Executive summary

The UK has set itself a challenging target with the Climate Change Act: to reduce greenhouse gas emissions by 80% by 2050 (compared to 1990). This objective may be achieved by implementing different options for energy reduction, or shifting to low carbon renewable energy technologies. At the same time, the UK has also committed to conserve biodiversity and contribute to the achievement of EU targets and those of the Convention on Biological Diversity. The UK's energy policy could lead to massive deployment of certain energy production technologies such as bioenergy, offshore wind power, tidal and wave power technologies. But how would this affect biodiversity?

Biodiversity impacts are difficult to characterise and quantify as they depend on which biodiversity components are considered (e.g. all taxa or only certain species and ecosystems), their conservation status and spatial context (e.g. whether they have a restricted range, are threatened and the scale of the threat) and the longevity of the impacts. Furthermore, energy technologies affect biodiversity in multiple ways when considering all stages of energy production from extraction of natural resources through energy conversion to distribution. Impacts of energy technologies can be positive or negative, direct (e.g. direct mortality, habitat loss and disturbance, etc.) and indirect (e.g. through impacts on other components of the ecosystem). Impacts at each stage also often vary spatially and over time. As the nature, magnitude and duration of impacts on habitats and species are site and context dependent, it is especially difficult to assess current and future impacts based on current available information.

Review of evidence of the impacts on energy technologies on biodiversity

To help aid policy decisions, this study performed an extensive review of the literature of impacts of different energy production technologies on biodiversity to provide a clear overview of available evidence and its robustness. While there is good evidence of the impacts on biodiversity for many energy technologies, the impacts of more recent renewable technologies are neither well understood or documented (e.g. offshore wind, second generation energy crops, agricultural and forestry residues, tidal stream, wave power, carbon capture and storage, etc.). This is of concern as renewable technologies are expected to be extensively deployed in the UK to meet the UK's 2050 climate change target.

Assessment of the current and future potential biodiversity impacts of energy technologies in the UK

A simple, transparent methodology that uses the existing evidence was developed to provide an indicative assessment of the current and potential future impacts of energy technologies on biodiversity in the UK. The aim was to integrate the impacts of possible energy technology deployment pathways on biodiversity in the UK into DECC's 2050 Calculator[1]. However, this was an ambitious task and a very innovative aspect of the project. In the end it was decided not to incorporate biodiversity into the Calculator because of data limitations and the difficulties of characterising the impacts across the wide-ranging scope and complexities of biodiversity. The work

[1] https://www.gov.uk/2050-pathways-analysis

done to develop the methodology and the outputs of applying it to a working model of the Calculator are, however, set out in the report for information.

The methodology for estimating the potential impacts on biodiversity was based on two basic parameters: the ***sensitivity*** of a particular habitat or species to a certain energy technology; and the ***exposure*** of the habitat or species to the energy technology. Each parameter was estimated by biodiversity experts in the project team (with internal checks) based on the evidence gathered in the literature review and other relevant available data, and then quantified using a percentage score. The assessments were of residual impacts and assumed that all feasible proportionate mitigation measures would be taken to minimise impacts, including the avoidance of impacts within areas that receive statutory protection for their biodiversity[2]. The residual impact on a particular habitat or species from each energy technology was calculated as the product (multiplication) of the two parameters. This was calculated for a baseline year (in most cases the year 2007) for all UK BAP Priority Habitats in the UK[3] (40 terrestrial habitats and 25 marine habitats) as well as a sample of higher plants, birds and marine fish in the UK (50 species of each including both priority and non-priority species). Future impacts on each habitat and species was calculated by extrapolating the baseline assessments according to existing parameters in the Calculator that characterise different energy deployment scenarios until 2050 (as proxies for change in exposure). Narratives, highlighting the main biodiversity impacts of each energy technology, were also developed to complement the quantitative assessments and provide additional information (e.g. impacts on biodiversity outside the UK). These have been incorporated into the Calculator to increase users' awareness of biodiversity.

The assessment of baseline impacts of each energy production technology on biodiversity in the UK showed that detrimental impacts were often no more than moderate and the majority were very low. Some technologies may also provide biodiversity benefits if carried out at appropriate locations and scales and carefully managed (e.g. use of dedicated bioenergy crops on arable land, forest residues and genuine wastes). Others have mixed impacts depending on their context, such as offshore wind farms, which cause some habitat loss, disturbance and bird losses, but create new habitat/shelter and prevent trawling within their vicinity. However, detrimental impacts from many technologies could increase substantially in the future (e.g. large-scale hydropower, tidal barrages, biomass and biofuels), especially for those that would need to be massively deployed to achieve the UK's climate target in 2050. For some technologies (e.g. tidal range) in future, under potential levels of increased use, it would be difficult or impossible to avoid impacts within protected areas.

Although the biodiversity assessment is a simplified methodology that has many assumptions and uses expert judgement, it is a good starting point in the work to help policy makers and the general public identify the main impacts that UK energy policy could have on biodiversity in the UK in the future. The biodiversity impact assessment takes many different aspects of biodiversity into account but does have several limitations. Therefore, the assessment methodology and it results should always be complemented with more in-depth assessments and robust evidence. Decisions on particular schemes and projects must also take into account their specific context.

[2] I.e. Sites/Areas of Special Scientific Interest, Special Protection Areas and Special Areas for Conservation.

[3] According to the UK Biodiversity Action Plan (UK BAP). Although the UK BAP has been superseded by national initiatives, this list remains the most relevant for this type of UK-wide analysis.

Approaches to improve the assessment of energy technologies in the UK on biodiversity

To overcome two of the identified shortcomings of the developed assessment methodology, spatially-explicit land use modelling and indirect land use change were investigated in more detail to see if they could be developed and integrated into future biodiversity impact assessments.

Using spatially explicit land use modelling to assess impacts on biodiversity

To explore whether spatially-explicit modelling could be used to better assess the impacts on biodiversity, two scenarios of bioenergy deployment were assessed using Countryside Survey Land Cover Map 2007 (LCM2007) of habitats in the UK. Based on spatial information of available land with potential for growing non-food (second generation) energy crops, the location of the habitats most likely to be converted to bioenergy production was identified. This was then used to estimate in a more systematic manner which habitats and plant species were most at risk due to increases in bioenergy production. It is possible to use spatially-explicit data and models in biodiversity assessments, but this approach is limited to whether reliable information exists on the (probable) location of future deployment of each energy technology. The current spatial and temporal resolution of land use and biodiversity data sets limit assessments.

Assessing the effects of indirect land use change on biodiversity

A framework for assessing the impacts of indirect land use change (ILUC, i.e. displacement of land use (either intensification and/or expansion) following increases in bioenergy demand) on biodiversity developed by the United Nations Environment Programme's World Conservation Monitoring Centre (UNEP-WCMC), was evaluated to see if this aspect could also be integrated into biodiversity assessments. The UNEP-WCMC framework is a broad framework which asks the right conceptual questions for assessing land-use related impacts on biodiversity, but does not offer detailed guidance on how to determine in practice indirect land use change or its impacts on biodiversity. While spatially explicit ILUC data at a fine resolution are a pre-requisite to perform a reliable assessment of the impacts on biodiversity, obtaining such information remains both a technical and conceptual challenge. Another challenge, common to most other biodiversity assessments, consists in identifying robust evidence and relevant information on key biodiversity indicators. Some of the assumptions made in the framework were found to be too limiting. The framework risks not taking into consideration some important effects of ILUC such as differences in crops and cultivation practices, long-term effects, off-site effects and habitat fragmentation. The WCMC framework can serve as a basis for ILUC impacts on biodiversity, but needs to be developed further.

Recommendations and further research

Biodiversity impact assessments are in general limited by robust evidence and available data of the impacts of energy technologies and knowledge of biodiversity in specific locations. This study recommends that the initial focus of future research should be on the energy technologies that have been identified as having potentially high impacts on biodiversity (e.g. tidal range, imported bioenergy), and those whose impacts are particularly uncertain (e.g. tidal stream, wave power, offshore wind, biofuels and dedicated energy crops (in relation to possible indirect land use change)). Other areas that would also merit more research are monitoring of the effectiveness of mitigation options, their expression in terms of population impacts and the consequences of combinations of energy generating technologies. There is also a need for future research to establish better biodiversity impact assessment methodologies and develop predictive models to feed decision support systems for policy and planning purposes.