species of wild plants and animals.

During the construction consent application process the regulator can apply conditions to an offshore wind farm consent that will ensure that construction restrictions associated with environmental sensitivities are effectively implemented. If developers cannot provide the evidence during the application process that they will not cause a significant impact on protected habitats or species then the consent restrictions applied can be substantial. For example in one UK wind farm a consent condition was applied which required no construction noise associated with piling operations for 6 months of the year in order to protect sensitive fish spawning areas, other sensitive environmental receptors include cetaceans, seals and certain fish species.

Examples of Good Practice

- Due to the environmentally sensitive nature of several offshore wind farm sites, regulators may have to stipulate construction timeline restrictions as a consent condition in order to comply with the EC Habitats Directive and national nature conservation legislation. There are many different types of environmental restrictions which can be applied to consent including: protective measures for spawning or nursery grounds, migratory pathways and breeding, mating or feeding grounds. For example spawning areas can be affected directly by the construction noise causing habitat loss as fish may leave the area. The greater Gabbard offshore wind farm foundations were installed over two seasons due to piling restrictions for sole spawning grounds.

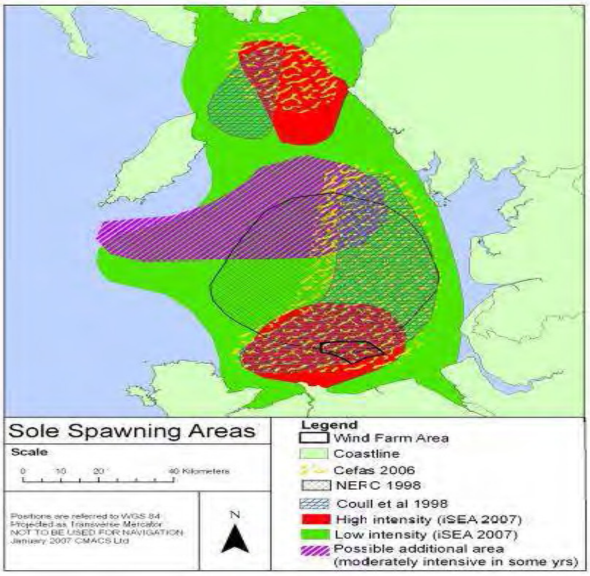
- Clear and focused consultation with regulators and key stakeholders can provide developers with the most up to date advice on the most appropriate data sources, and whether any additional surveys would be required. Where there is overlap between the location of spawning events/nursery grounds and the vicinity of the development site, construction work should be timed to minimise impacts.

- Potential impacts on marine mammals and some fish, such as basking sharks, associated with the development of offshore wind farms relate to both the construction phase with direct noise from piling activity and vessel traffic; and potential disturbance throughout their operational life span from emissions of sound and vibrations into the water column, and engine noise from and possible collisions with the fast boats typically used for service operations. The disturbance can impact on habitat loss due to avoidance or fragmentation of migratory routes and of sites for foraging and reproduction, induced permanent or temporary threshold shift in hearing (PTS/TTS), and/or reduced perception of biologically significant sounds. Mitigation measures may be required by the regulator during the construction phase; these are likely to include the use of deterrent sounds to chase animals away from an area where noise related impacts are likely to be high, and/or the application of a 'soft start' procedure. During soft start procedure the vessel gradually increases the sound level to provide animals with a chance to habituate to the sound, or time to leave the impact area. This is combined with the use of observers that scan a safety zone where no marine mammals should be present prior to commencement of activities (see JNCC Guidelines for piling activity).

Examples of lessons learnt

- For certain species, in the 'accepted' literature spawning events may range over many months, but experts, in particular local experts, know that spawning will often peak in a more restricted period in specific locations. Construction may need to take place outside peak spawning periods. Spawning and nursery grounds are not geographically or temporally fixed, and they may move according to the conditions of the substrate, seabed habitats, climate and hydrodynamic regimes. Consequently, provided the best available data is used and appropriate steps and mitigation measures can be implemented to minimise impacts, it should be possible to ensure that an individual offshore wind development will not have significant impacts on spawning events or nursery grounds. It will be necessary, however, for the cumulative impacts to be assessed in order to inform appropriate restrictions. Cumulative impact assessment should not only consider other offshore wind developments but also other marine industries and activities.

- The Rhyl Flats offshore wind farm is located 8km off the North Wales coast; the map below clearly shows spawning areas for sole. The regulator placed a consent condition on the licence which stipulated no piling work between October 2007 and March 2008 inclusive to manage potential noise impacts upon sole spawning grounds. Following further consultation with the regulator and statutory researchers the regulator added a retrospective condition to the consent which reduced the 'No piling' activity period from March - mid May 2008 this was due to peak spawning data gathered from the site.



Expert researchers identified sole spawning hotspots in Liverpool Bay. Following meetings with the regulator and extensive stakeholder consultation it was agreed to stage the piling activity. This flexible approach allowed the installation to progress starting with southern most foundation positions in mid April. The consultation process provides a very good example of good practice which reduced the initial construction restriction. This reduced the cost of the project to the developer by minimizing delays in the construction timeline.

Key Issues Identified No. 2: Scour

The design and placement of scour protection during future offshore wind farm construction should be considered in more detail in light of the data now being gathered from existing wind farms. The localised scour effects around the base of monopile foundations have now proven to be quite severe. This can lead to further impacts on the environment when poorly designed scour protection can lead to secondary scour effects and scour wakes

The principle impacts arising from scour are upon natural coastal processes, the pattern of erosion and deposition as well as the risk of the mobilisation of historic contaminated sediment.

There is a level of uncertainty with regard to the prediction of scour impacts through the use of modelling techniques. Whilst models are a useful tool there are examples where the reality has differed markedly from the predicted impact. As a result, the management of scour and use of scour protection is a complex and 'thorny' issue for the regulator on many offshore wind consent applications. Because of this, conservative and often restrictive consent conditions can be applied which may delay the construction process or require expensive detailed monitoring campaigns.

Examples of good practice

- During the UK Licensing Round 1 process, offshore wind farms such as Lynn, Inner Dowsing and Cromer carried out scour protection assessments prior to the installation of foundations on the seabed. They all undertook combined assessments using geomorphological interpretation and numerical wave and tidal modelling to assess the influence of the new structures on waves and tides and sediment transport. The outcomes were incorporated into the EIA as part of wind farm licensing and consenting processes. All assessments included the volume of scour associated with the marine installations such as piles or cables.

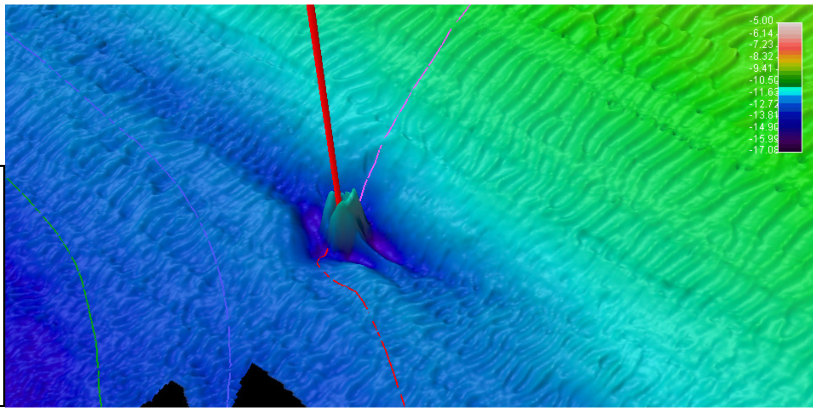
- The development at 'Scroby Sands' on the East Anglian coast had the potential to alter sediment transport and consequently affect the stability of large-scale coastal geomorphic features such as the sandbanks. The regulator stipulated a condition on the FEPA license that swathe bathymetry surveys were to be undertaken at six-monthly intervals to monitor longer term dynamics of scour pits and wakes, scour protection and wider scale changes in bed elevation and patterns of net sediment transport.

- Another example of good practice can be drawn from the Alpha Ventus offshore wind farm in Germany, which was constructed in 2009, and has now become a fully functioning off-shore installation facility for significant research and testing. Among its several research projects funded by the federal government, Alpha Ventus has carried out investigations of the flow conditions in the wind farm and has verified the suitability of scour protection for foundations. The facility has tested various types of scour protection, from rock and granular sands to geo-textile containers, testing their durability to withstand strong storm currents and installation methodologies.

Examples of lessons learnt

- A research project was set up at Scroby Sands offshore wind farm to provide the regulator with a set of coastal process data from before, during and after the construction, which could then be used to calibrate numerical models in shallow water sandbanks. Previously due to the high energy environment at the top of sandbanks numerical models were poorly calibrated due to the lack of real time data. The success of this project has provided the regulators with the reassurance that decisions on potential impacts in such situations as building near or on sandbanks can be supported by evidence, as can be seen below.

Figure 21 - Fledermaus image showing the scour protection around the base of the monopile, along with the secondary scour pits



- The scour wakes observed at Scroby Bank were classed as insignificant in comparison to the natural changes which occur there. The results also concluded that there was no change in the overall elevation across the bank and it maintained its overall morphology (structure/shape/pattern). These conclusions provided the regulator with a degree of confidence that bathymetric impacts on monopile-based offshore wind turbines are probably limited to 100m around each monopile. This has allowed regulators to ensure that the minimal spacing between each foundation is 300m reducing the bathymetric impacts cumulative risk across the array.
- Associated studies such as plume modelling can also be used to determine the fate of the material scoured away from around wind farm structures and cables including any far field effects this may have, including effects on sand waves. A good understanding of the coastal processes and sea bed changes within an area will allow an assessment of appropriate scour counter measures associated with marine foundations. This information can then be used to assess the optimal cable routes and burial techniques to be undertaken.

Implications for Policy and Practice

- Implementation of clear, research driven, generic guidance on all monitoring aspects associated with scour protection before, during and after construction. The guidance will then provide the regulator with a consistent approach which will allow a better understanding of the coastal processes and the appropriate level of mitigation required to reduce the impacts on the environment.

Key Issues Identified No. 3: Effects on marine birds and on migratory land birds

These issues are considered in Thematic Case Studies 1-4 (Species impacts onshore and offshore, Impacts on habitats, Biodiversity, Cumulative impact). Marine birds are potentially subject to dangers from collisions, especially if they are species such as gannets which frequently fly at turbine blade heights, and are slow maturing and slow reproducing. Potential avoidance of wind farms is another issue. Migratory land birds may be attracted to navigation/safety lighting at night or in certain weather conditions, which may put them at risk of collision, or of disorientation leading to mortalities through exhaustion over the sea.

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- **EU Directives**

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Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (Birds Directive)
Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment (SEA Directive)

Case Study theme 8 – OFFSHORE – Human commercial activities: fisheries, Marine industries, seabed issues, landfall sites

The main barrier

The impact on human commercial activities is one of the main barriers for developing offshore wind farms. Initial experiences in developing European offshore wind farms have revealed the conflicts with the various commercial activities which are carried out in offshore waters including fisheries, marine industries and also with seabed issues and landfall sites. While offshore wind power has received a positive evaluation by international organizations on marine protection and is successfully operating in a growing number of countries, some potential offshore projects have been stopped by rejection platforms and actions in other European areas with regard to commercial issues, such as tourism. Therefore, beyond the environmental and technical issues, local differences between countries should be analyzed in the light of the cultural context.

Case study purpose

The purpose of this case study is to cite experiences and attempts already made to overcome this barrier in the future. Good practice examples have been identified on offshore projects that have been successfully developed with the support of commercial stakeholders from the same offshore area, and corrective measures have been recognized with regard to works in seabed and landfall sites. Sharing good examples helps others to find solutions that have worked out successfully in other European areas. Lessons learnt have been sought from offshore projects which have faced problems or issues relating to conflicting human commercial activities. The thorough analysis of these cases can be the best way to avoid repeating unsuccessful experiences in other projects.

Case study research methodology

The case study was based on an extended review of academic literature and other material including decisions, technical bulletins, conclusions, consultations, press releases and questionnaires for stakeholders.

Key issues identified

Offshore commercial activities which share marine zone with offshore wind turbines are:

Human commercial activity	**Main disturbance/space shared**
Coastal tourism	Landscape
Fisheries (fishing, processing and aquaculture sectors)	Offshore area, fishing species distribution
Recreational boating	Offshore area
Offshore oil and gas extraction	Offshore area, seabed
Maritime services (maritime education & training, coast guard, shipbrokers)	Offshore area, landfall sites
Seaports & related services	Landfall sites
Shipping & Maritime transport	Offshore area, landfall sites
Shipbuilding	Landfall sites
Maritime works (e.g. dredging)	Offshore area, seabed

Other key issues identified in this TCS, which were identified in the previous report on key environmental issues relating to wind farm development of GP WIND, are as follows:

- Multiple uses
- Marine environment
- Identity culture, related to fishery areas
- Policy conflicts

- Cumulative impacts
- Depth of water
- Environmental value of location
- Grid Issues
- Corruption Issues

Catch at Nysted Wind Farm (Denmark)
(Danish Offshore Wind- Key Environmental Issues)

The scale of these barriers is similar across the EU, but the conflicts depend on several issues, including the economic activity of each area, the existence of other offshore wind farms in the area, the existence of policy divergences, the technical costs due for example to the water depth and grid issues, the climatic conditions in regard to the existence of conflicts with tourism, etc.

Examples of good practice

- ***Marine Spatial Planning for siting potential Offshore Wind development areas***

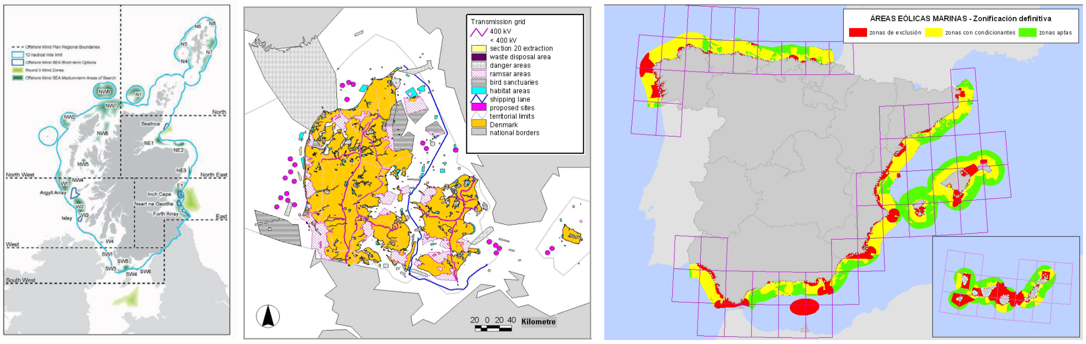
The seas are generally multiple use areas and integrating wind energy optimally in this mix is a challenge. The IEE funded SEANERGY2020 project provides in-depth analysis of national and international Maritime Spatial Planning (MSP) practices, and policy recommendations for developing existing and potentially new MSP for the development of offshore renewable power generation.

In order to ensure that the future development of offshore wind turbines does not clash with other major public interests and that development is carried out with the most appropriate environmental and socio-economic prioritisation, it is important that the most suitable sites for future offshore wind farms are identified through the use of mapping systems. Areas that it is important to map are: shipping routes, cruising routes, fishing areas, areas in which other marine industries such as oil and gas operate and areas with other technical constraints.

Detailed information on significant maritime activities by Member States can be found within the DG for Maritime Affairs and fisheries website. Examples of spatial planning are:

- "Roadmap for Maritime Spatial Planning". This is a key instrument for the Integrated Maritime Policy of the EU. It helps public authorities and stakeholders to coordinate their action and optimises the use of marine space to benefit economic development and the marine environment. It is a tool for improved decision-making and it provides a framework for arbitrating between competing human activities and managing their impact on the marine environment.
- "Blue Seas Green Energy" is the Sectoral Marine Plan for Offshore Wind in Scottish Territorial Waters and utilised a marine planning approach to guide development of offshore wind energy around the coast of Scotland. The process identified that there are generic issues related to shipping, fishing and environmental impacts which apply in all offshore wind plan regions around Scotland. In addition, there are significant environmental and cultural issues in certain regions such as visual impact and the effects on tourism. In the West and South West regions, community engagement and public acceptability were viewed as significant issues. A marine spatial planning tool, the Marine Resource system (MaRS) was used as a scoping tool in order to identify options (areas of search). These areas are the least constrained with enough wind resources.
- The Spanish "Environmental Strategic Study of the Spanish Coast for the Installation of Offshore Wind Farms", is the first planning document for regulating offshore development, laying down the administrative procedure for approval of power generation facilities in the territorial sea (a suitable zoning system has been established with three types of areas: "exclusion zones", "suitable areas with environmental conditions" and "suitable areas").
- In Denmark, the Committee for Future Offshore Wind Power Sites has examined in detail 23 specific suitable sites of 44 square kilometres each in an overall area of 1012 square kilometres

divided into 7 offshore areas. Relevant information is available in the public document "Future Offshore Wind Power Sites -2025".



Short-term sites & Medium-term areas of search for Blue Seas-Green Energy (Scotland); Danish indicative planning map for offshore wind; Spanish Offshore Wind Areas Map

○ *Close engagement with fisheries and other users of the sea*

Apart from communication and social acceptance issues which are analysed in both TCS 9 and 13, the involvement of fishery associations from the earliest stages of the consenting process is vital to the successful establishment of offshore, as they play a key economic role in the coastal communities.

- "Blue Seas Green Energy" is a good example of how an agreement can be reached to meet every party's demands and constraints. A Stakeholder Engagement Plan was developed to support its SEA (Strategic Environmental Assessment) which sought to understand the views of a wide range of stakeholders including: Scottish Government, Consultation Authorities and Agencies, Non-Governmental Organisations, land owners, marine users, wind farm developers, and the wind industry supply chain. During the stakeholder consultation, the two main issues raised by developers and the shipping and fishing industries were associated with navigation and inshore fisheries. Then, Marine Scotland included additional data on these topics of concern in the Plan.
- The Zèfir Test Station project (Spain) involves the development and setting-up of a deep-sea offshore wind turbine test station off the coast of Tarragona (it is in the consenting process stage). Local fishery associations and Tarragona harbour have been contacted regarding this project, which has helped fishermen to understand the issue of offshore wind and they have been assisted in negotiations for future offshore commercial projects. Appropriate permission has been asked from a petrochemical company to avoid future conflicts of interests in the use of the sea.
- Another strong example comes from Belgium, which has defined a 200 km² area far from the shore (to avoid local population's opposition), subdivided into 7 concessions, which have no interaction with other economic activities. The area was defined "after consultation of all Belgian sea users in order to better respect the constraints related to the numerous and sometimes incompatible uses of the North Sea. The area was established at a relatively respectable distance from the shore". By so doing, there is no competition between wind farm development and other human activities in the North Sea.

○ *Finding synergies with other maritime activities and organizations*

It is often possible to identify shared interests with other commercial activities within wind farm project areas. For example, aquaculture, large desalination plants or the development of artificial reefs to improve fish stocks. Wind farm areas may form 'nurseries' for fish which can improve catches of adult fish in the surrounding zone. Also, since the foundation structure in an offshore wind turbine is large and stable it may in the future be combined with ocean energies to give additional power production at a given offshore site. Examples of such synergies include:

- A study on the feasibility of fisheries and aquaculture within offshore wind areas by the Flemish Institute for Agriculture and Fishery, about the impacts of offshore wind farm development on fisheries. The survey advocates that every opportunity for alternative fishing or mariculture must be seized.

- Good references are provided from the Marine Institute of the University of Plymouth (UK), through an interesting project titled 'Suitability of Offshore Wind Farms as Aquaculture Sites'. The study analyzes the suitability of aquaculture in offshore wind farms in order to contribute to commitments towards marine spatial planning
- In the case of the project Zèfir Test Station (Spain), potential synergies have been found between marine industry and the offshore wind project, as a local petrochemical company found interest in entering the renewable energy market.

- ***Environmental monitoring programmes***

An **EIA**, at the minimum, as well as **geophysical and geotechnical surveys** of the seabed must be carried out as preliminary investigations in order to clarify all environmental issues concerned and to determinate the more adequate mitigation measures and techniques for avoiding the environmental impacts evaluated. However, once the wind farm is operating, environmental monitoring can be the best way to understand the real environmental effects of the offshore wind energy on the seabed and marine life, among others.

Good practice examples are found in the offshore wind farms at Horns Rev and Nysted in Denmark, which were planned not only on the basis of extensive EIAs, but were also followed up by an ambitious environmental monitoring programme from 2000 to 2006. Benthic fauna and flora were analysed, with particular focus on the consequences of the introduction of a hard-bottom habitat, which is the turbine foundation, and scour protection. Investigations into the effects on fish and fish behaviour from electromagnetic fields were made at Nysted. Data has shown some effects from the cable route on fish behaviour indicating avoidance of the cable as well as attraction, depending on the species. However, only flounder showed correlation between the phenomena observed and the assumed strength of the electromagnetic fields. The 'Danish offshore wind - Key Environmental Issues' Study, published by DONG Energy, Vattenfall, Danish Energy Authority and Danish Forest and Nature Agency in November 2006, shows both monitoring programme results.

- ***Floating foundations***

Floating foundations can overcome potential impacts on seabed while can allow to extend the offshore wind farms into transitional depths and eventually deep seas. In Northern Europe, Germany is moving into sea depths greater than 30 metres, with the commissioning of Alpha Ventus and construction of BARD Offshore 1. The UK is expected to continue to exploit its shallow waters for the next few years, but the Round 3 projects are planned in depths of up to 70 m. Norway is currently developing foundation structures suitable for deep sea wind farms. In addition, floating foundations are expected to be tested in Spain, in the second phase of the future commissioning of Zèfir Test Station, where 8 turbines are planned in depths of more than 100 m, and in the SeAsturlab Project (Phase 2) in waters of depths between 60-200 m.

Examples of lessons learnt

Despite the level of development of onshore wind energy in Spain, organised opposition has developed to in several offshore projects. "The crosses of the sea" and "Trafalgar Sea" projects (on the Cadiz coast) have led to the creation of associations for sea defence, mainly organized by the tourism sector and other economic interest associations in the area. The main objections are concerned with insufficient information about the unprecedented activity in the offshore area. Existing sea users are quite sceptical about compatibility as they do not have precedents for this type of development. However, onshore wind energy is highly developed in this region, roviding a good base from which to extend good practices regarding tourism and other economic interests to the offshore situation.

Implications for policy and practice

Developers and authorities are the main parties that can overcome these barriers. The key implications of this case study are: Marine planning for potential offshore areas must include information on inshore fisheries and navigation routes, as well as opinion surveys from commercial activities operating in the offshore area. Stakeholders must be fully involved from the early stages of the project and must be involved in all strategic meetings, etc. Regulatory rules should include siting guidelines and zoning of possible areas for offshore wind farm developments, as well as measures for avoiding environmental impacts and mitigating visual impacts of landfall sites. Preliminary knowledge of fishing activities is required, so later changes in fishing patterns can be detected. In order to manage the social effects of the implementation project, simulations could be done with regard to the position of fisheries and other commercial activities to assess sensitivities. Offshore experiences must be shared and the information provided by developers to all stakeholders must be clear and transparent. Potential impacts must be clearly highlighted and mitigating measures proposed. Results of studies and monitoring should be published (e.g by including a requirement in consent conditions), in order to share good practice and to stimulate appropriate application and parallel approaches in other European countries.

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Wind farms examples

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'BARD Offshore 1' offshore wind farm, Germany. http://www.bard-offshore.de/en/projects/offshore/bard-offshore-1

ZEFIR Offshore Test Station project, Spain. http://www.irec.cat/index.php?option=com_content&view=article&catid=9&id=129&Itemid=20

'Horns Rev' offshore wind farm, Denmark. http://www.hornsrev.dk/Engelsk/default_ie.htm

'Nysted' offshore wind farm, Denmark. http://www.dongenergy.com/nysted/en/Pages/index.aspx

Maps and IEE programmes

http://www.seanergy2020.eu/

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Case Study Theme 9 – Communications, Awareness, Information Cascades

The main barrier

Wind energy projects exist within and not separate to communities. A number of factors can often lead to mistrust, anxiety and low levels of acceptance which can directly or indirectly affect consenting and subsequent processes. These factors may include a lack of information, one-sided consultations, a breakdown of communication, and misinformation. Consenting Authorities do not accept incomplete information exchanges and nor should communities. It is natural for them to place the burden of proof concerning significant changes to their area proposed by outside interests, on those interests. Complete, two-way communications between a project promoter, consenting authorities and the community at the outset can minimise problems with misinformation, reduce conflict with other interest groups, reduce risks, shorten consenting lead times and lower the cost of planning for all involved in the process. Consenting authorities do not always communicate their own strategic goals clearly and consistently, creating a confusing landscape for wind project planning. Furthermore, political leaders in the community legislate national energy and environmental policy but may at the same time support opposition to the implementation of such policies at a local level.

Case study purpose

This case study seeks to distil and convey the collective knowledge from across Europe by showcasing examples of lessons learned and current good practice in a variety of settings and jurisdictions. Stakeholders in different regions encounter many similar challenges thus there is potential for acquired knowledge to be passed on and developed further elsewhere.

This case study on communications will be of interest to all wind energy stakeholders. It may be of particular interest to smaller wind developers who may not have developed a corporate communications strategy for their projects. It will also be of interest to community groups, leaders and consenting authorities who may find potential solutions for their challenges.

The concept of *not in my back yard syndrome* (*NIMBYism*) is an over-simplification of complex siting issues. Labelling of stakeholders in this way is only serves to make engagement adversarial rather than collaborative, and risks overlooking, or appearing to have a condescending attitude to, legitimate concerns. This case study hopes to contribute towards removing *NIMBY* from the wind energy lexicon. Theme N. 9 is complementary to Theme N. 13 which addresses community *buy-in,* Theme N. 14 on community benefit and Theme N. 15 on public perception.

Case study research methodology

The content of this thematic case study is built upon the contributions of GPWind partner organisations, and engagement with their local stakeholders through surveys and workshops. These contributions are combined with a wider literature review of research and current good practice.

Key issues identified

In the *information age* there is widespread availability of resources on the topic of wind energy. The key concerns raised by potentially affected parties are to some degree alleged adverse health effects, damage to property values, and to a greater extent environmental and visual impacts, noise, and impacts on other economic or sectionally important interests. Wind energy development may impact these areas, and the degree to which it does should be assessed and communicated accurately.

However, it can be difficult for stakeholders to reconcile global, national and local benefits with potential local impacts irrespective of whether they are real or alleged.

Examples of good practice

Governments and consenting authorities should proactively communicate their own renewable energy objectives through clear policies and targets complemented by robust, holistic strategies, thus setting the context for efficient consenting processes. For example, the Planning Guidelines for Wind Energy (Ireland) provided design signals to developers and planners and provided the impetus for the creation of wind energy strategies. The strategies include maps which communicate where wind energy is encouraged, potentially acceptable or unacceptable. These *locational signals* are a key consideration for consenting. It is vital therefore that the strategy is developed to best practice, incorporating all applicable environmental, social, economic and energy policies and objectives.

In 2006 the provincial administration of Savona (Italy) collaborated with Tecnocivis to establish an *Energy Desk* for the dissemination of information about authorisation processes, funding options for the realisation of energy projects and the hosting of energy events and exhibitions. APERe (Belgium) a publicly funded energy bureaux have published the *Rumours and Realities* of wind energy for their community (Rumeurs et Réalités). North American conservation group *The Sierra Club* published a literary review entitled 'The Real Truth about Wind Energy' to address the misinformation they encountered during their own research.

The independent Sustainable Energy Authority of Ireland (SEAI) disseminates many publications on the impacts and benefits of renewable energy, hosts topical events, publishes factual data about wind energy's impact on emissions and markets. A *Renewable Energy Information Office* was created to assist in providing independent information to communities.

Figure 1: Local stakeholders attending an SEAI hosted GPWind workshop

Developers of projects should maintain up-to-date and complete websites, social media networks and newsletters about the environmental and economic impacts and benefits of their project to the locality (access to the internet should not be assumed). Some examples of this include Pindos Energy (Greece), Bord Gáis Energy (Ireland), SSE Renewables (UK) and Iberdrola Renovables/ScottishPower Renewables (Spain/UK). However, in general, much of the information provided by developers is with respect to generic global benefits and constructed wind farms rather than isolating local impacts and benefits of planned or pre-construction projects. Local benefits such as municipal charges, leases, rates, taxes or financial development contributions should be detailed, in particular in areas where scarce municipal funds can be supplemented by wind energy projects.

A complex mediation process facilitated by the Municipality of San Marco dei Cavoti (Italy) has recently concluded with the consenting of a 12 turbine wind farm in Campania. The original project plan was for 30 turbines. However the process involved a local committee and ended with a revised plan for the formal consenting application. Many European consenting authorities facilitate an informal *pre-planning consultation* which assists project designers in understanding specific local issues.

Terpandros and Antissa wind parks on Lesvos Island (Greece) are situated in an archeologically protected area. As such it was very important for the developers, Elliniki Technodomiki Anemos S.A, to keep the local community fully informed. Local tourism operators, owners of holiday villas and other land owners were kept fully informed by the developer and a sensitive design approach, harmonious to the surroundings was adopted. No objections were encountered during the consenting of the project and the discovery of new fossils during developer funded excavation works enhanced the existing Petrified Forest Park, a *UNESCO Global Geopark*.

Estinnes Wind Farm (Belgium) was built in 2010 and utilises the largest onshore wind turbines in the world (7MW, 135m hub height). The proposal to use such large wind turbines was not without risk so the developers worked closely with the community. A scientific approach presented the positives and negatives of using 3MW or 7MW turbines and two separate environmental impact assessments (EIA), which *inter alia* limited the zone of visual influence, and created trust in the community. Local authorities and political leaders were positively disposed to the project and communicated their support with the community. Since inauguration a developer sponsored rock concert is hosted on the site each summer (*Rock'Eole Festival D'Estinnes*). Tours of the wind farm are available during the event.

Large scale wind turbines are often installed in *brown field* or industrial sites. The local benefits of such installations can be easier to communicate compared to a grid connected *green field* site. Projects generating clean electricity for an organisation which employs or benefits local people enjoy very high levels of support. Dundalk Institute of Technology (Ireland) installed one 850 kW turbine on-campus and in a residential area. The project was not objected to by any neighbours. The project team ensured all local people were engaged with in person.

Figure 2: DkIT (left) and Munster Joinery (right) (Courtesy of CREDIT and Wind Energy Direct)

Munster Joinery installed two 2 MW turbines on their industrial site in a rural area. The turbines were installed with the goal of making the business more competitive and thus securing local employment. Such rationale must be clearly communicated during the planning phase.

Allowing ongoing access to completed projects opens communication channels which can change perceptions of wind turbines- which are often only viewed from a distance. If ongoing access is not feasible, Global Wind Day occurs on June 15th each year and developers can take the opportunity to open their projects to the public, host organised events for schools, the local community or for residents close to a proposed project. Allowing access to wind energy developments can communicate the ability of well implemented projects to integrate with their environment post-construction. SSE Renewables have hosted walking events on their wind farms. Such events promote engagement with conservationists and outdoor enthusiasts who often provide input on planned projects.


Figure 3: Local community and consenting officials visiting an Airtricity/SSE Renewables Wind Farm

Some wind farms include visitor centres. This may not be a viable option for every project however an onsite display (and website) which showcases the project may help communicate the benefits attributable to an individual project. Sometimes, due to poor communication, the local benefits (e.g. to municipal budgets) or community gains are underestimated and at other times the expected benefits are unrealistic. Community benefit schemes or ownership models should be transparent and well communicated e.g. Fintry Development Trust (UK)
In Monaghan (Ireland) a community forum developed a Guide to Good Practice in Community Consultation. It sets out the principles and framework of good consultation. Other good examples are the WindProtocol project (UK), which includes a protocol which can be adopted by stakeholders, and the Canadian Wind Energy Assoc. guide to engagement.

Examples of lessons learnt

Some project promoters choose not to engage with local interest groups or residents. Some stakeholders have indicated that developers can be derogatory, dismissive and lack understanding of local concerns. Similarly, local stakeholders around a number of projects studied reported that there was no communication from the developers and they relied on the local authorities for information, who were in turn having difficulty accessing information from other stakeholders.

Promoters of projects must avoid an adversarial approach to engagement at all stages of the development process. Local stakeholder concerns should not be labelled as *NIMBYism* in order to avoid the risk of alienating a section of the community, and to risk entering into a contest which both *sides* feel they must win.

The engagement should be tailored to individual stakeholder groups so that they can assign their limited resources appropriately. Where it is not possible to modify certain constrained elements of a project, e.g. 'the turbines must be 85m high for the project to be viable', these should be identified and explained clearly from the outset so other areas can be concentrated on during consultations. Consultees who have wasted their time on unmodifiable elements of a proposal often feel ignored by the process. Feedback on what has happened as a result of the consultation should be provided.

Whilst awareness of energy and environmental issues can be high in some communities and among individuals, school curricula should include such topics to provide a foundation for balanced decision making later in life. Project promoters often operate a so-called *deficit model of consultation* i.e. information is provided but no real two-way communication takes place. Promoters often engage in a process which is simply trying to convince rather than consult.

Implications for policy and practice

Communications and awareness are, to a large extent, within the control of project promoters. However they must engage completely with stakeholders with the support of clearly communicated national policies, regional strategies and independent factual information.

Government and consenting authorities should communicate a framework for the implementation of policies and targets. This framework should assist consenting officials, developers and stakeholders to clearly understand the appropriate processes and potential risks.

The environmental benefits and impacts of indigenous wind energy should not be described in a 'this project or no project' context or vacuum. The project should be set out in comparison to the environmental impacts/benefits/advantages/disadvantages of other options for satisfying local and national energy and security requirements into the future.

Independent or state agencies can assist with providing accurate information and allaying of fears - or indeed confirming examples of bad practice. Independent energy bureaux and sources of information and advice are becoming increasingly important in an age of information overload and where communities are seeking help in developing their own position. Indeed, Article 14 of the Renewables Directive sets out high level information and awareness requirements for Member States.

Project promoters must engage in meaningful and real ways with local stakeholders at the earliest possible opportunity. Often, this will be long before a decision is made on whether a project is viable or not. If a local community is not engaged at the outset it is much more likely that they will set the communication agenda and schedule (using all available social media) and the promoter will be required to reactively defend the project from local criticism- rather than being proactive. Real engagement must continue from the site assessment through to construction, and continue during operation (each project will affect the next). The local stakeholders should have a contact for any concerns or questions they may have during the construction and operation of the project. Developers should consider employing a local person as a community liaison or construction supervisor. Communities should consider appointing an individual or council to liaise with the developer.

As well as verifiable global and national benefits, local impacts and benefits should be identified and presented in detail. Community gain should be identified and communicated clearly. Innovative community gain models should be considered e.g. leveraging Government incentives for energy efficiency or renewable technology. The revenues accruing to local authorities in development fees and taxes should be itemised and only allocated to local budgets and projects.

Wind energy's disadvantages should not be understated in communications**.** Characteristics such as intermittency, environmental impact, carbon accounting, visual impact etc. should be acknowledged and dealt with in a manner which prevents such well known issues being portrayed as *showstoppers* or road-blocks. National support mechanisms and subsidies should be explained clearly and contextualised e.g. when the wind isn't blowing the wind farm is not being subsidised.
And finally, remember: **Trust takes years to build, seconds to destroy and forever to repair.**

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Case Study 10 - Landscape & Managing Visual Impact

The main barrier

Attitudes to landscape and visual impacts are culturally sensitive and vary from place to place. Their importance should not be underestimated, however, as they are a major factor in quality of life to many people, and so a legitimate cause of concern. For these reasons the visual impact of wind farms on the landscape and seascape can be a significant barrier to their consent and deployment. Because of their size and location (for example, on the ridges of the hills, or viewed from sensitive coastal locations) the wind turbines can modify local views by presenting industrial features within the landscape or seascape which may in turn be perceived to impact upon the local visual amenity and tourism assets. Siting and integrating new developments within the landscape character by careful assessment of the location, scale and design of the wind farm helps secure community acceptance and the development of this renewable energy source.

Case study purpose

This thematic study explores the problems of "Landscape and Visual Impact" related to the implementation of wind farms. Through a thoughtful examination of good examples of solutions and mitigation – by considering how difficulties were successfully overcome – we attempt to draw out lessons for the future and how these can contribute to the development of wind energy.

Case study research methodology

A literature review has been undertaken (both technical and scientific) and an examination of environmental assessment procedures (EIA) adopted by public authorities for the implementation of wind farms examined. The key issues have been identified from consultations with stakeholders and the cataloguing of good and bad practice examples.

Key issues identified

In order to mitigate the visual impact of wind farms and arrive at a shared acceptance of them, various factors have to be considered:

♦ Landscape character and scenery

The siting of wind turbines and their ancillary facilities (stores, substations, transmission lines, roads, etc.) affects the scenery properties (panorama) of a place. The size and scale of infrastructures involved cause an evident contrast with the surrounding scenery in which they are implemented. It is not by chance that visual impact of wind farms seems to be the most important barrier to the deployment of this technology.[1]

Hills of Fortore

[1] Many studies agree in identifying the "visual impact" as the most serious barrier to the development of wind source. *M. Wolsink, 2007* – p. 1193, http://www.sciencedirect.com/science/article/pii/S1364032105001255

♦ Landscape as amenity

Amenity pertains to resources available for peoples' convenience, enjoyment and comfort. In this sense the value of a "landscape/place" – as residences, recreational areas, travel routes, etc – is influenced by its use. In addition to the dominant and obvious visual element of wind turbines, there are other effects that may impact on amenity, as *flickering* (cast moving shadows caused by rotating blades), *sun-glint and strobing* (caused by sun reflecting from the blades), *overshadowing, etc*.

Fortore countryside

♦ Landscape as cultural heritage

Landscapes can be recognized as part of the historical, cultural and social heritage of a nation, a people or a community. National and local governments throughout Europe have formally designated landscapes as part of their cultural heritage in order to preserve them for future generations. In these areas, an inappropriate approach to design or siting of wind farms is risky and ill-advised.

Examples of good practice in managing visual impacts:

- **Visualisation during the planning process - Stornoway Wind Farm Project (Isle of Lewis)**

  Although this application is still under consultation, the visualisation methodology can serve as an example of good practice. Versions of this project had been rejected twice. There were more than 11,500 objections, many of which criticised inaccurate visualisations of the turbines in the photomontages. With a third application, the developer made available a 3D Interactive Wind Farm Model, which could provide a simulated 3D image of the proposal from any site, home or business. The public responded positively, and no further criticisms regarding the visualisation were raised (there are also serious bird issues at the site). The model cost around £30,000 and is available on a CD-ROM.. Further information is available on http://www.stornowaywind.com/march-2011-public-exhibition/.

  Guidance from authorities

  Scottish Natural Heritage have produced, in consultation with stakeholders, a Guide to Siting and Designing windfarms in the landscape (Scottish Natural Heritage 2009). It was developed for Scottish physical and social conditions; however, much may be generalised to other regions. The approach is capable of adaption, and has advantages for stakeholders seeking accessible information on good practice relevant to the jurisdiction they are operating in.

- **The bottom up approach**

  Estinnes wind farm (Valonia – BE) is made up of the some of the tallest and most powerful onshore wind turbines of the world : 11 E-126 Enercon wind turbines, tip height of 198 m (rotor included) and with a 6 MW nominal power. These giant turbines produce 187,000 MWh/year, the equivalent of the consumption of 55,000 average households. In terms of managing the visual impact, different options were studied and presented, using and comparing photomontages. 3 wind turbines were finally moved during the planning phase to limit the max visual angle to 90°. The project only received a few remarks from residents during the public consultation process and was accepted in the first instance. It must be underlined that the distance between houses in Estinnes is 700 m or more, while for common 2 MW turbines, the legal distance is 350 m minimum. Although only one meeting during the siting and planning phase is compulsory in the legislation (before starting the EIA), several other meetings were planned by the developer. These meetings were planned to present the results of the EIA and provide information on the follow-up of the project. Some of these meetings were specifically aimed at the residents directly impacted by the wind farm or scheduled by district s. The two options for the project (classical 3MW turbines versus 6MW turbines) were studied (2 EIAs were undertaken) and rigorously presented to the population with their respective pros and cons. This transparent approach is suspected to have helped create trust and confidence in the project among the local community. The local authorities were fully in favour of the project and communicated positively about it with the local residents.

<u>San Marco dei Cavoti</u> (Fortore, Campania Region - IT). The Campania Region authorized the construction of a new wind farm in the Municipality of San Marco dei Cavoti. The preliminary project involved the installation of 30 wind turbines of 1.65 MW for a total capacity of 49.5 MW. The final draft plans a reduction to 27.6 MW of installed capacity and a significant reduction in the number of turbines – 30 to 12 – choosing as reference the wind-turbine Enercon E70 of 2.3 MW. According to this criterion the estimated production is more than 55.5 GWh corresponding to an operability of 2.100 yearly hours. The changes represent the final part of a consultative process which began when the local administration decided to hold an open city council meeting in the project area. The local committee of citizens has thus been able to make its requests/opinions to the municipal government. After a difficult period of clearly identifying the issues of citizens' concern, these have been summarized as the need to avoid the "jungle effect" which would be caused by the large number of towers planned in a relatively small area.

- **Landscape restoration projects**
  "<u>Ecovent" wind farm</u> is located in Tarragona (Catalonia, Spain). The site is at an altitude of 550 meters. The 48MW wind farm was approved in 2001, with 37 turbines. The energy produced is conducted by five underground circuits located inside the wind farm; it is transformed to 110.000 volts in the substation and is evacuated to the local grid line. Its intrinsic visual impact is high due to the inherent fragility of the environment . Due to the wind farm being located on high ground the zone of visual influence or viewshed is very large. The nearest residential areas are located between 6 and 9 km, so the visual impact is minimized with respect to local neighbours.
  A Landscape Restoration Project was demanded as a planning condition of approval, including the restoration of the slopes of access roads and services, restoration of the substation and control building and restoration of the access roads to wind turbines.

- **Harmonizing projects with surrounding areas**
  <u>The example of Antissa</u> (Lesbos island - GR). This is one of the first communities within which wind power has been developed in Greece. The wind parks are harmoniously integrated into the surrounding landscape. The wind turbines feature underground interconnectivity, the adapters are situated within the relevant pillars, the Medium Voltage distribution line is concealed and the construction of the "settlement" is designed to be in harmony with the surrounding area. The development process was not encumbered by any obstacles. Overall, this is considered to be a very successful case of wind park installation and an example of good practice in implementing projects. The parks are fully adjusted to the existing infrastructure. Due to their excellent aesthetics, they constitute a popular tourist destination. Special care had been taken by the company during the design and implementation process to keep local residents and nearby local communities fully informed of all developments, as well as the avoidance of any disturbance (eg. visual, noise, from tourist activities) to the residents.

Examples of lessons learnt

Landscape impacts from wind farms cannot normally be completely avoided. From a scenery point of view, methods and techniques of hiding/screening wind farms may not be compatible with the need for optimal wind energy to be captured. Moreover, as the case of vegetative screening, given the sizes in play (height, etc), it can only successfully be used for specific purposes like hiding the development from a particular viewpoint. It is also appropriate to clarify that methods for moderating the visual impact of wind farms such as integrating their development with the surrounding landscape character (topography, form, colour, texture, etc) are not always easy to achieve and may have other undesirable effects. On the other hand, *careful layout which avoids particularly sensitive features, and enhances a wind farms positive attributes* can be a more effective tool (WFLV – 2004). Taking all this into account, it is possible to approach a number of design, siting and management options which, moderating the impacts of wind farms, can considerably improve their visual and landscape acceptability. Some of these options, provided by the experience and lessons learnt worldwide, are summarized below[2]:

1) Siting and layout Various layout options can moderate landscape impacts. For instance, clustering turbines can avoid significant view lines or landscape features (S), but it may also reduce the generating efficiency of the wind farm (W); Siting wind turbines by integrating them with existing landscape features, for example reflecting the line of ridges in hilly topography or in a grid formation in flat areas, can have a positive impact.

2) Height The height of wind turbines is undoubtedly a dominant element however it also is a design constraint – the higher the rotor and the longer the diameter of the rotor blade, the greater the amount of electricity produced. Hence, a reduction in rotor height or diameter may lead to an increase in the number of turbines proposed, which may in turn generate other unwanted effects including visual clutter and an increase in the amount of land required for the development.

3) Spacing and density Locating numerous turbines in an open landscape can have a negative impact for some viewers. Indeed the number of turbines in an "array" can be more detrimental than the height of the turbines themselves. According to studies, people are in general more likely to prefer fewer larger turbines than smaller ones. Further, impacts caused by groups of turbines can be lessened by avoiding dense spacing which creates visual clutter, and clustering turbines into 'functional units', with substantial open space between them.

4) Enhance positive attributes of wind farms Enhancing positive attributes of wind farms including their aesthetic form (using clean lines and modern materials), consistency of design (turbines of the same colour, design and height) and function (all turbines moving, thus appearing to be functional) can greatly increase the acceptability of wind energy.

5) Hiding-mitigating negative attributes of wind farms Despite the difficultly of screening turbines, it is possible to hide or mitigate some potentially negative characteristics of a wind energy facility, including power lines (e.g. undergrounding intra-farm power lines), roads (appropriately sited to avoid sensitive areas; colour integrated in the environment), and clutter (cleaning up the site and removing waste).

6) Colour and materials Careful selection of colour and materials can reduce contrast and visual impact of wind turbines on the landscape. Colours which are muted (soft grey, tan, cream) and materials which have a matte finish can reduce distant visibility and contrast. However, borrowing colour from the surrounding landscape can increase contrast, where the sky is the backdrop. Because of the scale of wind turbines, most views of the tops of the towers and the rotors are against the backdrop of the sky, and as such lighter colours are frequently recommended.

Implications for policy and practice

Landscape character assessment on a regional basis is commonly accepted as essential to understanding the relative values of landscapes. The "importance or relevance" of landscape features

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[2] The six "options" here listed are commonly accepted solutions resulting from studies and experiences worldwide carried out. In this case they are briefly mentioned from the *WFLV (Wind Farms and Landscape Values)* made by "*Australian Wind Energy Association and Australian Council of National Trusts*", 2004, pp. 8-10. http://www.lga.sa.gov.au/site/page.cfm?c=6175

mainly results from an understanding of its corresponding "meaningfulness" or type[3]. There are different approaches and techniques for rating this "significance". The most reliable – from our point of view – try to address and balance all potentially relevant values, both from the quantitative and the qualitative (subjective) perspective, such as: *quality of a scenery and natural beauty*, *rareness* (the uniqueness of a specific landscape), *visibility* (connected to the number of people viewing a landscape and from where…), *occurrence in the arts*, *etc*. Given that most of the time landscape impacts are inevitable once wind farms are developed, failures and errors in determining which impacts are significant can create conflicts and risks of delays to the development of the technology. This is why these "techniques/methods" are increasingly highlighted and valued in regional, national and European policies and planning. As crucial factors for the development of wind energy they also have clear public relevance which needs to be properly approached. Hence the need to involve hosting communities of wind farms from the earliest stages of the planning phase. Beyond the various mitigation techniques considered, this seems the fundamental approach which can contribute across Europe to successfully managing the landscape and visual impact of wind energy, and thus lead to an effective and inclusive development of this important renewable source.

[3] Landscape Character Assessment – UK, http://www.naturalengland.org.uk/Images/lcaguidance_tcm6-7460.pdf

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Wind Farms and Landscape Values (WFLV)	*Australian Wind Energy Association and Australian Council of National Trusts* http://www.lga.sa.gov.au/site/page.cfm?c=6175

Web links

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Energy Research Centre of the Netherlands: www.ecn.nl
IRECon Italia S.r.l.: www.energia-eolica.it
European Wind Energy Association: www.ewea.org
General Electric Company: www.gewindenergy.com
IVPC – Italian Vento Corporation: www.ivpc.org
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Case Study theme 11 – Dealing with noise issues

The main barrier

In 1996 the European Commission published a Green Paper on Future Noise Policy which was the first step in the development of a policy which sought to ensure that no person should be exposed to noise levels which endanger health and quality of life. This was in response to a recognition that environmental noise, from traffic, industrial and recreational activities is a significant problem in Europe and that there is a link between environmental noise and public health. At an EU level Member States are obliged to comply with the Environmental Noise Directive (END) (EU, 2002) Directive 2002/49/EC. In 2009 the World Health Organisation (WHO) European Region published Night Guidelines for Noise in Europe.

Wind farms, both onshore and offshore, can give rise to noise during their construction and maintenance, from the devices themselves during their operation, or from associated infrastructure such as transmission lines. Steps therefore need to be taken to ensure minimisation of such noise.

Case study purpose

The purpose of the case study is to examine the significance of noise issues related to wind farms, both onshore and offshore, and to indicate by the use of examples of both good and bad practice how such issues can be ameliorated.

Case study research methodology

The case study was based on a desk review of the available literature, together with consideration of specific examples and the elaboration of lessons learned from good and bad practice.

Key issues identified

The principal factors to be considered in relation to noise from onshore wind farms are:-

- siting of wind farms in relation to residential and other areas of human activity;
- distance of wind farms from areas of human activity;
- size and type of turbine;
- level of background noise;
- nature of the area in which a wind farm is sited, e.g. urban, rural or maritime; and
- monitoring of noise from wind farms during operational phases.

For the present purposes it may be considered that noise deriving from the construction phases of onshore wind farm development is a temporary phenomenon which can be limited by application of controls such as conditions of hours of work which are similar to the establishment of other engineering operations. Although there may be some noise issues arising from infrastructure associated with onshore wind farms, notably transmission lines, it may be considered that such issues are relatively minor in scale and annoyance and to some extent can be ameliorated by sympathetic design and siting of such infrastructure. The principal factors to be considered in relation to noise from offshore wind farms relate more particularly to the potential effects on marine, rather than human life forms and especially from low frequency emissions. A report produced in 2010 for the European Commission set threshold levels for underwater noise above ambient levels which might affect deployment of marine turbines. Baseline data and research is required as well as modelling and monitoring of noise from offshore wind farms and their potential harmful effects on the marine environment. Much work in this area is underway in UK and Danish waters and is/will be available through the COWRIE and DEA websites. However, it should be noted that the construction phase for offshore wind farms may also give rise to potential harmful effects; see also here, particularly on mammals, from noise, for example from pile driving.

Wind turbines generate noise essentially from two sources, firstly, from a gearbox and generator typically housed within a nacelle mounted on top of a tower; and secondly, aerodynamic noise from the turbine blades. Leaving aside micro-generation, there has been a significant trend over the past 10 years towards larger turbines with most turbines now having towers of 25 to 100m, rotating variably at 5-20 rpm in relation to wind speed and rated between 500 kW and 3MW. Turbines with larger outputs, in particular for offshore applications are in development and have recently entered commercial use. Advances in design have allowed greater sound insulation of the mechanical components within nacelles and gearless turbines are also becoming more common, thereby reducing sound emissions. A further factor to be considered is trend towards the replacement of smaller, older, turbines with larger newer models, whereby consideration has to be given to the relation between the total output from a wind farm as against the number of actual turbines present.

Industry norms show that a typical single wind turbine will produce a sound pressure level of 50-60 dB(A) at a distance of 40m from the turbine, decreasing to 35-45 dB(A) at a distance of 350m. To put this in context the latter range is equivalent to the rustling of leaves in a gentle breeze. However, there is evidence from surveys, notably in Northern Europe, that some people perceive noise from wind farms to be annoying, and demonstrably more than that from other sources of the same sound pressure level. It has also been shown that there is a correlation between annoyance caused by the flicker effect created by turbine blades and noise from turbines. These perceptions are compounded by other factors such as multiple turbines where noise may be increased incrementally. Furthermore, it has to be recognised that wind farms when in operation generate constant, rather than intermittent, noise.

While noise can be shown to drop away significantly with distance from turbines, account has to be taken of the fact that onshore wind farms are frequently located in remote and isolated rural areas where background noise levels are low. In addition, onshore wind farm sites are often chosen in high ridge type locations where the resultant sound may filter down into the surrounding lower areas, which may be inhabited. Care should also be taken with the detailed siting of individual turbines within a wind farm to minimise possible increased cumulative noise generation. At the same time it may be observed that there is a relation between wind speed and sound generated by turbines; over a certain level the prevailing wind conditions may generate noise other than from turbines themselves.

Overall there is little or no evidence of direct adverse effects on human health from noise generated by wind farms. There is some evidence that wind farms can generate infrasound and low frequency sound and amplitude modulation, (AM), of aerodynamic noise, which can be detected at considerable distances and which may cause problems for some people. However, the balance of opinion would seem to indicate that such people may have similar problems from other sources of infrasound and low frequency sound, such as air-conditioning. These findings were contained in reports for the DTI and others published in 2005 and 2007 in the light of press claims of adverse health effects from wind farms.

Examples of good practice and lesson learnt

UK – England and Wales

Practice on the noise aspects of wind farms in England and Wales, and more generally in other countries, is largely based on the seminal 1996 Report from the Working Group on Noise from Wind Turbines, ETSU-R-97. This Report sought to give guidelines on the measurement on noise from wind farms and indicative noise levels to protect neighbours while not unduly restricting the development of wind farms. Subsequently, and partly in response to criticism from wind farm neighbours and others, the Department of Energy and Climate Change (DECC) commissioned a report investigate the way in which noise impacts for wind farms are determined in England, including the methods used to implement the ETSU-R-97 guidance. This study concluded that there were variances in the way in which the guidelines had been implemented. A further study for the Department for Food, Environment and Rural Affairs (Defra) examined the use of Statutory Nuisance to deal with wind farm noise complaints, when resolution via the planning system is not possible or has been ineffective. The culmination of this recent work has been the presentation to Parliament in June 2011 of a final set of energy National Policy Statements, including Overarching Statements and of particular interest for the present purpose, Statements relating to Renewable Energy Infrastructure. It should also be noted that EN-3 Renewable Energy Infrastructure makes specific reference to the potential impacts of noise from offshore wind farms. An important conclusion from this work is the need for on-going consultation with wind farm developers, manufacturers and local communities, and for the continual review of standards, methodology and policy on noise thresholds

UK – Scotland

Practice in Scotland parallels that in England (and Wales). At a national level Scottish Planning Policy (2010), contains a requirement that planning authorities should set out in their Development Plans a spatial framework for onshore wind farms over 20MW generating capacity. At a more detailed level Planning Advice Note PAN1/2011 relates specifically to Planning and Noise and refers directly to noise from wind turbines.

2 specific examples in relation to current Scottish practice are useful:-

In 2011 an updated noise assessment was undertaken regarding the reduction of turbines from 22 to 17 at Dunbeath Wind Farm, together with an increase in output for each turbine, resulting in revised noise predictions based on agreed practice between practitioners in the field.

Also in 2011 following complaints from local residents the Highland Council ordered the temporary shutting down of Achany Wind Farm. The stop notice was subsequently lifted following compliance by the operator with a planning requirement for the submission of noise monitoring data.

Belgium

Estinnes wind farm was built in 2010 and comprises 11 E-126 Enercon wind turbines, each culminating at 198m (rotor included) and with a 7 MW nominal power, producing 187,000 MWh per annum.

However, when only 6 turbines out of the 11 were operational, several residents complained of disturbance by noise. Some claimed not to be able to sleep any more, some complained about headaches, psychosomatic troubles, or troubles due to infrasound, although the turbines were located at more than 700m from the nearest houses, beyond the 350m initially provided in the legal documents. The problem was exacerbated by negative media coverage.

The turbine manufacturer determined that an abnormal level of noise was emitted by two turbines, due to a resonance phenomenon in the nacelle and sought to resolve this issue. The developer also decided to:

- tether all wind turbines at night
- commission a noise study by the University of Mons in partnership with consultants
- send a newsletter to local residents
- organise a public information meeting

Once the developer could demonstrate legal standards for noise levels were being observed opposition quickly decreased. In addition scientific studies showing that noise levels of 40 dB(A) at night are harmless to health also helped to calm protests. The transferability of this approach to other sites is potentially high but will depend on the nature of the perceived noise nuisance, the importance of the local opposition, and the developer's willingness to admit and recognise their responsibilities.

Greece

The Terpandros and Antissa Wind Parks, Lesvos became operational in 2003 and produc 24.000 GWh of electricity per annum. The Wind Parks were harmoniously integrated into the surrounding landscape and the development process did not encounter obstacles. Special care was taken during the design and implementation process, in order to keep local residents and nearby communities fully informed of all developments and to achieve a harmony between the works and the surrounding environment as well as the avoidance of any disturbance (e.g., visual, noise, from tourist activities) to the residents.

A significant factor in the successful implementation of the Wind Parks was the elaboration of a Special Noise Study during the design and environmental authorization stages of the project. Use of modern turbines and appropriate wind park design helped to allow achievement of the legal and desired noise levels. This good practice could be replicated elsewhere.

Implications for policy and practice

The main conclusions may be summarised as the need for:-

- best possible design and pre-construction assessment to minimise noise problems
- careful siting with respect to human activities especially residential development
- stakeholders to work together and to share information
- continual review of methodology, standards and policy for wind farm design and noise thresholds
- manufacturers to review continually blade and turbine design to reduce noise
- continual monitoring of noise levels and ensuring compliance with conditions
- greater co-ordination of research and policy at an EU level including maritime matters

Bibliography for TCS 11

TO BE DONE (none submitted)

Case Study theme 12 – Conflicts with other economic interests including tourism

The main barrier

Wind energy is strongly favoured by energy policies in European countries and worldwide, and a crucial pillar to address climate change. It is of relevance both to environmental protection and to energy policies that can also provide socio-economic prosperity while serving the aims towards sustainable development both at the EU and national levels. However conflicts with other economic operators are often detected as barriers to the deployment of onshore and offshore wind generation. In this sense, resistance is often encountered from other economic activities that operate in areas that are environmentally and technically suitable for the operation of wind farms.

Case study purpose

This thematic study examines any potential economic interests that are typically in conflict with wind farm developments while offering possible solutions for overcoming them. Examples of good practice have been selected with the aim of illustrating practical examples of solutions to minimise the conflict between different economic uses. Also, lessons learnt have been identified from case studies that were not approached properly. The comparison and thorough analysis of such cases studies can be the best way for repeating successful experiences in other sites while avoiding unsuccessful ones.

Case study research methodology

This paper was based on a review of extended literature, questionnaires for stakeholders, wind farm study visits and related material (e.g., decisions, technical bulletins, conclusions, consultations, etc.). Structured research questionnaires were used in order to standardise input from the different case study sites.

Key issues identified

A review of literature on wind farm case studies indicates that the major key issues related to dealing with conflict between economic operators in the area are:

- **Tourism**: it is often suggested that the installation of wind farms in some places (for example where they are prominent in the landscape) may reduce or even eliminate well-established human activities, such as those related to tourism. The perceived impacts of wind energy developments on tourism create an interesting problem. Wind farms may be represented as damaging the landscape, such that tourists will be deterred from visiting, but other studies suggest that any impact wind turbines might have on tourism is small, in some cases they can be popular attractions for tourists (Pasqualetti *et al*. 2002), and that enjoyment of holidays can be unimpaired by the presence of wind farms (Clark, 2003). Nonetheless it remains crucial to address the issue seriously by including a **Tourist Impact Statement** as part of the planning process.

- **Other economic interests**: Despite the demand for energy, resistance is sometimes encountered from other economic activities which operate in the same area.

- **Agriculture and animal husbandry**: local farmers occasionally have objections to the development of wind farms in their areas, while considerable experience demonstrates the feasibility of its coexistence with onshore wind farms. E.g. livestock owners in the area can graze animals within the windfarm and can reach an agreement with the wind farm property. They may therefore prefer to have a wind farm instead of another economic activity on the site.

- Impact on other **conventional and renewable generation systems** in the area.

- **Electromagnetic interference** (like scattering, masking, return/clutter etc) used in telecommunications, navigation and radar/microwave services nearby. The concern with electromagnetic interference (EMI) emitted by wind turbines is most usually with the disruption of telecommunication facilities, and in some cases TV reception (Harland, 2000). However, these issues can be easily addressed where necessary through booster or relay stations, and there are quite a few examples of wind farms that operate close to telecommunication sites or microwave corridors without causing any problems (Gipe, 2002; EECA, 1996).

- Impact on **property prices**. There is still no international evidence to support any claim of a decrease in property value that might be present in communities surrounding wind energy facilities. Specifically, neither the view of wind turbines or the proximity of houses to them is found to have any measurable and statistically significant effect on home sales prices. On the other hand, anecdotal evidence exists of increases in house prices (Hoen 2009, Reese 2006, Sterzinger et. al. 2003).

The existence and scale of these barriers is very variable depending on the location of the wind farm and the culture of the area affected. The existence of specific regulations (e.g. zoning) for the construction of wind turbines within a particular area does not imply the local community has fully accepted the concept.

Key issues related to conflicts concerning offshore wind farms, such as shipping routes, ports, fisheries, tourism, etc. are included in the theme study number *8. Offshore – Human commercial activities*.

The development of local employment is is covered in Case Study 14, *Community Benefit Schemes*.

Examples of good practice

- ***To include the wind farm in a local tourist route***

'Les Colladetes' wind farm is included into a touristic route (Catalonia, Spain)

Several examples are currently in operation, such as 'Les Colladetes', 'Les Calobres' and 'Conca de Barcera', in Catalonia (Spain). The first of these is open to the general public throughout the year. An information board is provided at the crossroads for visitors. Other good examples are the 'Terpandros' and 'Antissa' wind farms on Lesvos Island (Greece). These have been harmoniously integrated within the local natural and built environment and constitute a popular tourist destination, enhancing the local tourism sector has been enhanced.

- ***To enable free access for animals into the wind farm area***

Successful coexistence between livestock and wind farms is usual. In some cases, fencing of wind parks has resulted in enhancement of the local husbandry system, as not only does the existing livestock coexist with the implemented projects, loss of pasture to other potential developments is prevented. Good examples are found at "DEI-1", "DEI-2", "ROKAS", "Achladia", "Anemoessa" and "OAS Energon" Wind Parks, in the Lassithi Prefecture of Crete (Greece) and at 'Les Colladetes' wind farm in Catalonia (Spain). Another example is "Anavra wind farm" in Greece. Local farmers

Photo provided from 'Les Colladetes' wind farm (Catalonia, Spain) initially had objections to the development of the wind park, but these were withdrawn following active engagement with the farmers by the developers at an early stage of the project.

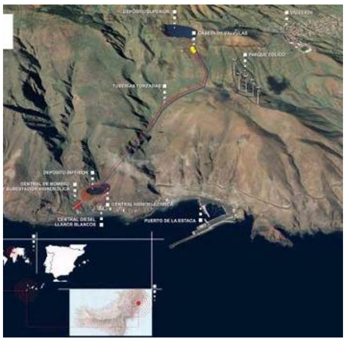
- ***Spatial planning systems***

The use of spatial planning systems is a powerful tool for supporting the implementation of wind energy. It helps to avoid potential conflicts between different activities sharing the same area, as regulatory authorities are able to select the most suitable areas for developing wind farms, in terms that do not conflict with other economic interests (environmental issues are a separate case). Moreover, wind developers and promoters are easily able to identify areas where future wind projects are unlikely to face economic conflict barriers to implementation.

For example, in Spain The Institute for Energy Diversification and Saving (**IDAE**) has developed a Wind Atlas of Spain to serve as support for Spanish Public Administrations on wind farm planning and other wind-related studies, and also to provide the stakeholders and the general public with a tool enabling them to identify and evaluate the existing wind resource in any area of the national territory. The functionality of Geographical Information Systems has been highlighted by including complementary information of interest: cartographic and topographic, environmental figures, maritime zoning, etc. Also the interface includes intuitive navigation devices to make browsing easier for the user. Examples of marine spatial planning are provided within the Case Study 8.

- ***To promote coexistence with other renewable energy industries in the same area***

Combination with other renewable energy in the same region is increasingly used in securing stable power supplies, following EU energy policies (e.g. PV installations). Most noteworthy is the 'El Hierro Hydro-Wind Power Plant' project in the Canary Islands (Spain) which will generate sufficient power to cover all of El Hierro island's electricity requirements using only renewable energy. The complete facility comprises a wind farm, a pumping unit and a hydroelectric plant. The wind farm is capable of delivering electricity directly into the power network while at the same time powering a pumping unit that collects water in a raised reservoir in the form of a stored energy system. The Hydroelectric Plant uses this stored potential energy, thus guaranteeing electricity supplies in low wind periods and ensuring stability in the network.



'El Hierro Wind-Hydro Power Station' (Spain)

- ***Tourist promotion of wind farm areas***

Wind farms are often installed in rural areas; sometimes there is potential for visitors centres to introduce tourism, enhancing the economy in the region.

Good examples include Whitelee Wind Farm in Glasgow (Scotland), 'Les Colladetes' Wind Farm in Catalonia (Spain) and 'La Muela' Wind Complex in Zaragoza (Spain). The latter is a 220 MW farm that also houses a wind museum that includes a wind interpretation centre. From its website people can manage future visits to the wind museum and are also offered to take a virtual tour.

Another example is in the Lassithi Prefecture of Crete (Greece) where the number of visitors in the area has increased due to the presence of the wind farms especially during the winter, thus extending the tourist season.

The 'Terpandros' and 'Antissa' wind farms in Lesvos Island (Greece) (see also above), lie in close proximity to the Lesvos Petrified Forest. Further fossils were revealed during the construction works, and led to further searches for fossils in the broader geographical location. This enhanced the Petrified Forest, and was capitalised upon as a visitor attraction, positively influencing the economy of the local communities.

A number of other examples are provided by the 'Wind Farms and Tourism' Fact Sheet 03 (June 2010) from Renewable-UK.

- ***Measures on Radar interferences***

The Wind Farms Impact on Radar Aviation Interests was carried out under contract for the Department of Trade and Industry (DTI) of the UK Government, as part of the DTI Sustainable Energy Programmes. In order to avoid potential conflicts between wind energy and radar systems and provide understanding of its interactions, the design of the tower and nacelle are proposed to be modified to have the smallest Radar Cross Section (RCS) possible. This can be achieved thorugh careful shaping and choice of construction materials. The spacing of wind turbines within a wind farm should be considered in the context of the radar cross range/down range resolution.

The Horns Rev offshore wind farm in Denmark was designed to allow clear differentiation of air traffic from wind turbine blades. This and other possible solutions are highlighted by the latest Wind Directions from EWEA.

Examples of lessons learnt

- Example at Mount Panachaikos (phase I and II, in Greece): Although the wind farm serves as visiting place for educational purposes (schools, etc), from the early stages the local community was of the view that the development of the wind farm would to some extent prevent the activities of residents (agriculture and livestock). Local mountain clubs complained about restrictions of their activity space. Currently the wind farm is successfully operating, but organisations situated around Mount Panachaikos are still dissatisfied with the development, since they believe the installation of wind farms in their area seriously negatively affects their economic or recreational activities. The main economic activities perceived to be negatively affected are related to sports, live-stock rearing and tourism. These conflicts could probably be reduced through enhanced communication with local stakeholders during the planning phase.

- "Peña Lugar" wind farm project, in Palencia (Spain): the project was refused planning consent due to a negative environmental impact statement. During the public information stage several conflicts with other economic interest were demonstrated, including with tourism. Landscape impact was the main reason for refusing consent, in order to protect the environment and other economic interests including tourism. The project could have been implemented in other areas, if effective initial scoping had been done.

Implications for policy and practice

- The promotion of socio-economic capacity should be one of the aspects taken into account by the regulatory authorities in the granting of wind energy permits, and they should ensure that: complementary investments (basic infrastructure, e.g.) are suggested, delivery in line with the objectives established in the Energy Plan, creation of new enterprises or extension of the existing ones in the projected area, etc. Authorities and developers should give special attention to the socioeconomic studies included in the EIA processes.

- Priority development areas for installing wind farms and the use of spatial planning systems are proposed by some regions and the authorities should consider: the proposed benefits to municipalities and landowners where the wind farm will be located, as well as neighbouring municipalities; contribution to business development; training activities and improving employment in the region; pipeline formulas of investment in private projects and local businesses, complementary investor actions, investment in basic infrastructure that would benefit the municipality or the region, etc.

- Proposed measures go through an open communication channel between investors and local stakeholders from the initial phase of the project, even if the project has been granted permission for deployment from the relevant authorities. Consultation with local stakeholders, including operators from all economic activities in the area, must be provided in advance by the developers.

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'Les Colladetes' Wind Farm in Catalonia (Spain)

'El Hierro Hydro-Wind Power Plant' project in Canary Islands (Spain) http://www.goronadelviento.es/index.php?accion=articulo&IdArticulo=70&IdSeccion=85

Terpandros' and 'Antissa' wind farms in the Lesvos Island (Greece)

"DEI-1", "DEI-2", "ROKAS", "Achladia", "Anemoessa" and "OAS Energon" Wind Parks, in Lassithi Prefecture of Crete (Greece)

Wind museum at 'La Muela' Wind Farm, in Zaragoza (Spain). http://www.museodelviento.com/portada.asp

Case study theme 13 - Community concerns and acceptance – how to achieve buy-in

The main barrier

Although most of the potential issues resulting from wind energy projects are subject to rigorous studies and strict regulations, the consent, support, buy-in and involvement of citizens and local authorities will be needed if the deployment of wind farms across Europe is to take place in a harmonious way. This is also one of the main factors in speeding the planning process: without community acceptance an adversarial, and therefore slow and expensive, process is very likely and refusal of consent by regulators a significant possibility.

Case study purpose

The aim of this thematic study is to determine the key issues raised by social and community acceptance, in order to identify the positive initiatives as well as lessons learned from measures undertaken to achieve citizens' support and buy-in. This theme could be read as complementary to themes n. 9, 14 and 15, which respectively address 'communication, awareness, information cascades', 'community benefits' and 'entrenched perceptions'.

Case study research methodology

A literature review allowed us to better define important concepts related to the scope of this theme study, namely community acceptance and social acceptance (see Wind Energy – The facts Part V Section 6 – from p. 399). Research shows that local opposition is more often based on distrust, negative reactions to the actors (developers, authorities and energy suppliers) and the way projects are planned and managed, rather than on pure physical or technical factors.

Consultations with stakeholders from GP Wind partner countries and with the two Federations of Renewable Energy producers in Belgium (EDORA and ODE) helped shed light on key issues, examples of good practice, and lessons learnt.

Key issues identified

Various related and interacting factors help create a fertile ground for citizen support:


Source: www.lemagazinechiro.com

- broad communication about the effects of wind energy (e.g. Wind Day, Danish Wind Ind. Association);
- wide diffusion of local information: initiatives from citizen cooperatives, local authorities, associations (e.g. Boyndie Coop in UK, Enercity in Belgium);
- early project- focused communication between developers and the local community on the wind farm project to create dialogue and trust;
- a fair and transparent decision making process providing all stakeholders with the opportunity to participate;
- local financing and equitable profit sharing through fair benefit scheme mechanisms, (see Welfi project, ReSHARE project, GPWind Theme 14);
- consistent and robust spatial planning.

Examples of good practice

- **Strict rules and frameworks**

In order to foster buy-in, it is important to develop a transparent framework of strict rules in the planning and decision making processes. This framework should also allow for equitable participation and not be perceived as one which favours well resourced parties. Such a framework will improve the local residents' confidence, as the decision making process will be seen to be fair.

In Wallonia, for example, as in most countries, the consenting process includes a compulsory public enquiry, which gives the local community (and all stakeholders) an opportunity to express their opinion. Moreover, a broad consultation (of 15 official bodies in Wallonia) is planned before the project receives green light. However, the process is sometimes criticised because the public receives no information between the initial public presentation and the public enquiry. Indeed, the important changes that a project can undergo during the EIA are most of the time not explained and, hence, not well understood.

Objective, transparent and scientific environmental standards are necessary to acquire the citizens' confidence. In Wallonia, the quality of EIAs is controlled by two independent regional bodies. In Scotland and Ireland, the authorities have defined a thorough list of EIA specifications. These and other independent sources of accepted guidelines provide a framework around the consenting process which contributes to increasing social and community acceptance.

- **Concession system for offshore development**

In Belgium, an area of nearly 200 km^2 was allocated to offshore wind development, divided into 7 development licenses. The area identified is 27 km away from the coast due to the presence of sand banks and to minimise visual impact, while ensuring minimal disruption of other economic activities in the periphery, e.g. fisheries. These zoning arrangements have allowed Belgium to develop offshore wind energy with relatively good levels of social acceptance.

- **Large public communication**

Whilst wind energy enjoys wide-spread support amongst European communities, there is often reluctance, anxiety or opposition towards an individual project. It is therefore important to invest in awareness raising efforts, as well as to ensure that clear and objective information is widely shared, even though the effect can be small and might take time and effort to reach the community level. In Wallonia, a reference website was developed (www.eolien.be) by the authorities accompanied by a "Rumors and realities" brochure in order to address misconceptions, and to communicate objectively on wind energy generation (see also GPWind Theme 9).

- **Diffusing local information**

Positive communication from communities already experiencing the benefits of wind energy can certainly contribute to giving wind energy more credibility in new projects. One of the objectives of the Walloon based Luceole cooperative is to widely communicate their ambitions and achievements.

- **Supporting jobs and industry**

One of wind energy's benefits is the creation of jobs locally during construction and operation.
In Portugal, the 2005 call for tenders led to the setting up of two assembling factories (Enercon and RePower), which created around 3,000 new jobs. Though wind energy development was already well accepted in Portugal, it probably contributed to improving social acceptance even further.

In Ireland, large energy user Munster Joinery installed two 2 MW turbines on their industrial site in a rural area. The factory is the biggest employer for miles around and the addition of 4 MW of wind energy helped the facility remain competitive on the international market. Learning from this model, multinationals and neighbours De Puy, Novartis, GlaxoSmithKline and Centocor plan to develop a wind project which will be installed across their combined landholdings in Cork.

- **Dialogue with the community**

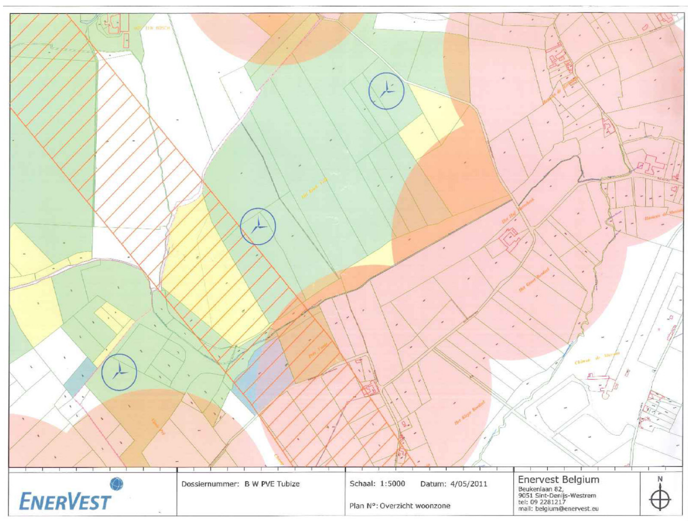
A regular and real dialogue with the local community and municipality from the early stages of the project is also essential to achieve buy-in. It helps inform the developer while involving the local community in the project, as they may have a say in the recommendations for the EIA or other planning processes. The Canadian Wind Energy Association has produced a useful good practice guide for community engagement.

An example of good practice is the planning phase of the Hitra project (Norway), where an open dialogue with the municipality and all other local stakeholders was included at the onset. Comments and recommendations were encouraged to reduce the potential for conflicts. The local newspapers were supplied with up-to-date information about the project. All of these endeavours appear to have fostered an improved acceptance. Dialogue with groups opposed to development was secured as well as it was felt that they could contribute to change local attitudes and opinions towards the project.

- **Financial aspects**

Distributing revenues from wind energy in an equitable way can also help to improve support from the local community, though this causal relationship is difficult to measure and implementation needs to be sensitive.

Examples of original benefit schemes can be found in Belgium, where two project developers, WindVision and Enervest, offered financial grants to landowners both directly and indirectly impacted by the implementation of the wind farm: the indirectly impacted landowners (landowners whose plot of land does not include a turbine, but is close to it) receive a surface grant (200 to 250 €/ha/year). In addition to that, the landowners who have a wind turbine erected on their plot of land (the directly impacted landowners) will be paid a fee ranging between 5,000 € and 12,000 €/turbine/year. One of these schemes also makes it possible for a directly affected landowner to receive a combination of these two grants.



Map from Enervest showing the plots of land impacted by a wind farm project:

Key:
Red: 350 m radius around houses
Green - Blue: plots of land belonging to landowners who agree with the proposed benefit scheme
Yellow: undecided landowners or plots not secured
Red stripes: exclusion zone around a high voltage line

Involvement of citizens in wind energy projects through shared ownership schemes (e.g. ECOPOWER and BeauVent in Flanders, Belgium) is another means of increasing community acceptance. Besides the distribution of dividends (up to a maximum of 6% per annum) from revenues generated by the renewable energy investments, Ecopower also supplies electricity at a reduced cost. When changing electricity supplier, getting affiliated as a member of a wind energy cooperative brings green energy and investment decisions closer to people and is thought to increase community acceptance of renewable energy projects.

In Belgium, some wind developments are majority owned by municipalities. This shareholding helps achieve a high buy-in also at the political/community level, since most of the benefits go to municipalities who can reinvest the revenue in local needs.

- **Synergies between wind energy projects and other renewable energy (RE) projects**

Financial revenues from wind farm projects can also help launch other RE initiatives. Similarly, local cooperatives active in other sectors can in turn generate new wind energy deployments. Such integrated wind turbine installations and complimentary projects are likely to increase the buy-in from the local community.

An example of this is in Sivry-Rance (Wallonia) where the municipality has developed an "Energy Action Plan" in which the financial benefits provided by a wind farm project are aimed at leveraging other renewable energy projects (photovoltaic, small hydro-electricity plant, local heating networks, biomass etc.) and energy efficiency measures.

The Ballynagran EnergyPlus Community Project illustrates a second type of potential synergies between sustainability and infrastructure development. In Wicklow (Ireland), a local landfill company contributes a per tonne donation to a fund which is managed by the local authority. The fund is aimed at making the community energy independent while reducing emissions. One of the benefits foreseen is the financing of a feasibility study for a community wind farm project. A unique aspect of this project is the leveraging of other funding schemes (Government incentives for renewable energy and energy efficiency) which result in these measures being carried out at no cost to the community while leveraging group discounts for their projects.

Examples of lessons learnt

- Information provision, transparency and involvement of local communities are important to achieve buy-in. However these steps take time. In Flanders, commercial developers are sometimes faster than cooperatives because the latter wish to discuss the project with the local authorities and communities before beginning to secure land. It may be possible to schedule a project so that the community engagement does not affect the 'critical path' of a project.

  In Wallonia, some developers remain unsure whether they should organise a second public information meeting (non-compulsory) when the results of the EIA are released. There is a trade-off between providing information to improve the transparency of the process and drawing disproportionate attention to unrepresentative criticisms. The challenge is to find the right balance securing both community involvement and efficient wind farm development.

- Financial measures (e.g. Green Certificates and feed-in tariffs) to sustain offshore wind energy deployment in Belgium and other countries are questioned by several energy intensive industries and consumer groups because of their growing costs. The media often point a finger at this lack of acceptance due to this increased financial burden on society, which might endanger community acceptance even for onshore installations. As a consequence, a revision of the prices for Green Certificates is currently being examined in Wallonia in order to adapt the system to the intrinsic profitability of different renewable energy sectors.

Implications for policy and practice

- A broad communication campaign meant to raise public awareness on wind energy development, and also tackling rumours and cost issues, is probably the most efficient way to build a strong foundation of confidence when obtaining citizen support to most offshore and onshore wind farm projects. These initiatives must take reasonable concerns seriously if they are to work.

- A broad communication of experiences and feedback is also important. The public needs to also have reassurance from local communities which already have wind farms that disturbance levels are very low, and it needs to hear positive experiences from cooperatives and similar citizen initiatives. In Flanders (Belgium), ECOPOWER supplies green electricity to more than 25,000 affiliates.

- Citizens' buy-in is conditioned to a large extent by the destination of the financial revenues from wind farms: community funds providing indirect community benefits, equitable benefit schemes, and electricity price reductions create a basis for community acceptance.

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Case Study theme 14 – Community benefit schemes

The main barrier

Wind energy deployment may raise considerable concerns in local communities regarding possible environmental, financial and social impacts such as noise, landscape and visual disturbance, local economic impacts and land use issues etc. Public consent for wind parks is often closely interwoven with the perceived balance of impacts and benefits to the host or local community.

In this respect, community benefit schemes provide various models for the sharing of the rewards from wind energy investments with communities in the vicinity of the project sites; via self or third-party administration. The main objective of community benefit schemes is therefore to allow for local community members to substantially engage in and receive specific benefits from wind energy projects over the development' life time. Conversely, adoption of so-called 'bad practice' (eg. no provision of community benefits / unsatisfactory community benefits from the generated revenues) may provoke objection or anxiety, which can often function as a barriers to the development and may lead to the stagnation of project development through loss of the developer's 'licence to operate' with the community.

Case study purpose

The purpose of this case study is to identify examples of good and bad practice in establishing community benefit schemes for wind energy development projects in Europe, in order to illustrate successful methods of overcoming the identified barrier. This case study includes collective knowledge from various wind park projects across Europe and can be considered as complementary to TCS No 13 "Community concerns and acceptance – how to achieve 'buy in'" and to a lesser extent to TCS No 9 "Communication, awareness, information cascades".

Case study research methodology

The methodology adopted to develop this case study consists of presenting two kinds of collected evidence:

(iii) information gathered from a selective review of the available literature in scientific journals, evaluation and follow-up studies, publicly available policy documents, industry guidance and the GP WIND Steering Group Advisors consultation documentation

(iv) evidence collected through in-person conducted interviews with wind power developers, environmental organisations, local authorities, educational institutions and NGOs, for the purpose of which appropriately tailored and structured questionnaires have been developed to include both generic and thematic / specific questions concerning community benefit scheme issues.

Key issues identified

The following items[4] can be identified as potential benefits that concern local communities rather than local individuals:

[4] Based on the following sources: **(1)** Delivering community benefits from wind energy development: A Toolkit website (berr.gov.uk), **(2)** A Community Commitment – The Benefits of Onshore Wind (bwea), **(3)** Wind Turbines in Denmark (ens),

- Community Funds: Receiving a lump sum or regular payments into some manner of fund for the benefit of local residents
- Benefits in Kind: Where the developer directly provides or pays for local community facility improvements, environmental improvements, visitor facilities, school and educational support, etc
- Local Ownership: Opportunity to purchase shares in the project either through their own investment or through a profit-sharing or part-ownership scheme designed to tie community benefits directly to the project performance and revenues.
- Local Employment: Contracting and associated local employment opportunities during construction and operation.

Issues related to the implementation of the above community benefit schemes include:
- the investigation of appropriate ways to offer, manage and secure benefits for local communities, especially where there is no relevant legislation
- the establishment of liaisons among implicated stakeholders under the principles of transparency, information, citizen involvement and innovative thinking
- the proactive involvement of local communities in wind power generation projects

Failure to implement community benefit schemes may not be crucial in the progression of a wind farm project, but it may create a negative precedent for the development of wind energy projects in the future. Limited indirect benefits may not be sufficient for balancing local impacts and therefore may not be sufficient for increasing acceptance of wind energy projects.

Examples of good practice

This section explores European cases where challenges to the implementation of community benefit schemes have been overcome successfully.

Anavra, Magnesia and Mount Rodopi in northern Greece.

The Anavra, Magnesia project (http://www.anavra-goura.gr/Village/enHighlights.php) is an excellent example of wind farm development, where local communities have consistently embraced the development since its very beginning. Although concerns over potential conflicts with local livestock activities had been initially expressed, the developers established an effective liaison with the local administration, and arranged open consultation meetings with local communities from the early stages of the project. In these meetings experts from NGOs and other institutions were invited to discuss their concerns and to explain the expected benefits for various local stakeholder groups. The community benefit scheme includes the distribution of 3% of the gross generated energy income to local authorities, for the implementation of local projects on environmental protection, actions related to local development and social actions for the communities. According to a recent revision, 1% out of this 3% will be returned directly to the local citizens through their electricity bills by the local power distribution company (p.27-28 . YPEKA). Additional community benefits included the implementation of several communal projects, such as public space enhancement and the refurbishment of municipal buildings.

The Mount Rodopi case constitutes a pioneering large-scale installation of wind farms in Northern Greece that has been endorsed by the local communities, which has resulted in a significant enhancement of local economic and employment prospects, and the enrichment of knowledge-based local skills. The average per capita local income has been increased due to the community benefit

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(4) RESHARE Sharing Mechanisms in Renewable Energy. Final Report. (reshare), **(5)** DKIT (ww2.dkit.ie), **(6)** Wind Energy Direct (windenergydirect), **(7)** Ballynagran Energy Plus Community Project ((ballynagranzerocarbon)) scheme implemented, which involves the distribution of 3% of gross energy production income to the local municipalities. This has led to several local investments by the municipality authorities of the rather remote and isolated local communities, which have benefitted local citizens.

In Belgium, the cases of The "Allons-en-Vent" initiative – Vents d' Houyett and the Enercity cooperative – "Villers-le-Bouillet" wind farms are examples of cases where developers effectively overcame barriers associated with:

(i) reluctance of private organisations towards investing in wind energy development,
(ii) lack of public awareness of wind energy
(iii) lack of citizen ownership in the context of wind energy projects
(iv) lack of commitment and engagement from the relevant public authorities in the development of decentralised electricity production units to meet local energy production needs.

The developer of the "Allons-en-Vent" initiative – Vents d' Houyett project set up an innovative cooperative structure with a shareholding model which is restricted to children. This initiative represents a successful citizenship participation model that clearly contributes to the social acceptance and buy-in of wind power production due to the involvement of children, as well as to the development of an understanding that investing in sustainable forms of energy may foster specific economic and other benefits, now and into the future.

Enercity cooperative – "Villers-le-Bouillet" was the first Belgian PPP (public-private partnership) project in the production and distribution of wind energy in a rural area. This development included the setting up of a community based cooperative, the primary objective of which was to draw sufficient earnings from the operation of a 2 MW wind turbine (out of a total of 5 wind turbines), which would eventually be invested in various renewable energy projects, including photovoltaic panels and heat networks. According to the project founders, the cooperative was designed with fostering citizen participation, raising awareness on sustainable development and promoting the use of innovative means to achieve both the developers' and the communities' ambitions in mind.

The key factors that appear to have led to the implementation of effective community based schemes in the context of the above-mentioned European projects can be summed up as follows:

Factor of success	**Anavra, Magnesia**	**Mount Rodopi**	**"Allons-en-Vent"**	**Enercity Cooperative**
Strong will of local municipalities to maximize benefits for local communities	✓	✓		✓
Developer – Local Authority / Community cooperation to inform, discuss concerns and explain expected benefits	✓	✓		
Assurance of stable income and tangible benefits for the community	✓	✓	✓	
Motivation/proactive involvement of local communities in wind energy projects	✓	✓	✓	✓
Local authority commitment to citizen involvement and expertise in community based development projects	✓	✓	✓	
Novelty in design and implementation approach			✓	✓

This table provides a clear indication that commitment to the principles of transparency, information, citizen involvement and innovative thinking, may assist in the development of effective community benefit schemes and overcoming the associated barriers in the implementation of wind power projects in Europe. This objective could be further facilitated through the inclusion of renewable energy related educational programmes to tackle issues of misinformation and prejudice and to allow for knowledge on wind power development to be diffused and communicated within local communities (see also GPWind Thematic Cast Study 9, 13 and 15). Although local particularities and the variation in applicable national legislation across Europe must be borne in mind, the above examples should in broad terms be replicable in many European locations.

Examples of lessons learnt

This section explores aspects of an unsuccessful attempt to overcome the identified barriers.

Local stakeholders at the wind parks of Mount Panachaiko in Greece perceive the community benefit scheme in operation as essentially unrewarding. Although strong opposition by local communities on environmental and need grounds marked this project initially, the developer, together with the local council and NGOs, arranged consultation meetings and workshops with local citizens to overcome this perception / barrier. A community benefit scheme including 3% of gross energy production income, as well as the participation in the construction works of the rural road network, was endorsed by the public and the project was eventually implemented. However, local communities now argue that the resulting economic benefits are negligible, though according to the developer this is mainly due to the lack of proper experience of local municipalities in the management of the funds paid to the communities.

This example illustrates the practical difficulties that can be involved in devising effective community benefit schemes. Careful design and implementation is necessary, having regard to the social structures and capacities available in the communities affected.

Implications for policy and practice

As a general conclusion from the above wind farm case studies, key barriers to the implementation of successful community benefit schemes in the context of European wind park installations include:

- lack of public consent, sometimes (not always) stemming from misconceptions, and
- the difficulty of ensuring that local societies receive tangible benefits from relevant projects

In order to overcome such barriers, an integrated approach should be adopted on the part of:

(i) Legislator and Policy Makers: To effectively provide an appropriate legal framework that will facilitate the design and implementation of such schemes and ensure the delivery of identifiable benefits for the communities (in some countries there are ongoing consultations on possible legislation of community benefits as accompanying measures for the support of renewable energy development, e.g. "Consultation on proposals to ensure Scotland and its local communities benefit from renewable and low carbon energy developments")
(ii) Developers and Operators of wind farms: To actively collaborate with all affected parties in order to discuss any concerns and to resolve issues that emerge at the early stages of the projects
(iii) Local Authorities: To collaborate with developers and to arrange educational seminars and programmes in order to tackle issues of public misinformation and misconception
(v) Local Community Groups: To engage and participate in the development and to work with local authorities and developers / operators, in order to promote their own views on wind power generation and to negotiate benefits that may result in substantial and sustainable gain for the community.

In addition to the above, consultations with educational institutions, techno-socio-economic expert groups and environmental organisations could further assist in the implementation of successful community benefit schemes and eventually in adopting an integrated approach towards bringing together social, economic and environmental objectives in the context of wind energy development in Europe.

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Case Study theme 15 - Dealing with complex or entrenched public perception issues

Case Study purpose

To identify and promote examples where efforts have been made to successfully promote accurate, experience based evidence that directly addresses public perceptions in ways that encourage the public to come to their own conclusions and hence possibly to increase the acceptance of wind energy.

Case study methodology

The case study explores examples from Europe of where projects have sought to provide accurate information to the public in a fair and balanced manner and, where possible, assess the success in addressing public perceptions.

These projects vary greatly in style, including innovative use of television, professionally produced information sheets, volunteer operated websites, and multi million pound purpose built facilities. It is difficult, therefore, to compare one with the other. Nevertheless, attempts are made to identify what works (and why).

Main barriers

- Wind energy is a relatively new technology which is producing rapid and obvious change in the landscape and so is of legitimate public concern (see Case Study 10).
- The open nature of internet information sources, in which the quality of information may be hard for nonspecialists to assess, is a challenge to discussing issues effectively. It is important in this connection not to appear arrogant or patronising when addressing these issues, and to take reasonable concerns seriously.
- The public have become increasingly suspicious of the impartiality of most proactive information sources, especially where a financial motive can be alleged. This makes achieving credibility challenging.
- As wind energy is promoted as one of the key methods of mitigating climate change, it is also associated with scepticism regarding climate science as illustrated by recent media coverage. Uncertainty can serve to undermine the raison d'être of the technology as well as the confidence and support of communities and decision makers.

Case study 1. Meteo Renouvable and Energiz'AIR - Belgium
Good example of how information about renewable energies can be presented in a colourful and appealing way: after the weather forecast, information on the energy produced thanks to the sun and the wind is given. Once a week, the amount of energy saved by the use of a standard solar thermal or PV installation and the number of equivalent households that have been supplied with electricity from wind farms are presented.

Factors for success:

- The appealing presentation of the information on renewable energy production.
- Clear link between one of the main human interactions with nature (weather) and technologies that are driven by the weather.
- Large dissemination through the public TV channel during weather forecasts (8pm) watched by a large audience (more than 500,000 people every week).

Next steps

EnergizAIR aims to add qualitative energy information to the regular weather forecast, quantifying the proportion of energy needs that were met from renewable energy sources. Those indicators stress the link between the weather, the energy sources and our consumption, emphasising what we can do with the available resources.
The Energiz'AIR EIE project aims to replicate the Belgian experience in 4 other EU countries (FR, IT, PT and SL). Potential replicability is high but developing partnerships must improve technical means for measurements and implement automatic data gathering and build contacts in the media to succeed.

Case Study 2. Rumeurs et Réalités - Belgium

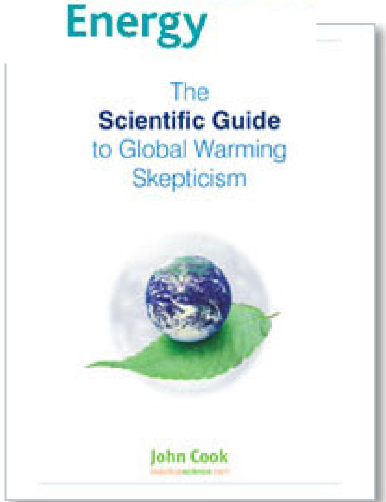
A brochure and website that provides factual, scientific evidence to refute commonly asserted misconceptions regarding wind energy. An example of how rumours can be tackled in a scientific and communicative way. The brochure is structured around 5 themes.
-Environmental benefits (assertion: a WF produces CO2 because we need to use classical means of energy production to compensate when inactive);
-Energy efficiency (assertion: a WF is ineffective in providing substantial and efficient power);
-Employment effects (assertion: WFs deter tourism);
-Landscape issues (assertion: WF development is anarchic and not adapted to a densely populated country as Belgium);
-Health problems (assertion: WFs impact health adversely through noise, electromagnetic fields).
Overcoming the barriers is long term and indirect and the effect on entrenched perception issues is difficult to measure. Nevertheless, the brochure provides a reference document (to developers, local authorities and other stakeholders) when WF projects are discussed in communities.
Factors having led to success:

- Multiple communication channels (brochure in paper and pdf format as well as website)
- Appealing presentation of the scientific information on wind energy rumours and realities.
- One of the few documents available that covers all the questions communities might ask when it comes to WF development and that tackles rumours in a clear and structured way.

Potential replicability:
Similar brochures are appearing in other countries – for example, **Common concerns about wind power – UK,** produced by CSE, a UK a national charity with over 30 years experience. It seeks to share knowledge and experience to help people change the way they think and act on energy. Similar to **Rumeurs et Realites** , their recently published report seeks to address a number of popular wind farm misconceptions.

Case study 3. Skeptical Science - UK

Skeptical Science is a website that seeks to assess criticism of the science of climate change. As mentioned above, AGW scepticism is often used as an argument against the deployment of wind energy.
The website is "based on the notion that science by its very nature is sceptical ... don't take someone's word for it but investigate for yourself ... look at all the facts before coming to a conclusion."
The website therefore explores arguments that aggravated global warming (AGW) is not occurring, and provides a clear and concise review of the science in each case.
The website regularly reviews current controversies in the media with respect to AGW. As such, it is an valuable resource for those who must respond publicly to such controversies.
More recently, Skeptical Science has produced "the Scientific Guide to Global warming Skepticism". This is available to download from the website in 11 languages including Czech, Dutch, English, French, German,



Italian, Norwegian, Polish, Portuguese, Spanish, and Slovak.

Effectiveness
It is difficult to judge effectiveness in terms of helping to influence public or political opinion. These are driven by many factors too large and varied for a single website to influence directly.

The effectiveness of the website should therefore be measured in terms of the quality and timeliness of its information. In both respects, Skeptical Science has proved itself a useful tool and one that can help to provide a reasoned answer to many public concerns about the nature of the evidence on climate change. For that reason alone, it is worthy of wider dissemination.

Furthermore, due to well referenced arguments, it is a valuable resource for providing reliable, science based information to key decision makers.

Case study 4. Whitelee Windfarm Visitor Centre - UK
The 322MW Whitelee Windfarm in Scotland, one of the largest onshore windfarms in Europe and only 20km from the centre of Glasgow (a city of nearly 600,000) provides an excellent opportunity to allow a significant number of people to experience modern large scale wind energy first hand.

As result, a purpose built visitor centre has been included as part of the project. With an exhibition hall including bespoke interactive facilities , a classroom, an electric powered bus and over 90km of trails, Whitelee has proved enormously successful in terms of visitor numbers.

Effectiveness
Nearly 100,000 visited in 2010 alone, including several hundred school classes. Education and interpretation is provided by staff from the Glasgow Science Centre, an education charity that operates a major science centre.

Public feedback is over 90% positive and "chat" on various blogs is also overwhelmingly supportive.

Professor Ian Stewart talks to pupils from Eaglesham Primary School about climate change and renewable energy at Whitelee Visitor Centre, March 2011

As its reputation grows, an increasing number of official government delegations from across the world are coming to Whitelee. Already, visitors from France, China, Mongolia and Thailand have come to learn more.

Equally importantly, the local community is using Whitelee as a resource. The local primary school in Eaglesham used the windfarm as a case study for a web based video which explores local attitudes to the windfarm.

Whitelee was the overall winner of the Scottish Awards for Quality in Planning in 2009, and has recently been awarded the Queens Award for Enterprise, Sustainable Development.

Replicability
While it is true that only a very large windfarm such as Whitelee can sustain a visitor centre of this type, and only one such facility can operate successfully in a particular region, it might be possible for regional centres similar to Whitelee to be developed cooperatively.

Conclusions

The renewable energy industry faces criticism from a variety of sources, and various means (traditional media, websites, public campaigning).

It is essential that factual information be provided to help overcome misconceptions, and adverse opinions based on these misconceptions, that are associated with the development of wind farms. However, legitimate concerns must be addressed seriously.

This case study illustrates how many different approaches are being used. But it also shows that this is a widespread and long term challenge. It is therefore difficult to accurately measure the effectiveness of individual initiatives in terms of influencing public perceptions. Nevertheless, the effort is worthwhile, and replication of these methods may help, together, to produce success.

Furthermore, the provision of factual information, in an open, clear, and honest manner, will improve the reputation of the sector in the long term, if pursued consistently and with integrity (see Case Study 9). The approaches outlined here can be effective in influencing key decision makers by providing such information in accessible form.

REFERENCES TO BE DONE (NONE PROVIDED)

Case Study theme 16 – Undertaking Socio-Economic Impact Assessment

The main barrier

In order to gain planning consent for the development of a wind farm, it is necessary to undertake an environmental impact assessment (EIA). This involves a number of steps including scoping the likely issues, baselining current environmental conditions, identifying the main potential impacts and assessing the likely significance of these impacts. The EU Directive 2001/42/EC requires that impacts arising from the implementation of a new wind farm project must be identified, described and evaluated. The likely impacts on the following must be considered:

> *"biodiversity, **population**, human health, fauna, flora, soil, water, air, climatic factors, material assets, cultural heritage including architectural and archaeological heritage, landscape **and the interrelationship between the above factors**"*

The inclusion of population, and the interrelationship between population and the other factors, implies "a wider definition of 'the environment', encompassing its human (i.e. social, economic and cultural) dimensions" (Chadwick, 2002). However, this is open to interpretation and the lack of clear legislative impetus for the consideration of socio-economic impacts in EIAs may be an important reason as to why socio-economic impact assessment (SEIA) has long been considered as the "poor relation" (Glasson & Heaney, 1993) in EIAs. The human aspects of wind farm developments should not be forgotten because of their potential to impact on a wide number of different aspects of people's lives. It has also been recognised that socio-economic concerns may lead to delays in planning consent: "These concerns extend the time wind farm projects spend progressing through the spatial planning system and can be responsible for development control committees declining planning consent. If the attitudes of local populations to a wind farm improve over time then planning consent for up to three times the total installed wind energy capacity of the UK may have unnecessarily been declined" (Altham et al, 2008).

Case study purpose

The rationale for this case study is to ensure that SEIA is given due consideration in the EIA process: "the close relationship between social and environmental systems makes it imperative that social impacts are identified, predicted and evaluated in conjunction with biophysical aspects" (UNEP, 1996, cited in Glasson, 2001). The case study identifies real life examples of good practice in undertaking SEIA as well as citing good practice from other sources. The case study also provides recommendations for ensuring that SEIA is considered in the development of EIAs.

This case study will be helpful to a wide audience; it allows planners and regulators to understand what they should expect from SEIAs, it provides guidance for developers and EIA practitioners who are involved in undertaking or commissioning SEIAs and it also provides community groups potentially affected by new wind farm developments with a means of understanding and engaging in the process of identifying any socio-economic impacts which are likely to occur, the sensitivity of receptors and the magnitude of these impacts. In turn this can help identify a means of enhancing the positive impacts and mitigating the negative impacts.

Case study research methodology

In developing this case study, the study team undertook:

- a review of existing literature, guidance and legislation relating to socio-economic impact assessment in the planning process for wind farm developments and reviewed the socio-economic chapters of 37 published wind farm environmental statements (see bibliography for a complete list of sites)

- developed and analysed an online survey to gather the views of as wide an audience as possible on the role of socio-economic analysis in the development of wind farm projects and undertook a series of consultations to explore these issues in more detail.

Key issues identified

The literature review identified weaknesses with the socio-economic element of the EIA process. For example, Glasson and Heaney (1993) appraised 110 Environmental Statements (ESs) produced between 1988 and 1991 and found that less than 50% included any social or economic impacts and those that did were generally of poor quality. Sadler (1996) rated more than half (52%) of the ESs reviewed as 'poor' or 'very poor' in their effectiveness of examination of socio-economic impacts. Chadwick (2002) reviewed 110 ESs produced between 1993 and 1999 and found that although 83% of the EISs did consider socio-economic impacts, the coverage "tends to be somewhat superficial".

As part of the GP Wind project, a review of 37 environmental statements (ES) of wind farms published between 2002 and 2010 was undertaken. The findings of this research echo the existing literature. It is clear that in many cases, socio-economic assessment remains less developed than other elements of the EIA process. Although the majority of the ESs reviewed did cover key socio-economic issues such as project employment, direct economic contributions and tourism impacts, the analysis tended to be brief and often very basic.

Examples of good practice

- **Inclusion of key socio-economic issues**

The Department of Energy & Climate Change's (DECC) Overarching National Policy Statement for Energy (2011) provides strong guidance and states that where a project is "likely to have socio-economic impacts at local or regional levels, the applicant should undertake and include in their application an assessment of these impacts as part of the ES". It states that socio-economic assessments should consider all relevant socio-economic impacts, which may include:

- the creation of jobs and training opportunities
- the provision of additional local services and improvements to local infrastructure, including the provision of educational and visitor facilities
- effects on tourism
- the impact of a changing influx of workers during the different construction, operation and decommissioning phases of the energy infrastructure
- cumulative effects – if development consent were to be granted to for a number of projects within a region and these were developed in a similar timeframe, there could be some short-term negative effects, for example a potential shortage of construction workers to meet the needs of other industries and major projects within the region

The literature provides a wider range of socio-economic factors which could be affected by the development of a new wind farm and which, in terms of best practice, should therefore be considered in the EIA process. These are shown in the table below.

Direct economic ○ Local and non-local employment ○ Characteristics of employment ○ Labour supply and training ○ Wage levels	**Indirect/wider economic** ○ Local and non-local supply chain effects ○ Employees' local expenditure (induced effects) ○ Impacts on other commercial activities (e.g. tourism, fishing, agriculture)	**Demographic** ○ Changes in population size (temporary and permanent) ○ Changes in population characteristics (e.g. socio-economic groups, income levels, age groups, sex) ○ Settlement patterns
Housing ○ House prices ○ Housing availability	**Socio-cultural** ○ Lifestyles/quality of life ○ Social problems (e.g. crime, illness etc)	**Other local services** ○ Educational services ○ Health services, social support

	○ Community stress and conflict; integration, cohesion and alienation	○ Transport services and infrastructure ○ Other (e.g. police, fire, recreation)

Source: Adapted from Glasson (2001) and Chadwick (2002)

A number of good examples of assessing the impact on these factors were identified through the review of existing EIAs. For example, the proposed Allt Duine wind farm in Scotland included a thorough approach to assessing tourism impacts, including the development of a baseline of existing tourism activity, consultations with local tourism related businesses and identification of potential direct and indirect impacts on these businesses.

An interesting example of assessing socio-cultural impacts comes from the proposed Bald Hills wind farm in Australia. As part of a Social, Economic and Tourism Impact Assessment, a series of focus groups and stakeholder interviews were held in order to understand community attitudes and potential social impacts of the new development.

One of the few robust economic assessments of a proposed wind farm identified as part of the review was not part of an EIA but was commissioned by Scottish Enterprise. Nevertheless, the Windfarm Construction: Economic Impact Appraisal report is an example of good practice in assessing the economic impact of a wind farm. The methodology included detailed consultations with developers; consultations with turbine manufacturers; interviews with the main balance of plant contractors in Scotland and a survey of likely subcontractors in the local economy.

- **Incorporate consultations with local residents and businesses**

The SEIA is an important means by which local communities can engage with the EIA process. The online survey carried out as part of this case study research found that most respondents thought that there was demand for detailed SEIAs from community groups but that the current consideration of socio-economic impacts in Environmental Statements (ES) is insufficient. One example of communities pro-actively engaging with developers and other key stakeholders to encourage greater consideration of socio-economic impacts is the Argyll Renewables Communities (ARC) consortium. The Consortium is made up of three community groups (the community-owned Islay and Kintyre Energy Trusts and the Tiree Community Development Trust) and has been established to *"investigate fully the impacts, both positive and negative, on their local communities of offshore wind and marine energy exploitation"* (Islay Energy Trust, 2009).

In addition, there are examples of good practice in terms of maximising the positive socio-economic impacts arising from wind farm developments. One example comes from TWEED (the Cluster of Energy, Environment and Sustainable Development technologies in the Walloon Region of Belgium) which, in 2010, mapped all the companies in Wallonia subcontracting in the wind energy supply and value chain. The study, which has identified more than 80 companies, is a good example of one approach for encouraging developers to have more regular discussion with, and subcontract out to, local companies.

- **Monitor and evaluate impacts**

While monitoring of environmental impacts is commonplace, very few ESs state that socio-economic impacts will be assessed during the lifetime of the wind farm. One example of good practice in this regard is the Gwent y Môr offshore wind farm off the coast of Wales. The SEIA chapter of the ES for this wind farm states that "further tourist attitude surveys will be conducted following the construction of Gwynt y Môr. Such a survey will seek to repeat the method used during the pre-construction survey commissioned by npower renewables to illicit the views of tourist visitors at a representative number of locations around the Liverpool Bay coastline." It is important that socio-economic impacts are monitored so that changes to local communities and economies can be tracked and understood. In Denmark and England, separate studies comprising before and after research were undertaken to assess the impact that the Horns Rev offshore wind farm and the Carland Cross wind farms respectively were expected to have and actually had on local communities.

Examples of lessons learnt

- **Lack of official guidance or best practice**

One of the clearest issues facing the development of SEIA for wind farm developments is the lack of clarity over what is expected to be included and how EIA practitioners should approach the SEIA process. Many of the 37 EIAs reviewed for this case study make specific mention of the lack of guidance for undertaking SEIA and this lack of guidance was also highlighted by a number of survey respondents. This is in contrast to other EIA disciplines which have extensive guidance and best practice data sources to guide their work. However, there is some existing good practice. In France, Le Ministere de l'Écologie, de l'Énergie, du Développement durable et de la Mer (The Ministry of Ecology, Energy, sustainable development and the Sea) has produced guidance relating to the environmental impact studies, and this includes consideration of socio-economic factors. One particular problem relating to the general lack of guidance is around significance criteria. Socio-economic effects, including the direct and indirect employment and wider economic impacts, do not have recognised criteria for the assessment of significance. This means that the determination of significance often comes down to 'professional experience' which is likely to differ between EIA practitioners. It therefore becomes difficult to compare impacts across different projects and potential cumulative effects. The lack of robust quantification of direct and indirect employment and economic impacts exacerbates this problem.

- **Lack of existing evidence of socio-economic impact**

There is a lack of existing evidence of the impact which wind farms can have on key socio-economic factors such as local labour markets and supply chains, housing markets and industries such as tourism. There are a small number of examples which provide evidence of the actual economic impacts which a new windfarm has had. For example, a study was conducted of the employment and economic benefits the Scroby Sands offshore wind farm generated for the local economy. Often studies such as these are used as 'ready-reckoners' and the impacts scaled up or down to other proposed wind farms. However, there may be major differences between the ability of different local or regional economies to capture the socio-economic benefits of a wind farm. Therefore the lack of up to date and location specific secondary evidence makes ex-ante predictions about the impacts of proposed wind farms more difficult.

- **Non-specialists writing socio-economics sections**

There was a clear difference in the quality of SEIAs undertaken by specialists and those undertaken by the EIA lead consultancy. This gap echoes the findings of Chadwick (2002) who found little use of specialised consultants. Coles (2007) survey of EIA practitioners found that 60% of those surveyed agreed that *poor practices are a consequence of limited experience*.

Implications for policy and practice

In order to address the issues raised by this case study, there are a number of possible steps which could be taken:

- Clear guidance is needed from planners as to what is expected in relation to socio-economics in planning applications for wind farm developments

- The development of official guidance to provide a standardised approach to assessing potential socio-economic impacts. Government and public sector development agencies could consider commissioning evaluations of socio-economic impacts of existing wind farms which could be used as 'ready reckoners' for future wind farms for EIA process –these could be used as a 'public good' by the industry

- Developers need to be as open and transparent as possible about the likely socio-economic impacts which may arise as a result of developments, positive and negative. This will help local communities to better understand the potential socio-economic effects of developments and build the trust without which all information may be regarded sceptically.

Complete list of reviewed documents, Theme 16

Title	Year	Type of development	Size of development	Name of Developer	Country
Allt Duine Wind Farm - Environmental Statement	2010	Onshore wind farm	31 turbines, 93MW	RWE	Scotland
Arecleoch Wind Farm - Environmental Statement	2006	Onshore wind farm	60 turbines, 180MW	SPR	Scotland
Beinn an Tuirc 2 Wind Farm - Environmental Statement	2005	Onshore wind farm	21 turbines, 42MW	SPR	Scotland
Boardinghouse Wind Farm - Environmental Statement	2009	Onshore wind farm	5 turbines, 10-12.5MW	Creek Farms Ltd	England
Breaker Hill Wind Farm - Environmental Statement	2009	Onshore wind farm	15 turbines, 19.5MW	Wind Prospects Development Ltd	Scotland
Clyde Wind Farm - Environmental Statement	2004	Onshore wind farm	173 turbines, up to 622.8MW	Airtricity	Scotland
Dunbeath Wind Farm - Environmental Statement	2005	Onshore wind farm	23 turbines, 69 MW	RDC and Falck Energy	Scotland
Fallago Rig Wind Farm - Environmental Statement	2005	Onshore wind farm	62 turbines, 186MW	North British Wind Power	Scotland
Glenkerie Wind Farm - Environmental Statement	2007	Onshore wind farm	11 turbines, 1.8-2.5MW	Novera Energy plc	Scotland
Gwent y Mor Offshore Wind Farm - Environmental Statement	2005	Offshore wind farm	150 - 250 turbines, max 750MW	Npower renewables	Wales
Hadyard Hill Wind Farm - Environmental Statement	2003	Onshore wind farm	52 turbines, 130MW	SSER	Scotland
Harestanes Wind Farm - Environmental Statement	2004	Onshore wind farm	94 turbines	SPR	Scotland
Hemsby Wind Farm - Environmental Statement	2009	Onshore wind farm	4 turbines, up to 10MW	SLP Energy	England
Kelmarsh Wind Farm - Environmental Statement	2010	Onshore wind farm	7 turbines, up to 17.5MW	E.ON	England
Lewis Wind Farm - Environmental Statement	2004	Onshore wind farm	702MW		Scotland
Limmer Hill Wind Farm - Environmental Statement	2005	Onshore wind farm	33 turbines, 99MW	RDC and Falck Energy	Scotland
Lincs Offshore Wind Farm - Environmental Statement: Vol. 1 - Offshore	2007	Offshore wind farm		Centrica	England
Lincs Offshore Wind Farm - Environmental Statement: Vol. 2 - Onshore	2007	Offshore wind farm		Centrica	England
Muaitheabhal Wind Farm - Environmental Statement	2004	Onshore wind farm	133 turbines	Beinn Mhor Power	Scotland
North Rinds Wind Farm - Environmental	2006	Onshore wind	11 turbines	Wind Energy (North	Scotland

Title	Year	Type of development	Size of development	Name of Developer	Country
Statement		farm		Rhins Ltd)	
Nunwood Wind Farm - Environmental Statement	2008	Onshore wind farm	12 turbines	Npower renewables	England
Oriel Offshore Wind Farm - Environmental Statement		Offshore wind farm			Ireland
Sheringham Shoal Offshore Wind Farm - Environmental Statement	2006	Offshore wind farm	45 - 108 turbines, 240 - 315MW	Scira Offshore Energy	England
Social, Economic and Tourism Impact Assessment for the Proposed Wind Farm Project at Bald Hills (commissioned for evidence for inquiry)	2003	Onshore wind farm		Wind Power Pty Ltd	Australia
St Fergus Moss - Environmental Statement	2010	Onshore wind farm	3 turbines, 6-7MW		Scotland
Swinford Wind Farm - Environmental Statement	2008	Onshore wind farm	11 turbines. 27.5MW	Nuon Ltd	England
West of Duddon Sands Offshore Wind Farm - Environmental Statement		Offshore wind farm	83 - 139 turbines, up to 500MW	Scottish Power/DONG Energy	England
Whitelee Wind Farm - Environmental Statement	2002	Onshore wind farm	140 turbines, 240 MW	SPR	Scotland
Whitelee Wind Farm Extension - Environmental Statement	2008	Onshore wind farm	36 turbines	SPR	Scotland
Whitelee Wind Farm Extension Phase 2 - Environmental Statement	2009	Onshore wind farm	39 turbines	SPR	Scotland
Dunbeath Wind Farm - Supplementary Information, Volume 1, Part 1 and Part 2.	2007	Onshore wind farm	23 turbines, 69 MW	West Coast Energy	Scotland
Kilchattan Wind Farm - Further information, Volume 2: Main Text	2010	Onshore wind farm	16 turbines	Wind Prospects Development Ltd	Scotland
Largie Wind Farm Environmental Statement	2004	Onshore wind farm	19 turbines	Eurus Energy UK Ltd	Scotland
Druim Ba Wind Farm Environmental Statement - Volume 2 Written Statement, Document 4	2011	Onshore wind farm	23 turbines, 69 MW	DBSE (a wholly owned subsidiary of EFRG)	Scotland
North Harris Community Wind Farm: Environmental Statement	2006	Onshore wind farm	3 turbines, each 850kW.	North Harris Trading Company	Scotland
Feiriosbhal Windfarm: Natural and Cultural Heritage Regeneration Plan	2007	Onshore wind farm	16 turbines	Beinn Mhor Power	Scotland
Forth Energy Environmental Statement, Volume 1 (Non Technical Summary) and Volume 2 (Main text)	2010	Other renewable development	100MWe	SSE and Forth Ports	Scotland

Bibliography and Web links Theme 16

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