NATURE CONSERVATION
AND RENEWABLE ENERGIES
Research at BfN

Federal Agency
for Nature
Conservation

FOR DEBATE

"More areas for wind energy" – allocated in harmony with nature and landscape

Key topics

- There is an indisputable need for further expansion of onshore wind energy. However, current model calculations of the estimated potential fail to include nature and landscape conservation adequately. They therefore present an incomplete picture of the distribution of area potentials in Germany.
- In order to accelerate the expansion of wind energy use, it is important to take nature and landscape conservation into account of at an early stage of the planning process. It is often not possible to resolve conflicts merely in the context of the approval of specific projects.
- Taking into account nature and landscape conservation, 3.6% of the land area of Germany is suitable for wind energy use.
- However, different expansion targets (area quotas) should be set for each federal state, as suitable land (area potentials) is unequally distributed among them.
- The method developed in the R+D project "Planspiel EE" enables a transparent and rational derivation of area potentials and area quotas using spatial criteria and paramount objectives on climate protection.
- This method can also be used to calculate area quotas for photovoltaic use and can be adapted to the subsequent planning levels of the federal states and regions.

Land area is the new currency in the energy transition

In 2021, the Council of Europe and the European Parliament agreed on a European Climate Law. Member states have committed themselves to become climate neutral by 2050 and to reduce greenhouse gas emissions by at least 55 % by 2030 in comparison to 1990. This also affects the expansion of renewable energies and nature conservation in Germany: The expansion targets are adjusted upwards, making the availability of suitable sites for wind and solar energy the main challenge of the energy transition. Thus, it is more urgent than ever to include the interests of nature conservation and landscape management in the required planning and evaluation processes in a constructive manner.

In the light of this, there is an increasing demand for a stricter spatial regulation of the expansion of renewable energies at national level (e. g., Stiftung Klimaneutralität 2021). The Federal Government should set expansion targets for wind energy use and the associated area quotas. These are derived from the overriding climate protection targets and could also be determined for the expansion of photovoltaics.

However, it must be remembered that a uniform national area target such as e.g., the long-discussed 2 % flat-rate area quota (Bundesverband WindEnergie e. V. 2011) will not be equally achievable in all federal states in a way compatible with nature and the landscape due to different local conditions. This becomes particularly clear when the suitability criteria and conflict risks for specific areas are taken into account.

» **The criteria and methods used so far at national level only provide a rough picture of the regional area potentials.**

In order to be as compatible as possible with nature and landscape, the criteria for the definition of the areas which are actually suitable for wind energy utilisation, like wind conditions, are complemented by additional ones (e.g., proximity to residential areas). Mapping these criteria spatially at a national level has been done so far only by what are known as exclusion areas. There are now initial studies in which the interests of nature conservation and landscape management and the usage restrictions arising from these are included at national level via exclusion areas (e.g., nature reserves and national parks) in regionalised potential analyses (Walter und Wiehe 2018; Stiftung Klimaneutralität 2021; Umweltbundesamt (UBA) 2013).

However, these area designations are not ideal. Just because specific areas are excluded from the outset, this does not mean that all the remaining areas are equally suitable for wind energy use from a nature conservation perspective. Conflicts with nature conservation and landscape management interests also occur regularly outside the defined exclusion areas and can later lead to delays in the approval procedures or to the failure to obtain approval.

Up to now, these conflicts have not been included in the detailed calculations of area potentials and area quotas. The area quotas calculated in the studies available to date (e.g., Walter und Wiehe 2018; Stiftung Klimaneutralität 2021; Umweltbundesamt (UBA) 2013), which have been allocated to the federal states or regions, therefore take insufficient account of the concerns of nature conservation and landscape management. Hence, the studies give a false impression of the optimal distribution of wind energy use among the federal states and regions. This hampers the strategic spatial planning of the expansion at all levels and often delays the subsequent implementation. A more precise method for the determination of existing area potentials could help to:

- avoid many of the conflicts that have to be resolved from the outset,
- take greater account than previously of nature conservation and landscape management when expanding renewable energies and
- as a result, significantly accelerate the expansion.

In view of this need for a more adequate method, in what follows a newly developed method based on the groundwork carried out by Riedl et al. (2020) will be presented.

Determining area potentials realistically

A more precise method for spatially estimating the conflicts with nature conservation and landscape management caused by wind energy use and their influence on the identification of area potentials is provided by the R+D project "Planspiel EE". The project has mapped and evaluated the conflict risks resulting from the expansion of wind energy use for the entire territory of Germany in a GIS model (Figure 1).

» **Take account of the uneven distribution of conflicts at an early stage – include nature conservation and landscape management at the strategic level**

The new method shows that the interests of nature conservation and landscape management can be included in the distribution of area quotas at national level and that the spatial distribution of wind energy use can thus be better aligned with the criteria of nature and landscape from the beginning (Tables 1 and 2). The early identification and avoidance of conflicts achieved in this way considerably increases the prospect of success in the approval procedures for wind turbines.

» **More than sufficient area potentials that are environmentally sound – area quotas should be set at national level**

According to the new method, a total of 5.5% of the national land area with legal, technical and economic suitability displays a very low to medium conflict risk and is therefore mostly suitable for wind energy use. Around 82% of the land surface of Germany should be classified as exclusion areas. Outside the exclusion areas, 12% of the land surface has a high or very high risk of conflicts with the interests of nature conservation and landscape management. Although it should not be excluded categorically, an approval for building wind turbines in these areas is unlikely and not worth pursuing due to the expected conflict of interest with nature conservation and landscape management.

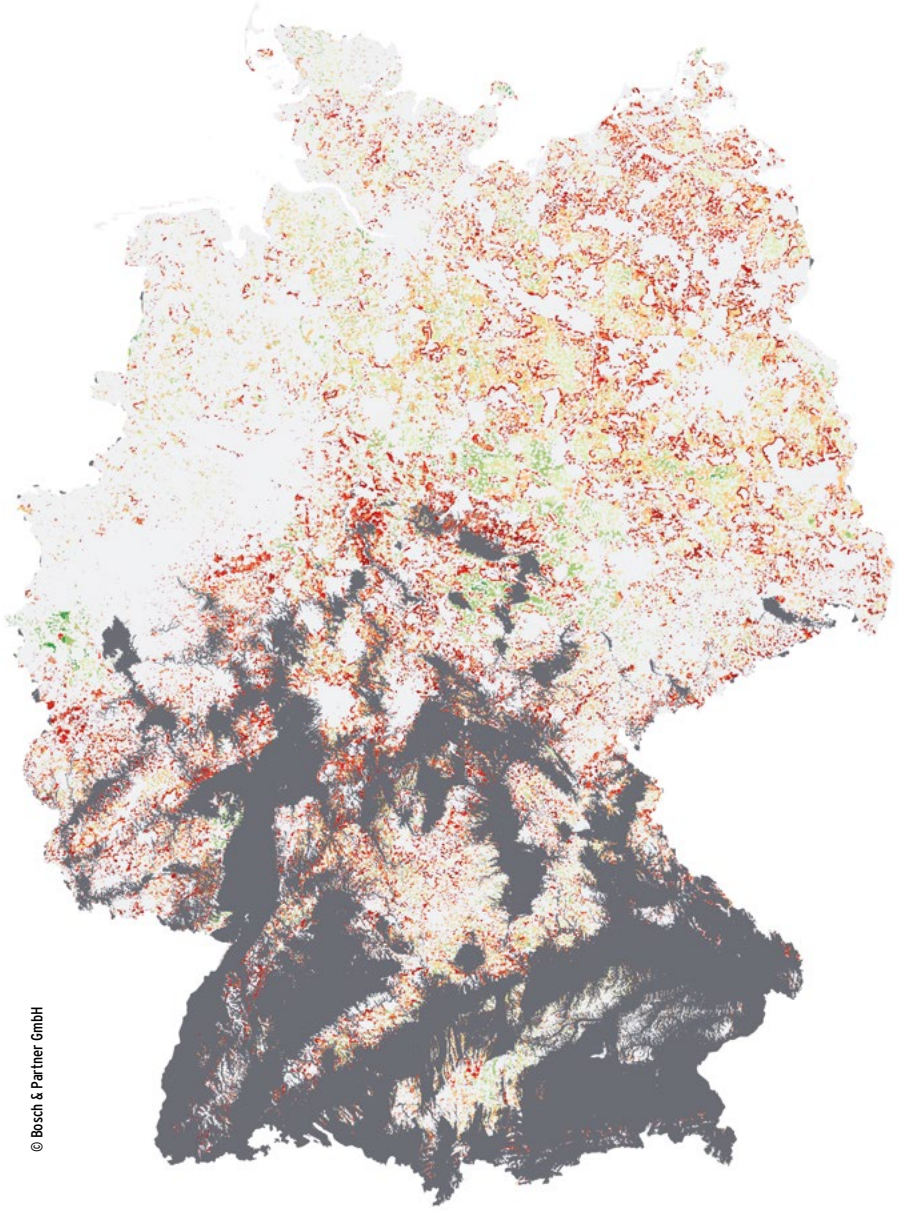

Figure 1: Conflict risks for wind energy expansion with nature conservation and landscape management interests

Exclusion areas:
- Exclusion due to wind abundance <7m/s
- Technical and/or legal exclusion

Conflict Risk Classes (CRC):
- 1: very low conflict risk
- 2: low conflict risk
- 3: medium conflict risk
- 4: high conflict risk
- 5: very high conflict risk
- 6: very high overlapping conflict risks

» Detailed statements on realistic area potentials using a nature and landscape related allocation formula

Realistic planning requires a more detailed evaluation of the suitable areas. Even areas with identified low conflict risks may probably not be included entirely in the calculation of the area potential. Approval practice has shown that transferring the resolution of predicted serious conflicts to this level does not result in all the planned turbines actually being built, because many conflicts cannot be effectively resolved at the specific site.

Therefore, an individual allocation formula (conflict risk class factor) is assigned to the conflict risks, which defines the extent to which the different areas are included in the area potential. This means that areas with very low conflict risk are included at 100% in calculating the area potentials, those with a low conflict risk are included at 80% and those with a medium risk at 60% (Tables 3 and 4). Areas with higher conflict risks are not considered because it must be assumed that these areas are not suitable for wind energy use as a result of nature conservation and landscape management factors.

Table 1: Exclusion categories

Areas adjacent to inland lakes 5 m
Areas adjacent to campsites, facilities for sport, leisure and recreation 400 m
Areas adjacent to industrial sites and business parks 300 m
Areas adjacent to rehabilitation and hospital premises 750 m
Areas adjacent to mixed-use zones 400 m
Areas adjacent to direction finders (DF) for civil and military aviation 3 km
Areas adjacent to VOR installations for civil and military aviation 5 km
Areas adjacent to weather radar for the Deutscher Wetterdienst (DWD) 5 km
Areas adjacent to housing 600 m
Areas adjacent to housing outside built up areas 400 m
Building protection area at airports
Restricted building protection area at airports with a radius of 1,760 m
Inland lakes
Biosphere reserves Zones I and II
Campsite, facilities for sport, leisure and recreation
European bird protection area (SPA) with WT-sensitive bird species
Wetlands
FFH sites with WT-sensitive bird/bat species
Areas with particularly steep slopes
Running waters
Airports and aerodromes
Air safety facilities (radar and ground navigation systems)
Power line (electricity) corridor 135 m
Industrial sites and business parks
Health resorts and hospital premises
Mixed-use zones
National parks
Nature reserves
Miscellaneous legislation
Transport infrastructure national motorway 100 m
Transport infrastructure railways and cable cars 150 m
Transport infrastructure other streets 40 m
Water protection areas I + II
Housing outside built up areas
Housing in built up areas

Table 2: Exclusion and restriction categories

Special protection area (SPA) without bird species sensitive to wind turbines	2
Areas adjacent to bird protection areas (SPA) with bird species sensitive to wind turbines 1,000 m	5
Areas adjacent to bird protection areas (SPA) with bird species sensitive to wind turbines, 2,000 m	3
Areas adjacent to bird protection areas (SPA) with bird species sensitive to wind turbines, 3,000 m	1
FFH sites without bird or bat species sensitive to wind turbines	2
Areas adjacent to FFH sites with bird or bat species sensitive to wind turbines 1,000 m	5
Areas adjacent to FFH sites with bird or bat species sensitive to wind turbines 2,000 m	3
Areas adjacent to FFH sites with bird or bat species sensitive to wind turbines 3,000 m	1
Protected landscape areas	2
Nature parks	2
Biosphere reserve development zones (III)	2
Water protection areas (WPA) III	2
Ramsar sites	3
Areas adjacent to Ramsar sites	1
Important Bird Area (IBA) outside SPAs	4
Areas adjacent to Important Bird Areas (IBA) outside SPAs	2
Areas adjacent to national parks	3
Areas adjacent to nature reserves	2
Ecological network wetland habitats/habitat networks of international importance	3
Ecological network dry and woodland habitats/habitat networks of international importance	1
German Green Belt areas	3
Deciduous woodland	4
Areas adjacent to deciduous woodland	3
Coniferous woodland	3
Areas adjacent to coniferous woodland	2
Mixed woodland	4
Areas adjacent to mixed woodland	3
Permanent grassland	3
Open land outside areas used for agriculture	3
Floodplains	3
Conflict risks related to bird strike Habitats of bird species sensitive to wind energy (data from DDA, CORINE, Bernotat 2016)	1 to 5
Conflict risks related to landscape Evaluation of diversity, distinctiveness, beauty, naturalness and recreational value	1 to 5

Conflict Risk Classes (CRC):

- 1: very low conflict risk
- 2: low conflict risk
- 3: medium conflict risk
- 4: high conflict risk
- 5: very high conflict risk

» 3,6 % of Germany's land area is suitable for wind energy

Even with the exclusion of areas with high and very high conflict risks as well as exclusion areas (due to their lack of suitability), and with the factorisation of the remaining areas with realistic percentages, the calculation still resulted in a 3,6% of the area of the Federal Republic of Germany which is available for wind energy utilisation and where serious conflicts with nature conservation and landscape management are unlikely.

These area potentials are very unevenly distributed across the federal states. As a result, not all federal states can and should provide equal percentage of areas for wind energy use. While North Rhine-Westphalia only reaches 1.9%, primarily due to the high percentage of exclusion areas from the dense population, there is a far greater area potential in Saxony-Anhalt.

» Managing wind energy use in harmony with nature conservation and landscape management

From the point of view of nature conservation and landscape management, it is imperative that wind energy use is expanded in those places where the conflict risks are shown to be lowest. Federal states that have larger areas with lower conflict risks should therefore make larger percentages of their land area available for the expansion of wind energy. When setting area quotas for the federal states, a decision must first be made at national level as to how the distribution of conflict risks in a federal state should determine the calculation of the area quota.

The calculated area potentials only form the basis for the allocation formula of the national expansion targets across the federal states. The actual implementation requires the federal states and regions to work out the details by setting their own priorities through spatial planning.

Outlook

The mix of energy sources plays an important role in the transformation to a climate neutral energy supply. The individual energy sectors each have specific impacts on nature and the landscape, which produce different effects depending on the region and area. This effect should be included right from the start of the planning process.

The landscapes in Germany are highly diverse, and so are their sensitivities towards different energy sources. In some landscapes, for example, solar power generation can be implemented with less conflict than from wind. This could be included in the evaluation of different strategic expansion scenarios with the help of this newly developed methodological approach.

» The methodological approach can also be used at the regional planning level

With the help of the new evaluation system, evaluation bases can be developed for the downstream planning levels of the federal states and regions, enabling an appropriate consideration of nature conservation and landscape management in the expansion of wind energy. For this purpose, the national area categories previously used to depict nature-related spatial characteristics must be clearly defined, based on the data set available in the respective regional planning area. At the same time, the assignment of values (conflict risk classes) can be adapted to the specific regional context, if necessary. This would give the regions the opportunity to shape the expansion of renewables according to their individual planning and policy framework conditions.

In this way, a consistent inclusion of nature conservation and landscape management concerns in the staged planning of the energy transition would be enabled and thus the pace and stringency of the planning processes would be increased. The legal framework in which this takes place, is of secondary importance. Even if regional guidelines on conflict risk classes had only an informal character, this would lead to an acceleration in planning. In addition, the stringent and transparent derivation of expansion goals is one of the key factors for gaining local acceptance (Hübner et al. 2020).

» Initiate a wide-ranging professional debate on area-related conflict risk evaluation

Our proposal is built on a widely recognised expert assessment of conflict risks that has been substantiated by in-depth research. In principle, the assessments made are amenable to expert discourse on the conflict risk classes.

This debate is required in order to increase the validity and acceptance of the evaluation results. Against the background of political and legal changes, e.g., in the most recent case law on the Climate Change Act, a con-

tinuing debate on the nature and landscape related allocation formula (CRC factors) is likewise advisable. In order to further develop the method, efforts should also be made to expand this to ground-mounted photovoltaic systems.

Table 3: Area potentials of the federal states

Federal state	Little conflict (CRC very low to medium)	High conflict (CRC high to very high and overlapping)	Exclusion
Baden-Württemberg	2.1 %	6.7 %	91.2 %
Bavaria	2.4 %	7.0 %	90.6 %
Berlin	0.1 %	2.6 %	97.3 %
Brandenburg	10.2 %	20.4 %	69.4 %
Bremen	0.2 %	1.1 %	98.8 %
Hamburg	0.0 %	1.2 %	98.8 %
Hesse	2.7 %	14.6 %	82.7 %
Lower Saxony	9.2 %	11.8 %	79.0 %
Mecklenburg-Western Pomerania	6.8 %	21.3 %	71.9 %
North Rhine-Westphalia	2.7 %	6.9 %	90.4 %
Rhineland-Palatinate	2.6 %	14.7 %	82.7 %
Saarland	0.3 %	12.1 %	87.6 %
Saxony	4.2 %	12.9 %	82.9 %
Saxony-Anhalt	16.5 %	20.9 %	62.6 %
Schleswig-Holstein	6.0 %	9.2 %	84.8 %
Thuringia	7.5 %	14.3 %	78.2 %
Nationwide	**5.5 %**	**12.0 %**	**82.5 %**

Tabelle 4: Realistische Flächenpotenziale der Länder in Abhängigkeit von Konfliktrisiko und KRK-Faktor

Conflict risk	very low	low	medium	
Federal state	**CRC Factor 1**	**CRC Factor 0.8**	**CRC Factor 0.6**	**Area quota**
Baden-Württemberg	1 km²	134 km²	343 km²	1.3 %
Bavaria	14 km²	325 km²	743 km²	1.5 %
Berlin	<1 km²	<1 km²	1 km²	0.1 %
Brandenburg	11 km²	170 km²	1,683 km²	6.3 %
Bremen	0 km²	<1 km²	<1 km²	0.1 %
Hamburg	0 km²	<1 km²	<1 km²	< 0.1 %
Hesse	2 km²	102 km²	268 km²	1.8 %
Lower Saxony	50 km²	948 km²	1,883 km²	6.0 %
Mecklenburg-Western Pomerania	5 km²	96 km²	871 km²	4.2 %
North Rhine-Westphalia	101 km²	294 km²	265 km²	1.9 %
Rhineland-Palatinate	16 km²	98 km²	229 km²	1.7 %
Saarland	<1 km²	1 km²	4 km²	0.2 %
Saxony	1 km²	80 km²	409 km²	2.7 %
Saxony-Anhalt	1 km²	683 km²	1,518 km²	10.7 %
Schleswig-Holstein	12 km²	127 km²	461 km²	3.8 %
Thuringia	41 km²	379 km²	418 km²	5.2 %
Nationwide	**257 km²**	**3,436 km²**	**9,096 km²**	**3.6 %**

Annex

Area quotas are policy objectives that are set, for example, by the German Federal Government for the federal states or that the federal states assign to the regions. For a long time, there have been repeated calls for a standard area quota of 2% of the surface of the respective planning region to be made available for wind energy use.

Area potentials describe the proportion of the area of a federal state that can be provided for wind energy use under defined criteria. At present, inconsistent approaches with different criteria and methods are used to calculate the area potentials. However, many scientists agree that instead of standard area quotas, which must be fulfilled equally by all federal states and regions, the actual area potentials of the federal states need to be taken into account when setting objectives.

Exclusion areas are those areas not suitable for wind energy use due to legal, technical or economic reasons. Legal reasons result, for example, from the German Federal Building Code (BauGB), which stipulates that wind turbines are not to be installed in populated areas, but rather in the outer zone according to the Building Code (so-called privileged projects for the outer zone). Factual reasons are e.g., that wind turbines cannot be erected on steeply sloping ground (usually more than 30° inclination). Economic reasons are represented by wind abundance (areas with a wind speed of < 7m/s at 150 m height).

The **conflict risk** describes the likelihood of the occurrence of conflicts with the interests of nature conservation and landscape management. Conflict risk classes are used to make comparable estimates of the conflict risks for different natural resources. The spatial management of wind energy use requires knowledge of the extent of the probable conflict risks linked to the use of a place, and the ability to derive a corresponding formula for allocating the quotas.

Conflict risks are calculated in relation to area. This is based on mapping the conflicts with the interests of nature conservation and landscape management, which are available as geodata at national level. (Figure 1).

Methods for the spatial prediction and evaluation of nature conservation conflict risks for the expansion of renewable energies at national level

The newly developed method enables a national land evaluation, on the basis of which detailed statements about the nature and landscape compatibility of the expansion of wind turbines can be derived. The evaluation is the result of an iterative expert debate and GIS-based spatial analyses. The model divides the areas that are not excluded from the outset for wind energy use into a 25 x 25 m grid and allocates each cell on the grid individual conflict risks on a six-level scale from "very low" to "very high" and "very high, overlapping conflict risks". The factual basis for this is the spatial characteristics of nature conservation interests (areas) that are shown by land categories available as geodata at national level. These 38 land categories (type levels) are initially evaluated in terms of the importance (derived from the aims and legal criteria of nature conservation and landscape management) and sensitivity (towards the impacts of wind energy use) of the land characteristics of relevance for nature conservation that they represent, as well as the mapping accuracy. This evaluation is carried out both for individual natural resources as well as across resources. The land categories available as geo-datasets serve as indicators for the type and extent of negative changes to the interests of nature conservation and landscape management and the resulting conflicts that would arise with a specified likelihood if a wind turbine were erected on a grid cell (conflict risks). By projecting the land categories spatially with their overlaps, a spatial evaluation of the conflict risks resulting from the impacts of wind energy use can be produced.

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