FONDATION POUR LA RECHERCHE SUR LA BIODIVERSITÉ

IMPACT OF WIND ENERGY ON BIODIVERSITY

Project summary

BRIBAT

Smart wind turbine management: a win-win system based on algorithms for optimising the trade-off between energy production and collision risks with airborne wildlife

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Introduction

Onshore wind turbines cause collisions with bats. However, these collisions can be minimized by using the "braking" technique, i.e., by stopping the blades. The use of algorithms trained on large amounts of data to anticipate when shutdowns are necessary is promising, and allows for better protection of bats while limiting energy loss due to blade shutdowns. However, the criteria for implementing these algorithms remain to be defined, such as whether or not it is necessary to collect site-specific data on the area targeted for braking to be included.

Context and objectives

Onshore wind turbines cause numerous bat deaths through collisions with their blades. These collisions can be predicted by taking into account environmental factors that influence the activity of these animals.

Throttling wind turbines, i.e., shutting them down during low winds and mild temperatures—when bats are active and energy production is low (Voigt et al., 2015)—is a measure with high potential for reducing mortality. Although this approach can significantly reduce mortality rates, its effectiveness remains extremely variable and is never total. This is all the more problematic given that (1) the mortality currently observed due to wind turbines may call into question the viability of these populations with low renewal rates, particularly high-flying species such as noctules, and that (2) less than half of French wind turbines are throttled.

The lack of effectiveness of conventional speed limiters is due to the fact that other parameters are not taken into account: weather, phenology, landscape characteristics, and wind turbine operation also influence the risk of collision. Research has already demonstrated the advantage of algorithms over conventional methods in protecting significantly more bats with equivalent energy production losses.

The BRIBAT project aimed to transform these algorithms into operational tools that can be used and generalized in the field, according to different scenarios, in order to define the most appropriate framework for implementing the tool, with three main objectives:

(i) To evaluate the added value of predictions of future collision risk based on past meteorological data, compared to a prediction approach based on near real-time meteorological data.

(ii) To define the most appropriate spatial use of the tool, assessing whether or not it is necessary to include site-specific data when training the algorithm.

(iii) Define the criteria for limiting the probability of presence predicted by the algorithm and taxonomic resolution to be considered when deciding to shut down the blades.

Finally, the project also defined the modeling method required to make the most of the data despite significant material heterogeneity.

Methods and approaches used for the project

In order to evaluate the relevant criteria for implementing wind turbine management algorithms, the algorithms were trained on a portion of the available data (131 acoustic monitoring sites in wind turbine nacelles, totaling more than 29,000 full nights of recording and more than 100,000 bat detections), then tested by having them predict the necessary blade stops in the event of a collision risk, in order to quantify the proportion of bats they protect, as well as the associated blade rotation losses. The algorithm was trained and evaluated in different ways corresponding to scenarios for using the tool in the field, in order to identify the prerequisites for its use (type of data, temporal resolution of stops, etc.).

Principal conclusions

BRIBAT has demonstrated that algorithms developed to predict the risk of collision between wind turbines and bats, and to stop the blades when the risk is too high, can be trained using methodologically heterogeneous monitoring data, allowing the full power of nationally compiled data to be harnessed. The algorithms are more effective than current methods, resulting in a lower proportion of blade rotations being lost while protecting a greater proportion of bats. These algorithms are even more effective when used on a fine time scale (e.g., 10 to 30 minutes). The inclusion of site-specific tracking data during training is essential, particularly for high-flying species at high risk of collision.

Anticipated (or actual) impact of these results for science, society, and public and private decision making

BRIBAT has shown that the algorithms developed during the project to predict the risk of collision between wind turbines and bats based on good weather conditions are theoretically more effective than conventional wind turbine management approaches, providing better overall protection for bats while resulting in less energy loss. It has also made it possible to begin defining the operational prerequisites for these algorithms to be effectively implemented as decision-making tools that can be used in practice, beyond computer simulations. This research therefore has a significant potential socio-ecological impact, as it will help mitigate the conflict between the development of wind energy infrastructure and flying species (most of which are protected or even endangered), which is a regular topic of public debate. In addition to promoting better protection of wildlife, this research will potentially limit energy losses thanks to sophisticated methods of managing wind turbine operation based on algorithms that are better able to detect situations where it is not necessary to stop the blades. The results of the project therefore lie at the crossroads of ecological, political, climatic, and economic issues, and form the basis for the future provision of a management tool for all stakeholders in wind power development.