Environmental constraints to onshore wind energy development:
Integrating project experience into the traditional GIS based site prospecting procedure

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Abstract

This paper will explore an approach which combines professional experience and knowledge with a GIS based approach to identify new onshore wind farm sites. This approach is targeted at overcoming the challenges posed by environmental concerns; other constraining factors to wind energy development fall outside the remit of this topic. The site selection process is undertaken in a number of stages, beginning with a GIS approach to identify areas of unconstrained or least constrained land, giving due consideration to national, regional and local environmental designations and protected areas. Experienced wind farm developers are able to discern ‘show stopper’ issues from those environmental issues which may be mitigated. In doing so site selection teams can efficiently identify developable land, which otherwise may have been overlooked. Thereafter, consultations with statutory and non statutory organisations are undertaken whilst concurrently preparing an in-house environmental survey. Findings of the studies and consultation discussions then inform evolution of site specific design.

Commercial scale wind turbines are large structures which, as with all civil engineering and electricity generating projects, will have an impact on the immediate environment. It is important when assessing a wind farm proposal to weigh up the impact of the development upon the local environment against the need for the development, particularly in regard to global environmental changes associated with climate change.

Onshore wind energy development is becoming increasingly constrained in many European countries and developers are seeking new opportunities in marginal environments. The aim of this paper is to propose a new approach to traditional GIS based site prospecting, which enables the identification of suitable land for wind energy developments in previously overlooked areas. This will allow onshore wind energy to continue to play a vital role in meeting the ambitious 2020 European Union (EU) Renewable Energy targets.

This approach will allow the EU to contribute towards the alleviation of climate change pressures and associated global environmental damage whilst minimising local environmental impacts by virtue of being more practical in wind farm development. Alongside the obvious emission reductions, the renewable energy industry will benefit from a portfolio of viable new sites which will encourage further growth in the sector.

Introduction

In 2007, the European Commission adopted a legally binding renewable energy target of 20% by 2020, and has since set mandatory national renewable energy targets for each Member State. As the cheapest of the renewable electricity technologies, onshore wind is likely to be the largest contributor to meeting these targets; by 2020, most of the EU’s renewable electricity will be produced by onshore wind farms [1].

In the UK alone, 258 onshore wind farms account for an operational capacity of 3,753 megawatts (MW), and there is currently 1,104MW of capacity in the construction pipeline [2].

The graph opposite shows the growth in onshore (and offshore) wind energy in the UK between 2000 and 2010. Development forecasts suggest this growth in onshore wind energy is set to continue [2]. This growth scenario is reflected across Europe – during 2010, 8,412MW of onshore wind energy was installed by EU Member States [3].

In countries with a well established onshore wind energy industry – Germany, Spain, Italy, France, UK, Denmark, – development look at marginal environments and previously overlooked areas are being re-investigated. In an attempt to find new sites for onshore wind developments, site prospectors must be creative and use greater levels of scrutiny when preparing selection criteria.

Commercial scale wind turbines are large structures which, as with all civil engineering and electricity generating projects, will have an impact on the local environment. Environmental Impact Assessments assist decision makers in determining whether the negative local environmental impacts of a wind farm proposal are outweighed by the positive global environmental benefits of a scheme. A site prospective must make a judgement during the site finding process about the environmental sensitivity of a site without the benefit of full environmental surveys.

Development of an appropriately sized and well designed proposal in the early stages will lead to fewer problems during the later stages of the development process, and ensure that a scheme with good site design, including maintaining separation distances between wind turbines and residential properties to mitigate noise and shadow ficker impacts and setting the turbines into a landscape which offers the least possible visual impact whilst still maintaining optimum wind speed levels, can alleviate the magnitude of environmental impact of a project substantially.

The authors propose an innovative site prospecting process, combining conventional GIS-based site finding methods with past experience of wind energy development issues to ensure key constraints and issues are identified at the earliest stage in the development process, and ensures that search areas which have previously been overlooked are reinvestigated.

Innovative Site Prospecting

‘Show stopper’ issues

‘Show stopper’ issues – those constraints which are considered of paramount importance to warrant immediate termination of a project – can be either technical or environmental. By their nature technical issues can be resolved, however doing so may render a site financially unfeasible and as such is a commercial consideration. Environmental constraints, on the other hand, are less objective and a site prospective must draw on past experience of similar issues and make a balanced judgement on the sensitivity of a particular constraint.

At an early stage, a site prospective must decide whether to discard a project and avoid incurring subsequent expense, or to proceed with costly environmental surveys at risk. Knowledge and experience is therefore of the relative importance of one environmental designation over another and recognising ‘show stoppers’.

Detailed investigations

Understanding the key issues relating to an environmental asset and the rationale for its designation is key to discerning the relative importance of the designation.

In the United Kingdom, the most ubiquitous natural heritage designation is the Site of Special Scientific Interest (SSSI) covering 8% of the country’s land area. SSISs are designated either for biological or geological reasons, and have very different implications when sited a wind farm; the former having potential ecological sensitivity extending beyond the SSSI boundary. Discerning between the two types of SSSI is crucial.

Similarly, the EU’s Birds and Habitats Directives provide protection to wild bird, animal and plant species, and valuable habitat types. The directives led to the establishment of the Natura 2000 network. Within Natura 2000 sites, Member States are required to avoid damaging activities that could significantly affect species. Judging whether a potential wind energy development will have an impact on the protected species will largely be determined by full ecological surveys. However, during the initial site finding stage, identifying topographic or habitat links between Natura 2000 sites and the other ecological designations, can be a good first indication of potential impact on birds using flight paths.

Proximity to an environmental designation does not necessarily relate directly to magnitude of impact. Indeed a wind energy development very close to a SSSI or Natura 2000 site may have very little ecological impact, whereas another one on a migration path many kilometres from a designation may have a much greater impact.

Landscape graphics

Modern wind turbines are very large structures, in many cases reaching heights of 130 metres (or more) above ground level. The visual impact of these developments on the local landscape and nearby cultural heritage assets is a key consideration, and in countries with an established onshore wind energy industry this issue has been particularly controversial.

Experienced site prospectors can use graphics – such as wireframes and Zone of Theoretical Visibility (ZTV) diagrams – to make an informed judgement about the extent of visibility of a wind farm development, and the magnitude of impact on sensitive receptors. In areas with operational or consented wind farm developments, taking account of nearby wind farm developments using cumulative graphics is essential at an early stage, to establish the current baseline conditions and to gain an indication of the additional impact of another wind farm development would have an unacceptable visual impact.

These graphics are a very powerful tool, allowing a site prospective to use GIS software to locate areas with good topographical screening, and make a balanced judgement whether a wind energy development would be acceptable in an area.

Spatial planning publications

Increasingly, national and regional planning bodies are publishing spatial planning guidance to direct onshore wind developers to areas of least environmental sensitivity. In general, this has been a very useful exercise and has reduced uncertainty and risk for both the industry and public authorities.

On occasions, however, these spatial planning exercises deviate from the objective at hand, and take account of factors that are entirely commercial considerations – for example grid connectivity and wind speed. It is worth noting that national wind speed databases are notoriously crude and some developers would develop sites on the margins of profitability. It is the role of market forces, not local planning bodies, to ensure developments are directed at areas with sufficient wind speed.

In order to identify new feasible sites, it is important to scrutinise planning documents and the supporting evidence base, and where necessary undertake an exercise to filter out these ‘commercial’ constraints.

Site design and mitigation measures

Appropriate site design in the early stages of site development is essential to ensure that environmental designations are not adversely affected by the development of a wind farm. Adjusting the size and location of turbines is just one of a number of mitigation measures which can be incorporated in the early stages of site design to ensure the most appropriate development is achieved.

Many onshore wind energy developers adopt mitigation strategies to alleviate impacts on birds and bats. Measures might include a turbine shut-down strategy, or locating turbines in blocks to create corridors for birds to pass through, using fewer but larger turbines (Please note: the effectiveness of this approach is still being researched).

Conclusions

If the EU is to meet its renewable energy targets, then it is clear that onshore wind must continue to play a crucial role. In countries with established operational wind farms, developers must endeavour to identify unconstrained or least constrained land. Traditional GIS-based site searching is no longer sufficient, and developers must adopt an innovative site prospecting approach which: uses past experience to discern between site issues and site opportunities; and recognises the severity of any site impacts; requires a detailed understanding of the designations; scrutinises spatial planning documents to ensure viable development areas aren’t being discounted for ‘commercial’ reasons; and ensures best practice site design and mitigation measures are adopted.

References

1. Powering Europe: wind energy and the electricity grid, European Wind Energy Association, November 2010