

General principles of onshore wind environmental impact assessment

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Abstract

In a decade, the contribution of wind power to UK electricity has grown from <1 to 10%, making wind energy the UK's single biggest source of renewable power. In 2015, almost a third of Scotland's electricity was provided by wind energy. A key tool in the development of onshore wind is Environmental Impact Assessment (EIA). The aim of EIA is to provide decision makers with knowledge of the likely significant effects of the proposed development. It is then for those decision makers to decide whether to grant planning permission for a project. For any project developer it is important to understand the concepts behind EIA and the role it plays in the development process. There are a number of key steps that must be undertaken and these are set out in this study. The study has a particular focus on the mitigation hierarchy of avoid, minimise and compensate. The preferred option is always to mitigate by design and a number of case studies have been provided to show how this can be achieved. A selection of software tools have been discussed which can help an EIA practitioner identify and present the results of the EIA in an easily understood manner.

Introduction

Since 2000, cumulative installed wind capacity across the globe has grown at an average rate of 24% per year [1]. In 2012, about 45 GW of new wind power capacity were installed in more than 50 countries, bringing global onshore and offshore capacity to a total of 282 GW [1]. New investment in wind energy in 2012 was USD 76.6 billion [1].

Although the UK's first onshore wind farm was opened in Delabole, Cornwall in 1991 it was not until 2000 that level of investment in new projects began to gain momentum [2].

In <10 years to 2015, the contribution of wind power to the UK electricity mix has grown from <1 to 10%, making wind energy the UK's single biggest source of renewable power [2]. In 2015, almost half of the Scotland's electricity needs (49.7%) were provided by renewable sources and of that amount, 62% was provided by wind energy [3] or just over 30% of total generation.

A key tool in the development of onshore wind projects is Environmental Impact Assessment (EIA). The aim of EIA is to provide decision makers with full knowledge of the likely significant effects on the environment as a result of proposed development. It is then for those decision makers, in consultation with key

stakeholders, to decide whether to grant planning permission for a project.

Furthermore, EIA can help ensure that the public are given early and effective opportunities to participate in the decision-making procedures, a key pillar of the Aarhus Convention [4].

It is important to note that it is the purpose of this paper to provide an overview of the general principles of the EIA process rather than a review of the specific regulatory and legal requirements within the UK. Case studies have been provided to illustrate some of the key themes. However, it should be acknowledged that whilst the EIA process will be similar in other parts of the UK there are differences both in terms of the key stakeholders and consenting processes and this must be considered as part of project planning. Even in the same jurisdiction there will be a different process to follow depending on the size of a project.

General overview of the EIA process

The framework for EIA is provided by European Directive: 85/337/EEC (as amended). This has been brought into practise in the UK and other EU jurisdictions through various laws and regulations which govern the assessment process and determine which projects require to be assessed. The most recently amended EIA Directive (2014/52/EU) entered into

force on 15 May 2014 (the ‘2014 EIA Directive’). Member States, including the UK, have to apply these rules from 16 May 2017 at the latest (the ‘2017 EIA Regulations’).

The findings of an EIA are presented in an Environmental Statement (ES) and the ES is used to support an application for authorisation to develop a project. Note that under the new 2017 EIA Regulations this will be referred to as an EIA Report.

A robust EIA process can have the following benefits:

- Improved project design/siting;
- More informed decision making;
- More environmentally sensitive decisions;
- Increased accountability and transparency during the development process;
- Improved integration of projects into their environmental and social setting;
- Reduced environmental damage;
- More effective projects in terms of meeting their financial and/or socio-economic objectives;
- A positive contribution toward achieving sustainability.

When undertaken correctly, EIA should provide a clear, unbiased account of the impacts of a project to allow a decision to be made in full knowledge of the significant environmental and social effects. However, failure to do so can leave a project at risk of expensive and time-consuming delays or at worst can leave a project open to legal challenge. It is therefore vitally important that EIA be fully integrated into the project design and development process and that this is achieved from the outset.

Changes to the EIA process

As noted above EU EIA Directive was revised in 2014 and is to be transposed into law in member states by 2017 (including the UK devolved administrations). The revised Directive brings in new areas that need to be addressed by EIA practitioners. These include:

- ESs will be renamed ‘Environmental Impact Assessment Reports (EIA Reports)’;
- The EIA Report must contain a description of the reasonable alternatives studied by the developer including an indication of the main reasons for the option chosen, including a comparison of the environmental effects;
- In order to ensure the completeness and quality of the EIA Report, the developer must ensure that the

EIA Report is prepared by ‘competent experts’ although this is not defined within the draft regulations;

- Where appropriate, a new requirement to describe any proposed monitoring arrangements during both the construction and operation phases;
- The requirement to provide a description of the expected significant adverse effects on the environment deriving from the vulnerability of the development to risks of major accidents and/or disasters which are relevant to the project;
- A new opportunity to notify the planning authority in writing of the intention to submit an EIA Report outside of the scoping process.

The steps of undertaking EIA

As a process, the methodology adopted for the project EIA should incorporate the following steps:

- (a) *Screening* to determine whether EIA would be required for the proposed development;
- (b) *Scoping* to confirm the extent of the assessment and baseline data requirements;
- (c) *Baseline studies* as necessary, to establish the state of the environment and socio-economic conditions prior to the implementation of the project;
- (d) *Impact assessment* in consideration of the potential effects of the project on the established baseline conditions;
- (e) *Assessment of cumulative impacts* to identify those combined impacts which may arise from other existing or planned developments in the area;
- (f) *Mitigation design* involving the development of measures aimed at reducing any negative impacts;
- (g) *Assessment of residual impacts* following the application of mitigation measures;
- (h) *Development of appropriate monitoring processes* of construction and operation.

The main EIA steps are summarised in the sections below, however, EIA is a wide ranging topic and there are numerous sources of guidance available which should be referenced when undertaking EIA [5–8]. It should also be noted that EIA practise globally can vary from that in the UK – a useful source of information can be found in [9].

Although each project and site may have its own specific sensitivities and risks, there are a number of environmental and social aspects that will generally apply to all onshore wind projects. These are:

- Landscape and visual impacts
- Noise

- Biodiversity
- Archaeology and cultural heritage
- Hydrology and hydrogeology
- Aviation and telecommunications
- Shadow flicker
- Socio-economics
- Traffic and transportation

It is the purpose of the initial screening and scoping stages described below to identify which aspects need to be considered in more detail and ensure that they are factored into the EIA process.

Site selection and design

Before considering the EIA process in more detail first it should be stressed that the first stage of assessment should come at the site selection and initial conceptual design stage. This places an increased emphasis on the importance of the 'avoidance' tier of the mitigation hierarchy. For example, it is good practise, as well as being far more cost effective, to include a suitable buffer between turbines and residential properties at the design stage to reduce noise levels, than to implement curtailment measures during operation. However, this procedure is relevant to many topics including visual amenity, shadow flicker and biodiversity.

Case study

A site selection exercise was undertaken to identify appropriate sites for offshore wind development in the Channel Islands. Although clearly not onshore development the principles apply nevertheless. In this example SgurrEnergy identified all relevant constraints at the regional level and scored then in accordance with level of risk. A matrix approach was used to then rank each constraint and assign an overall score for each 1 km square on the map. The resulting data was presented in GIS format (see Fig. 1) and allowed a number of preferred sites to be identified.

Case study

Following the initial site selection process it is common practise for developers to undertake further feasibility studies to determine whether the site is likely able to support an onshore wind development and whether it will be financially viable. An important step in this process is the development of a constraints map using GIS software. The constraints map will build up layers of appropriate data including roads and infrastructure, residential properties, protected

sites, watercourses and cultural heritage sites. An appropriate buffer is applied to each feature to identify the amount of available land (Fig. 2). The initial layout should then be developed on the basis of the available unconstrained land. Although often viewed as a separate exercise to the main EIA, it is important that the initial constraints mapping is viewed as part of the same process.

Screening

In practical terms, the first formal stage of EIA is screening, the aim of which is to determine whether a particular development is likely to have significant effects on the environment and hence whether an EIA is required.

Developments falling within a description in Annex I of the EIA Directive [10] will always require EIA. Development of a type listed in Annex II to the Directive will require EIA if it is likely to have a significant effect on the environment, by virtue of factors such as its size, nature or location. In the UK, projects are classified as Schedule 1 or 2 under the corresponding devolved EIA Regulations [11]. Screening is generally undertaken for Annex II (UK Schedule 2) projects.

In the UK, the planning authority has 21 days, soon to be increased to 30 days under the 2017 Regulations, from receipt of the request in writing to provide its opinion, in writing. The screening opinion will confirm whether an EIA is required.

Scoping

Scoping provides an opportunity for developers to identify and assess the key environmental impacts and issues of concern that will need to be fully considered during the full EIA process. The key outcome of the scoping process is to agree the level at which environmental aspects should be studied. This could be in terms of the extent of a bird survey programme, for example, and whether 1 year or 2 years of survey data would be required, or it could be seeking agreement on the number of viewpoints to be considered as part of the landscape and visual impact assessment. Scoping is facilitated by thorough consultation with, among others, planning officers, statutory and non-statutory consultees, non-governmental organisations and the public.

Whilst there is no statutory requirement to seek a formal scoping opinion, UK Regulations and guidance

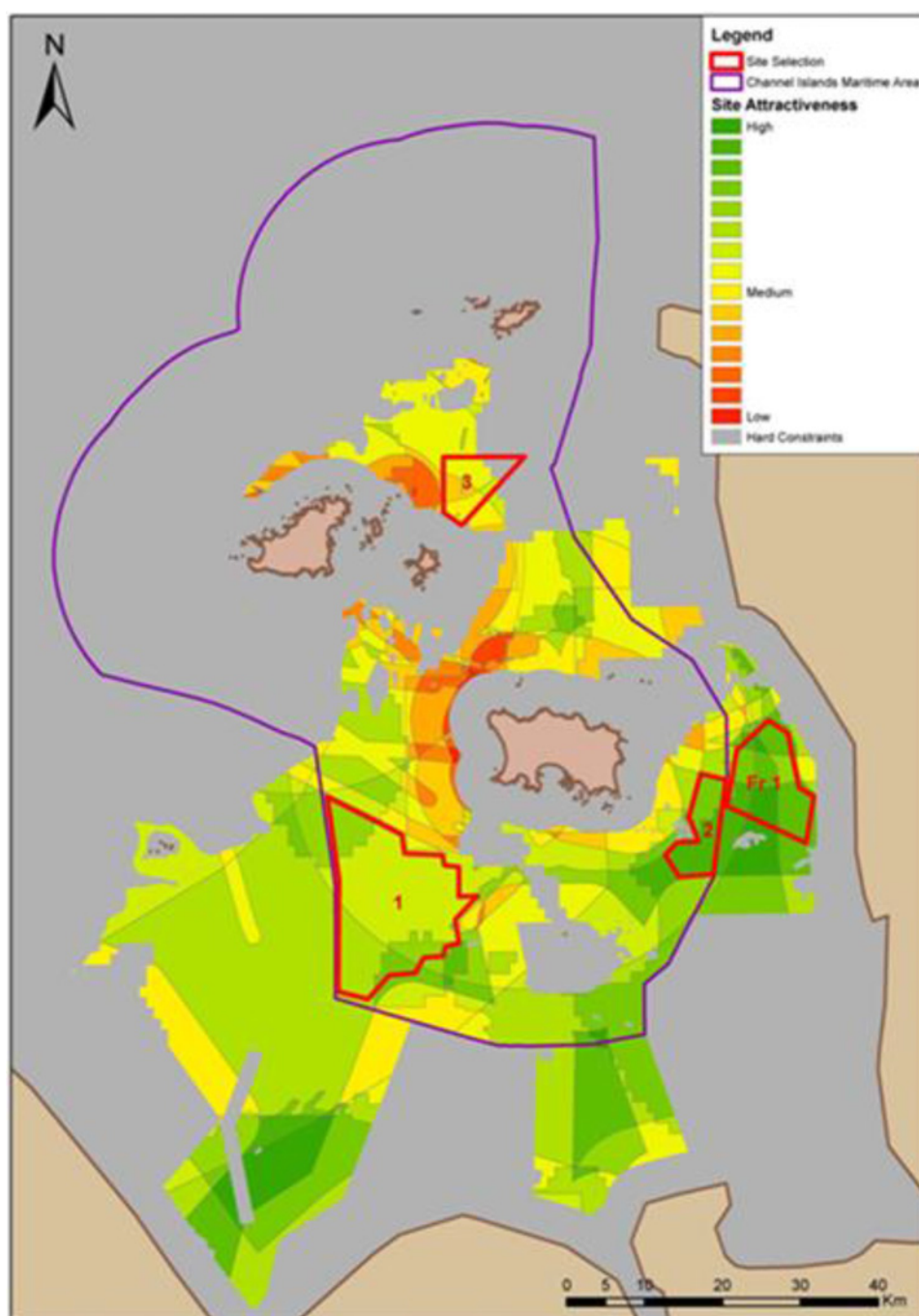


Fig. 1 Example site selection exercise (Channel Islands)

are very clear that the preparation of the ES should be a collaborative exercise involving discussions with the planning authority, statutory consultees and other parties. Seeking a scoping opinion can facilitate a useful mechanism for dialogue.

The draft 2017 EIA Regulations provide a new opportunity to notify the planning authority in writing of the intention to submit an EIA Report outside of the

scoping process. Following notification, the planning authority must notify the consultation bodies and any other public body likely to have an interest in the development of the duty to make information available to the person writing the EIA Report.

Baseline data collection

The assessment of potential impacts should be considered in terms of a deviation from the baseline

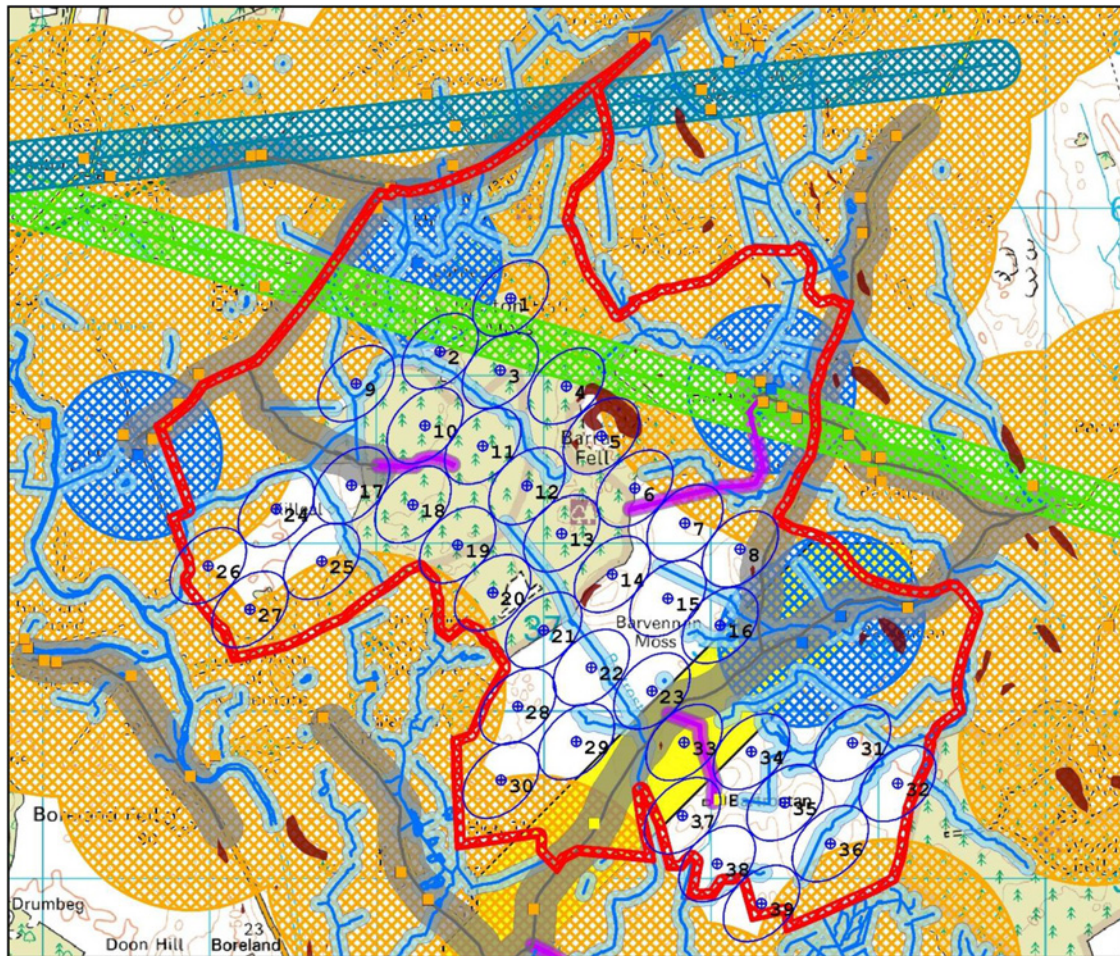


Fig. 2 Example constraints map

conditions. Therefore, it is extremely important that the baseline is sufficiently robust to allow a similarly robust level of assessment. The baseline information describes the existing environmental conditions on the site and the wider area where applicable. Baseline data should be collected from a wide range of sources involving desk-based studies, field surveys and consultation with statutory and non-statutory consultees. Where information is available, the baseline information should detail future trends in the absence of the project.

For a wind energy project in the UK, the following surveys should be considered:

- General site walkover survey
- Phase 1 habitat survey
- National vegetation classification survey
- Protected species survey (great crested newt, otter, badger, water vole etc.)
- Aquatic surveys (salmonids, freshwater pearl mussels)
- Vantage point surveys (1–2 years) for soaring birds and raptors
- Breeding bird and upland bird transect surveys (two per month during breeding season)
- Bat surveys (two per month April–September)
- Viewpoint analysis for visual impact assessment
- Peat probing in areas of deep peat (>1 m)
- Background noise measurements at noise sensitive receptors
- Wind measurement (met mast or Lidar) to align with noise measurements
- Survey of archaeological sites/features with potential trial pits in areas of greatest risk
- Access study including driven run of the delivery route and identification of pinch points.

The actual survey requirements will depend on the individual characteristics of the project and surrounding area. As discussed above, the scoping process is the mechanism by which those survey requirements would be formally agreed with the planning authority and relevant consultees.

To ensure the completeness and quality of the EIA Report, the developer must ensure that the EIA Report is prepared by ‘competent experts’. This will apply to all stages of EIA.

For a project developer it is important to understand the survey duration and survey periods for different aspects. For example, spring bird migration surveys must be conducted between mid-March and late May/early June. If the data gathered is insufficient then there would be a delay of a year before the next survey window. Often the financial cost of delaying the project can far exceed the cost of undertaking a more robust level of survey.

Assessment of effects

One of the key requirements of EIA is to conduct an assessment of likely significant effects of the development on the environment, which should cover the direct effects and any indirect, secondary, cumulative, short-, medium- and long-term permanent and temporary, positive and negative effects of the development.

Short-term effects are those considered to extend over a short period. In the context of this type of development, short-term relates typically to the construction and decommissioning periods. Effects lasting less than the life of the project are considered to be medium-term whilst those over or exceeding the life of the project are considered long term. Reversibility of effect, i.e. whether the effects will be reversible either wholly, or in part, in the short to medium term, are also considered where relevant.

It is important to note that under the draft EIA Regulations 2017 there is a new requirement to provide a description of the expected significant adverse effects on the environment deriving from the vulnerability of the development to risks of major accidents and/or disasters which are relevant to the project, including measures to prevent or mitigate

Table 1 Assessment criteria – receptor sensitivity

Magnitude of change/impact	Criteria
high	site or species subject to international or national protection
medium	site or species subject to regional or local protection
low	site or species subject to no specific protection measures
negligible	site or habitat already significantly degraded

Table 2 Assessment criteria – magnitude of impact

Magnitude of change/impact	Criteria
high	fundamental change to the specific environmental conditions assessed resulting in temporary (long term) or permanent change
medium	detectable change to the specific environmental conditions assessed resulting in non-fundamental temporary or permanent change
low	detectable but minor change to the specific environmental conditions assessed
negligible	no perceptible change to the specific environmental conditions assessed

the significant adverse effects of such events and details of the preparedness for a proposed response to such emergencies.

Initially, the competent expert will determine the quality and sensitivity of the receiving environment or potential receptor. The sensitivity of the receptor depends upon the relative importance of existing environmental features on or in the vicinity of the site or the sensitivity of receptors which have the potential to be affected by the project. The criteria for determining sensitivity or importance are based on existing guidance, legislation, statutory designation and/or professional judgement.

Following the assessment of receptor sensitivity, the potential impact on a receptor and the predicted magnitude of that change or impact will be identified (i.e. the scale or degree to which the environment is affected from the existing situation). An example of the framework used to assess sensitivity and magnitude is given in Tables 1 and 2. However, it should be borne in mind that the criteria used will very much depend on the specific environmental aspect being considered.

Evaluating the environmental sensitivity of a receptor and magnitude of change or impact on a receptor together will allow the significance of the impact to be predicted. Potentially significant effects can then be identified for further analysis. Effects are

Table 3 Establishing significance of impact

Magnitude of change/impact	Sensitivity			
	Negligible	Low	Medium	High
negligible	negligible	negligible	negligible	negligible
low	negligible	low	low	moderate
medium	negligible	low	moderate	moderate
high	negligible	moderate	moderate	major

considered to be 'significant' in the context of EIA where the assessment indicates a moderate effect or higher. Table 3 highlights a suggested method of establishing impact significance.

There are certain environmental disciplines where pre-determined thresholds for identifying the level of effect (and therefore its significance) already exist. Such predetermined thresholds have generally been developed through the adoption of recognised industry standards, EIA best practice and professional judgement. Some environmental disciplines may therefore deviate from using the assessment methodology and criteria set out above. Where this is the case it should be made clear within the individual chapter, with a clear reference to the relevant standards or guidance provided. The key is consistency. The assessment criteria should be defined at the outset and then followed throughout the EIA process.

Assessment of cumulative effects: Cumulative impacts are an important issue to be considered for the project. Cumulative impacts are those effects that may result from the combination of past, present or future actions of existing or planned activities. While a single activity may itself result in an insignificant impact, it may, when combined with other impacts (significant or insignificant) in the same geographical area and occurring at the same time, result in a cumulative impact that is significant.

The assessment of the cumulative impact depends very much on the type of impact. For example, issues such as noise can be modelled by adding additional turbines into the project noise model using commercially available software packages whilst the cumulative visual impacts of multiple wind farm developments relies on professional judgement within an assessment framework. When considering cumulative impacts of other planned development in the area, the worst case scenario should be considered for all sites and generally only projects that have been built, consented or are subject of a valid planning application should be considered.

Case study

A cumulative noise impact assessment was carried out in support of the planning application for Gass Wind Farm, Dumfries and Galloway. The assessment found that the impacts of Gass Wind Farm on its own were within required noise limits, however, the proximity of a number of consented and operational wind farms resulted in noise

levels in exceedance of allowable limits (see Fig. 3). In this example, the worst case scenario would have been 40.9 dB(A) at a wind speed of 6 ms^{-1} at the nearest property. The allowable limit was 35 dB(A). A possible means of addressing this would be to reach a commercial agreement with neighbouring properties which would increase the allowable limit to 45 dB(A). This could be achieved by agreeing access to the site through neighbouring land. In this example, financial involvement was not agreed therefore the impacts were mitigated by reducing the development from 19 turbines to 9 turbines with additional mitigation required. This required turbines to be operated in a reduced noise mode at certain wind speeds. Following the implementation of this mitigation the project was accepted by the local authority and was granted planning permission in August 2015.

Case study

A cumulative Landscape and Visual Impact Assessment (LVIA) was carried out also at Gass Wind Farm, Dumfries and Galloway. As noted in Fig. 2 there are a large number of wind farms in the general vicinity of Gass. The initial assessment highlighted that the original site layout appeared disjointed when viewed against neighbouring wind farms would did not accord with relevant guidance. In this example, the worst case scenario would have resulted in a high level of overlap and clustering between turbines when viewed at key viewpoints. To address this, a landscape design study was undertaken to redesign the wind farm as an extension to the neighbouring wind farm at Aires (Fig. 4). With appropriate redesign the assessment found that the impact was not unacceptable and allowed the project to proceed with minimal number of local objections.

Mitigation design

When developing an onshore wind project, and in particular when it comes to recommending mitigation which would involve changes to the project design – either physically or operationally – it is important to ensure that both the environmental and technical teams work closely together to develop solutions that will work in practise.

It is important to ensure that the EIA process effectively interacts with other pre-application project activities, to generate an improved development proposal, and

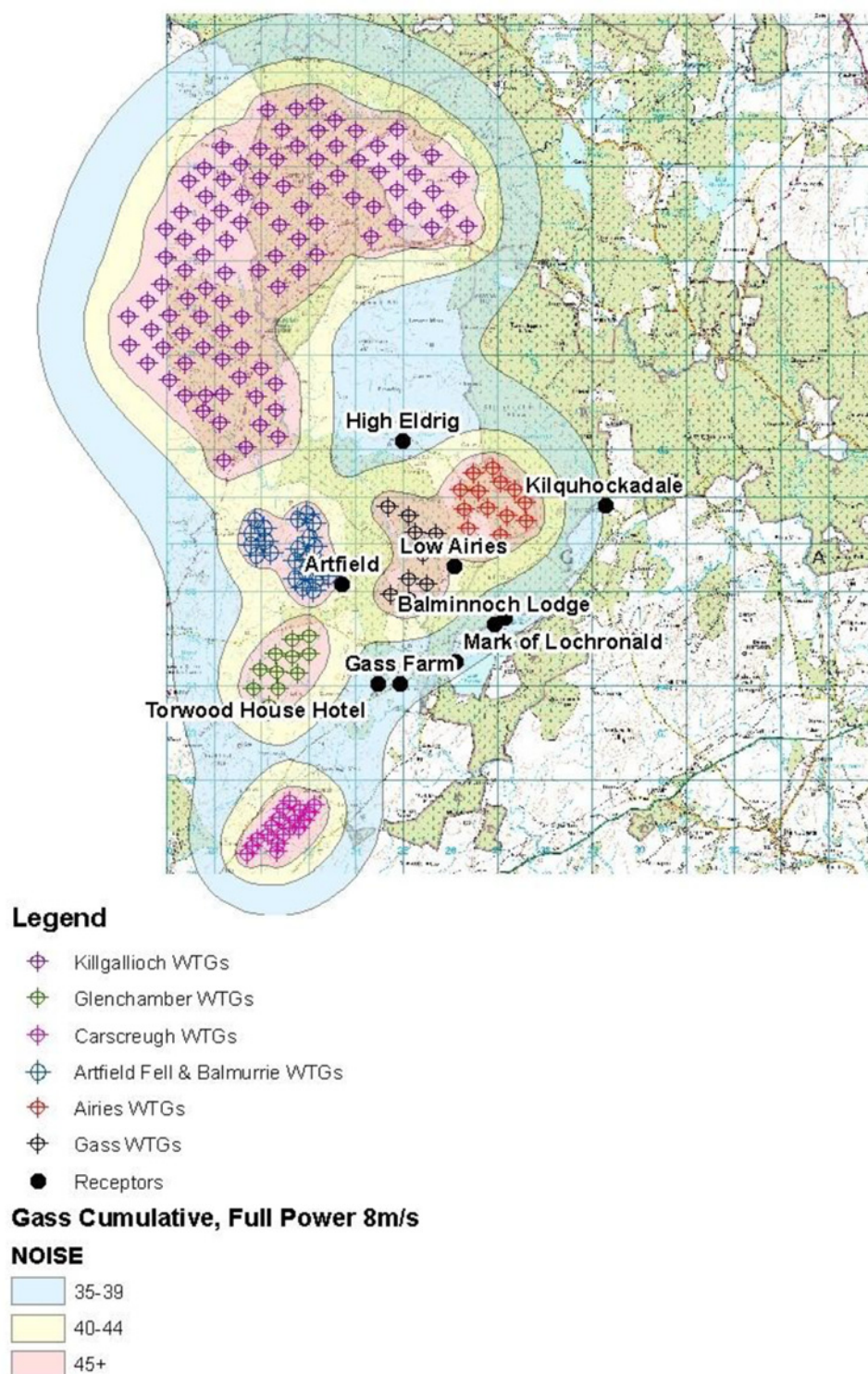


Fig. 3 Example cumulative noise impact assessment (noise contour map of Gass Wind Farm, Dumfries and Galloway)

better environmental outcomes that otherwise would not have been achieved [12]. When considering the level of mitigation required the objective is to reduce the impact to a level which is deemed not significant (see Tables 1–3). However, this may create conflict between individual specialists who may feel that a

more comprehensive mitigation approach should be implemented. For the EIA project manager it is advised to clearly define the overall approach and objectives of the EIA at the outset. If there are specific project parameters that must be adhered to, then these should also be defined so that mitigation is

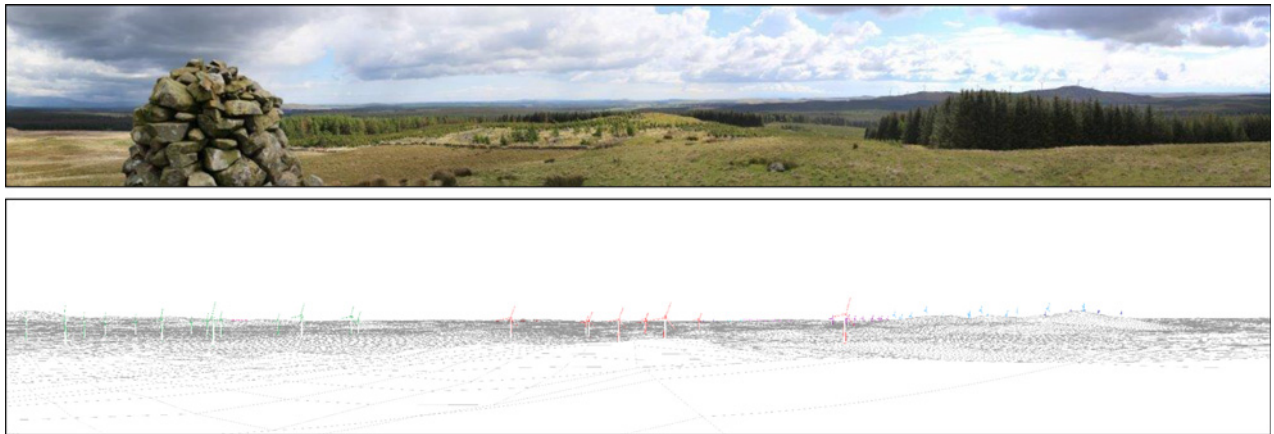


Fig. 4 Existing view and example cumulative wireframe to aid assessment (Gass Wind Farm, Dumfries and Galloway)

developed in line with an achievable project concept. Nevertheless if there are opportunities to implement more robust mitigation measures which would deliver a better environmental outcome without impacting the viability of the project, then these should be encouraged.

All mitigation measures should be guided by the mitigation hierarchy (Fig. 5); a systematic approach to addressing environmental impact and its potential compensation. The key principles are:

- Identify the impact.
- Avoid the impact.
- Minimise the impact through appropriate mitigation measures. Mitigation can be achieved through project design or through on-site operational measures. To illustrate the differences, noise impacts, for example, could be mitigated through the selection of a quieter turbine model (design) or through the operation of the original turbines but in a reduced noise mode (operational measures).

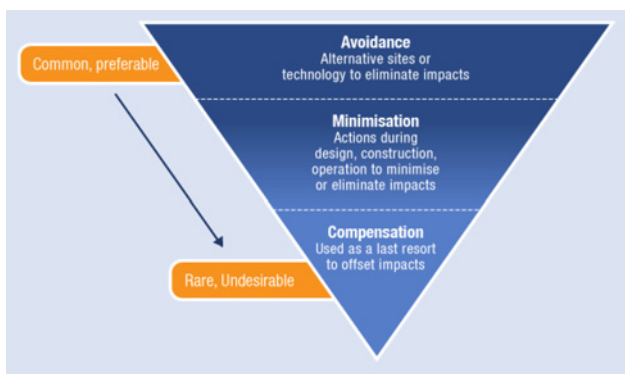


Fig. 5 Mitigation hierarchy

- Compensate for the impact by offsetting residual, unavoidable impacts primarily through on- or off-site restoration and improvement works. When implementing offsetting and compensation measures, the minimum objective should be no net loss or reduction in environmental quality.

Mitigation can be carried out by:

- *structural measures*, such as design or location changes, engineering modifications and landscape or site treatment;
- *non-structural measures*, such as economic incentives, legal, institutional and policy instruments, provision of community services and training and capacity building.

Structural measures are well established for large-scale projects, such as energy generation, dams, roads, and oil and gas exploration and development. In the case of onshore wind generation, numerous examples of good practice guidance are available and have been cited elsewhere in this paper. However, these need to be applied with regard to the nature and severity of environmental impacts; for example, taking account of nearby protected areas, patterns of wildlife mitigation or constraints imposed by natural hazards. Some examples would include changes to track layout, turbine locations, method of watercourse crossings or dimensions of turbines.

Non-structural measures are used increasingly. They can be applied to reinforce or supplement structural measures or to address specific impacts. For example, many types of social, community and health impacts are addressed by non-structural measures and their use is becoming broader. A good

example of this would be the requirement to develop a community benefits package which has now become an almost mandatory requirement for all new onshore wind projects. The level of community benefit payments in the UK has typically ranged from £2000 to £5000 per installed MW per annum.

The three key steps in the mitigation hierarchy are described below.

Impact avoidance: This should be applied at an early stage of project planning. It can be achieved by:

- not undertaking certain projects or elements that could result in adverse impacts;
- avoiding areas that are environmentally sensitive;
- putting in place preventative measures to stop adverse impacts from occurring, for example, installing a free span bridge crossing rather than a pipe culvert to cross a watercourse.

Impact minimisation: This step is usually taken during impact identification and prediction to limit or reduce the degree, extent, magnitude or duration of adverse impacts. It can be achieved by:

- scaling down the proposal, i.e. reducing number of turbines;
- redesigning elements of the project such as reducing height of turbines;
- taking supplementary measures to manage the impacts, for example, installing bird diverters on overhead transmission lines.

Impact compensation: This step is applied to mitigate unavoidable residual adverse impacts. It can be achieved by:

- rehabilitation of the affected site or environment, for example, by habitat enhancement;

- restoration of the affected site or environment to its previous state or better;
- replacement of the same resource values at another location, for example, by peatland restoration to provide an equivalent area to that lost.

Case study

Many wind farms in Scotland and Wales are developed in upland areas which often have significant amounts of peatland. Peatlands are an important carbon store and as such should be protected. When seeking to develop mitigation to avoid impacts on peatland it is important to understand to key feature of such a habitat. Peatlands are a wet environment which depend on hydrological flow across the site to maintain water levels close to that of ground level. When considering road layout for example, in areas of deep peat the first mitigation option is to design the road layout to avoid deep peat. Where this cannot be avoided a ‘floating’ track design could be utilised (Fig. 6). The floating track will incorporate a strip of geotextile material laid on the surface of the peat turf with a layer of crushed stone on the geotextile to form the track with the edges of the site track raised above the peat surface. Further layers of crushed stone and gravel are laid on top and compacted to make an even surface. Drainage is installed at regular intervals to maintain hydrological flow across areas of peat.

Case study

Mitigation through the avoidance tier of the mitigation hierarchy will always be the preferred option. As an example a wind farm developer carried out bird surveys over the course of 2 years due to the presence of sensitive raptor species on the proposed project site. The results of those surveys were interrogated using GIS

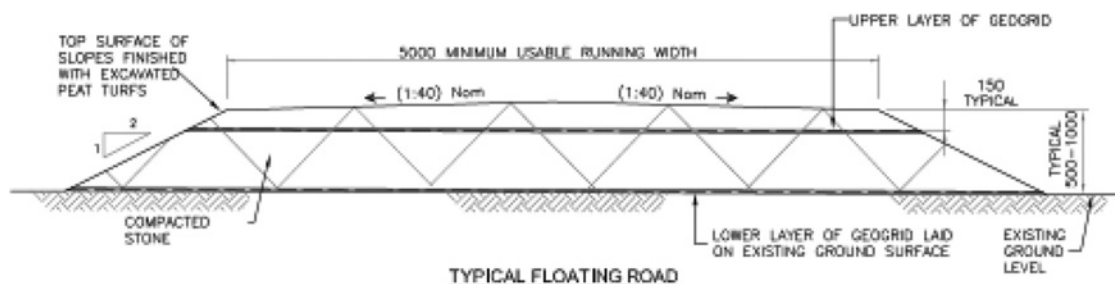


Fig. 6 Typical floating track design

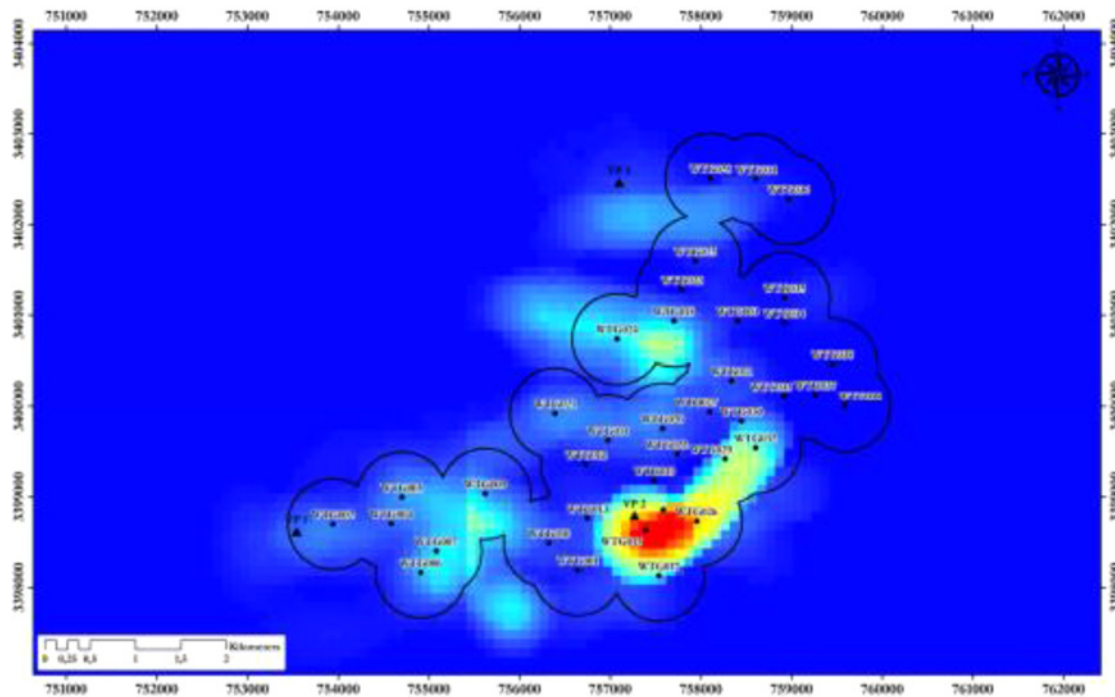


Fig. 7 GIS-based heat map showing bird movements across a wind farm site

software and the results presented as a GIS layer (Fig. 7). It is clearly evident from the figure that there is an area on the south eastern part of the site that experiences a higher density of bird flights. It is then a relatively simple process to re-design the site layout and move turbines out of those high-risk areas and re-site them in areas to the north east where there have been significantly fewer flights recorded. As a result of this approach, the predicted number of collisions and hence impacts were significantly reduced without the need for more costly mitigation during the operational phase. Operational mitigation in this instance would consist of turbine shut-down when birds fly within 500 m of the site which would in turn impact on energy yield. This also requires the continual presence of on the ground observers to initiate the shutdown procedure.

Assessment of residual effects

Following the identification of mitigation measures to address significant adverse effects, an assessment of the significance of any residual effects (i.e. those remaining after mitigation) should be completed. Where significant residual impacts remain, consideration should be given to offsetting or compensating for residual impacts.

Monitoring of impacts

Any programme of mitigation should be accompanied by a corresponding monitoring protocol to measure the actual impacts following mitigation. Subsequent to the completion of the EIA, proposals for monitoring requirements should be put forward. Proposals for monitoring should be designed to evaluate the accuracy of the impact prediction and the success of any implemented mitigation measures. The 2017 EIA Regulations include a new requirement to describe any proposed monitoring arrangements, explaining the extent to which significant adverse effects on the environment are avoided, prevented, reduced or offset during both the construction and operation phases. The monitoring programme should be implemented during construction works and typically for the first 2 or 3 years of operation. The actual impacts should be compared against the impacts predicted in the EIA and if necessary the mitigation and monitoring should be revised to account for any changes in impact significance.

Conclusion

Wind energy has experienced significant growth since 2000 and now represents one of the main sources of electricity in the UK. In parallel to this, many good practice principles have emerged which reduce the environmental impacts – both real and perceived – but there are still areas of concern.

A key tool in addressing areas of concern is EIA which aims to provide decision makers with full knowledge of the likely significant effects on the environment as a result of proposed development. It is then for the decision makers, in consultation with key stakeholders, to decide whether to grant planning permission for a project.

As a process, there are a number of clearly defined steps which should be adopted for the project EIA. The general EIA methodology of setting out the baseline conditions, assessment impacts as a deviation from that baseline then developing mitigation for any significant impacts should be followed for all projects. A robust EIA process can have a number of benefits including improved project design/siting which reduces the environmental damage caused.

Ultimately the success of each project will depend on the mitigation measures implemented during the design and implementation process to ensure there are no significant impacts. Mitigation should be guided by the mitigation hierarchy of avoid, minimise and compensate. The preferred option is always to mitigate by design and avoid the impact in the first place. However, to enable such an approach there is a need to have a suitably robust suite of baseline data to allow a similarly robust approach to the assessment. There are a number of software tools available which can help an EIA practitioner in identifying and presenting impacts in an easily understood manner.

It is important to monitor the actual impacts against the impacts predicted in the EIA and if necessary the mitigation and monitoring protocol should be revised to account for any changes in impact significance. A monitoring programme should be implemented during construction works and typically for the first 2 or 3 years of operation with less frequent monitoring thereafter.

When undertaken correctly, EIA should provide a clear, unbiased account of the impacts of a project to allow a decision to be made in full knowledge of the significant environmental and social effects. However, failure to do so can leave a project at risk

of expensive and time-consuming delays or at worst can leave a project open to legal challenge. It is therefore vitally important that EIA be fully integrated into the project design and development process and that this is achieved from the outset.

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- [12] Institute of Environmental Management and Assessment: 'Environmental impact assessment guide to shaping quality development November 2015', 2015. Available at <http://www.ida-design.co.uk/wp-content/uploads/2015/11/IEMA-Guide-to-Shaping-Quality-Development.pdf>, accessed 1 February 2017