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technical talk "Anti-collision systems for birds"

A look at the development and testing status

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1. Introduction

What progress has been made in the further development and testing of anti-collision systems? Does the current status of selected systems allow their use in practice? If so, under what conditions and for which bird species? How can anti-collision systems be technically certified? The **KNE expert discussion "Anti-collision systems for birds – ready to take off?"** addressed these and other questions. with 160 participants on July 7, 2021.

A KNE conference was held in Kassel in 2019 on the subject of "Bird protection on wind turbines" (KNE 2019b). Among other things, various camera and radar systems as well as ongoing test projects were presented there. This year's technical discussion served to refresh the level of knowledge about the system development and to put the first comprehensive test results up for discussion. In the following chapters, the contents of the event are reproduced and supplemented by the KNE.

Anti-collision systems have the potential to reduce the significantly increased risk of killing bird species that are sensitive to wind energy to such an extent that the prohibition under species protection law is not met. They can represent an alternative to a longer-term "blanket" day shutdown during the breeding and reproduction season (so-called phenology-related shutdown). Automatic, needs-based shutdown using anti-collision systems could significantly reduce the losses in electricity production compared to a blanket shutdown. The probability of effectiveness of anti-collision systems depends largely on their performance. This must be proven by systematic testing in the field. The test results should be published and verified by an independent third party. The KNE has a "requirements profile" (KNE 2019a) for the scientific implementation and documentation of test projects. This provides guidance for

test project.

2. Recommendations on minimum requirements for anti-collision systems

As part of an R&D project, the KNE, together with technical experts, has developed recommendations for minimum requirements for the effectiveness of technical monitoring and shutdown systems on wind turbines (Bruns et al. 2021). The effectiveness of a monitoring and shutdown system is determined by performance criteria for detection, signal transmission and response (shutdown).

The focus of the technical discussion was on the performance criteria of detection systems. These include **detection range, detection rate, detection rate,** and **spatial coverage at the site.** The latter depends on the location and is influenced by whether factors such as topography or vegetation reduce the visibility of the detection area. The detection range should include at least the species-specific reaction distance1 and a safety buffer. A minimum range of 500 meters is recommended as a guide value for the detection range (ibid., p. 44). The acquisition rate should be in the reaction area and in the area of the safety buffer, i.e. in the monitoring area,
be at least 75 percent. From the point of view of effectiveness is a species recognition but not mandatory. The recognition of species, species groups or size classes makes it possible to selectively control shutdown processes. It makes it possible to reduce the number of switch-off events. A high detection rate is required to ensure that the ban on killing is reliably observed even in the case of selective shutdown. In the surveillance area, it should be at least 75 percent (ibid., p. 25 ff.). The spatial coverage rate achieved by the system at the site should be at least 75 percent radially in relation to the surveillance area (ibid., p. 30). The further the individual performance parameters are above the minimum requirements mentioned, the more reliably the preventive effectiveness can be achieved and the level of protection to be maintained can be guaranteed.

Information on further effectiveness criteria and on the assessment of effectiveness in individual cases can be found in Bruns et al. (2021).

3. Development and test status of various systems

For the technical discussion, selected system manufacturers and developers were asked about the performance parameters of their systems (see Tables 1 and 2). These primarily include the demonstrably achieved detection range and rate. In addition, the detection rate of the systems – if available – was queried.

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[1] r reaction [m] = v art [m/s] xt spin [sec] + r rotor [m], where r reaction equals the radius required for a timely shutdown, v art equals the species-specific airspeed (Bruderer and , Boldt and 2001), t spin equals the time until the rotor coasts to a halt and r rotor equals the rotor blade length. The duration for signal transmission and processing as well as for flying object classification should be added to t spin if it is not in the millisecond range.

3.1 Radarsysteme

The **BirdScan®** radar system is being developed by the FEFA engineering office for regenerative energies in cooperation with Swiss Birdradar. BirdScan® has been further tested at two locations in Saxony-Anhalt since 2019 (Osterburg with wind turbine, Hohenberg-Krusemark without wind turbine). The reference data were collected by observation using a laser range finder. TNL Environmental Planning and BIOME - Technical Office for Biology and Ecology carry out the statistical evaluation. An official test report is still pending. Compared to the status of 2019, specific values for detection and detection rates could be named. Jonas Hellmig (FEFA engineering office for regenerative energies) gave this as 75 or 88 percent (see Table 1). One problem is that the radar signal is sometimes disturbed by the wind turbine during the tests. We hope to be able to fix this in the future.

A detection rate for individual large birds (80 percent) can now also be specified for the **RobinRadar MAX®** radar system. The detection range for large birds is eight kilometers. The system was tested in a first version in 2019 in Brandenburg and in a further developed version in 2020 in the Netherlands. A test report has not yet been published. Ms. Claasen (Robin Radar Systems) drew attention to the further developments, such as the distinction between different size classes of birds and a radar camera combination, but also to the restrictions to which the radar system is subject. Species identification is still not possible with the further developed system (see Table 1).

Where available, Tables 1 and 2 provide sources for the performance characteristics. However, not all of the statements made in the technical discussion could be corroborated. Several releases have been announced for 2021. It should be noted that the survey method and the number of samples can influence the performance indicators.

Table 1: Performance characteristics of radar systems.

Radarsystem	performance metrics
BirdScan®	ÿ Detection range: 1,200 m for red kites/large birds, ÿ Detection rate: 72% for large birds, 75% for red kites, ÿ Recognition rate (in relation to the red kite: correctly recognized as a bird) 68%, 88% of them correctly identified as large birds.
RobinRadar MAX®	ÿ Detection range: up to 8 km for individual birds, ÿ Capture rate: 80% for large birds, ÿ Classification: Differentiation according to size classes possible, identification of species not possible.

3.2 Camera systems

The **BirdRecorder®** camera system is being developed as part of the NatForWINSET project by the Center for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW). The project is funded by the Federal Agency for Nature Conservation (BfN). In 2019 and 2020, a first test took place on the wind energy test field on the Swabian Jura (Geislingen site), which also belongs to ZSW. Laser range finder observations and data from GPS-tagged red kites are used to compare the system data. In the size class Milan, is the detection range of the first system version with static wide-angle cameras 400 meters. The detection rate cannot yet be quantified. The wide-angle cameras achieve a detection rate of 91 percent for the red kite. A test report has not yet been published. The second version with doubled camera resolution and additional swiveling stereo zoom cameras is also to be tested on the wind energy test field in 2021. Here the detection range will be 700 to 900 meters (see Table 2). According to Anton Kaifel (ZSW), recognition should be extended to species such as kestrels and peregrine falcons in the future.

The **SafeWind®** system from Biodiv-Wind, which uses high-resolution wide-angle cameras for detection, is already being used in other European countries (e.g. France). There, however, different requirements apply to the effectiveness of prevention and any obligations to provide evidence than in Germany. During a test at the Hassel wind farm in Paderborner Land (North Rhine-Westphalia), detection ranges of 330 meters and 397 meters were achieved for red kites and black storks, respectively, explained Henri Pierre Roche and Fred Santolaria (both Bio div-Wind). Within the respective detection ranges, the detection rate for red kites is 80 percent and 100 percent for black storks. Observations served as reference gene with the laser range finder. In the French department of Bas-Rhin, drone tests were able to prove that the higher-resolution cameras used had a detection range of around 450 meters. Both trial studies from 2020 and 2021 are unpublished. Species identification is not yet possible, but is planned for 2021 (see Table 2). The system is now part of the approval for a wind farm in Paderborner Land in North Rhine-Westphalia.

The **BirdVision®** camera system has been tested on several wind turbines in Weißbach, Baden-Württemberg, since 2019. Accordingly, the detection range for large birds is 250 to 300 meters, the detection rate is 95 to 96 percent. Comparative data were collected using a laser range finder. According to Katharina Pohl (BirdVision), a range of 450 meters can be expected after a system update. so far have been Wide-angle cameras used. In order to be able to measure the distance of birds, a

Stereo version developed. It consists of six stereo wide-angle camera pairs attached to the base of the wind turbine tower. The detection of kites, buzzards and hawks at species level is planned (see Table 2).

BirdVision® is primarily developed for site monitoring. Needs-based shutdown is not the priority. In addition, BirdVision is developing an infrared camera system to also record nocturnal flight events of bats and migratory birds. A test report is not yet available.

The **Bioseco®** camera system is in operation in other European countries. It consists of several stereo cameras attached to the base of the tower of the wind turbine. It was on site in 2019 Geislingen (NatForWINSENT) tested, a corresponding report was published (Aschwanden and Liechti 2019)[2]. After the use of higher-resolution cameras, improved performance could be demonstrated in a test in a Polish wind farm. According to Adam Jaworski (Bioseco), the capture rate for birds is the

- ÿ Size class small (spans from 0.5 to 1.1 meters) up to 200 meters 100 percent,
- ÿ Size class medium (span 1.1 to 1.5 meters) up to 400 meters 94 percent,
- ÿ Size class large (span 1.5 to 2 meters) up to 500 meters 93 percent and
- ÿ Size class very large (span more than 2 meters) up to 600 meters 100 percent.

The reference data were collected through field observation. The distance from the bird to the wind turbine was either estimated or measured using a laser range finder. Bioseco® is able to reliably identify two size classes. The detection rate for the size class small (wing span 0.5 to 1.1 meters) is 99.6 percent. For the size class medium/large (over 1.1 meter wingspan) it is 91 percent. A species-level detection is planned (see Table 2).

The IdentiFlight® camera system is dealt with in detail in Chapter 4 due to the advanced state of testing.

3.3 Classification of the KNE

In order to ensure timely and reliable detection, the development of camera systems seems to be moving towards combining wide-angle cameras and trackable stereo zoom cameras. IdentiFlight® and Bird Recorder® rely on this technology. But

2 For large birds such as red kites, the detection rate was about 97 percent up to 200 meters, about 68 percent between 200 and 300 meters, about 22 percent between 300 and 350 meters, and about 12.5 percent between 350 and 400 meters (Aschwanden and Liechti 2019, p. 5).

Camera systems that only consist of wide-angle or fixed stereo cameras have also been able to gradually increase their detection ranges.

Table 2: Performance characteristics of camera systems.

Camera system performance characteristics	
BirdRecorder®	ÿ Detection range: 1st version za. 400 m for size class Milan, 2nd version za. 700-900 m for size category Milan, ÿ Capture rate: not yet determined, ÿ Detection rate: 91% for red kites (up to 400 m).
SafeWind®	ÿ Detection range: the 2Mp camera is 330 m for the red kite and 397 m for the black stork, the detection range of the 4Mp camera is 455 m (drone test)3 , ÿ Acquisition Rate: 80% up to 330 m for Red Kites, 100% up to 397 m for Black Storks4 ÿ Species recognition from the end of 2021.
BirdVision®	ÿ Detection range: 250-300 m for large birds, system update up to 450 m the time in development, ÿ Capture rate: 95% and 96% for large birds, ÿ Classification: intended to identify kites, buzzards and hawks at species level.
Bioseco®	ÿ Detection range: 200-600 m depending on size class (see below), ÿ Acquisition rate: 100% to 200 m for the small size class (span 0.5-1.1 m), 94% to 400 m for the medium size class (span 1.1-1.5 m), 93% to 500 m for the large size class (wingspan 1.5-2 m), 100% up to 600 m for the Size class very large (wingspan > 2 m), ÿ Recognition rate: 99.6% for the size class small (0.5-1.1 m wingspan), 91% for size class medium/large (>1.1 m wingspan)5 , species-level detection planned.
IdentiFlight®	ÿ Red kite detection range: 750 m, ÿ Detection rate: 92% for Red Kites, ÿ Detection rate: up to 97.5% for red kites6

3 Exen (2021): Testing the effectiveness of the SafeWind® automated video system in reducing the risk of vehicle collisions rapaces, February 2021 (unpublished).

4 Lackmann Phymetric GmbH (2020): Testing and evaluation "SafeWind" bird protection system Hassel Windpark, August 2020 (unpublished).

5 Gradolewski, D., Dziak, D., Kaniecki, D., Jaworski, A., Skakuj, M., Kulesza, W.J. (2021): A Runway Safety System Based on Vertically Oriented Stereovision. Sensors 2021, 21(4), 1464. Szurlej, A. (2020): Report on ornithological monitoring performed at FW Lotnisko between May 2020 and October 2020, 24.11.2020 (unveröffentlicht).

6 Reichenbach and Reers (2021): How well does IdentiFlight protect the red kite? Overview of system effectiveness for reducing the risk of collision on wind turbines, March 2021 (unpublished).

The synopsis provides an overview of the functionality and level of knowledge regarding the performance of detection systems as of 2020 of the KNE (KNE 2020).

4. Test Results of IdentiFlight®

dr Marc Reichenbach (ARSU GmbH) and Dr. Henrik Reers (Oekofor GbR) tested the **IdentiFlight®** camera system for three years at six German locations and presented their results in the KNE technical discussion. ARSU GmbH is responsible for the scientific project management, Oekofor GbR for statistical evaluation and TÜV Nord AG for quality assurance accepted. e3 GmbH financed and coordinated the project and installed and maintained the devices.

IdentiFlight® consists of eight wide-angle cameras with a fixed orientation and a high-resolution moving stereo camera. The system is attached to a separate tower at a distance of 100 to 150 meters from the wind turbine to be monitored. It works with two variably programmable, three-dimensional virtual protective cylinders around the wind turbine. Objects are detected and tracked in the outer cylinder. If a target species is heading directly towards the wind turbine at high speed, a switch-off signal is already triggered in the outer protective cylinder, otherwise when it enters the inner protective cylinder. This means that the radius of this cylinder corresponds to the minimum switch-off distance. In the case of wind turbines with a high lower edge of the rotor, the inner cylinder does not have to reach the ground. Rather, the lower edge of the cylinder can be raised (see figure 1, page 11). As a result, flights at an altitude of 30 to 40 meters, which are not critical in terms of the risk of collision, can be excluded and the frequency of shutdowns reduced if necessary. dr Reichenbach explained that depending on the distance and position of the wind turbines from one another, an IdentiFlight® system can cover a maximum of two to three turbines.

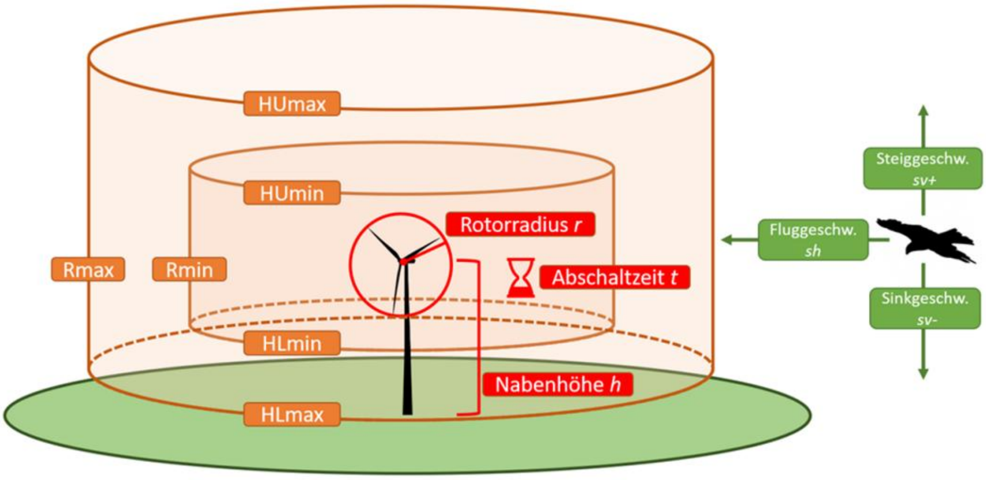

Figure 1: Schematic of the inner raised and outer spacer cylinders of the Identi Flight® system. *Rmin* and *Rmax* represent the radius of the inner and outer spacer cylinders, respectively. *HUmin* and *HUmax* stand for the upper limit of the inner or outer distance cylinder (height upper or lower boundary). *HLmin* and *HLmax* stand for the lower limit of the inner and outer distance cylinder (height lower boundary) (Reichenbach and Reers 2021).

The tests, which were carried out in Plate (Mecklenburg-Western Pomerania) and Helfta (Saxony-Anhalt) in 2018, in Lübesse (Mecklenburg-Western Pomerania) and Gerbstedt (Saxony-Anhalt) in 2019 and in Bütow (Mecklenburg-Western Pomerania) and Geislingen (Baden-Württemberg) in 2020) with real or virtual wind turbines were based on the KNE requirement profile.

Drone and laser range finder data as well as GPS data from a tagged red kite served as a reference for validating the data collected with IdentiFlight®. The evaluation showed that the detection range for the red kite is 750 meters. For the white-tailed eagle it is around 1000 meters. Around 76,000 measurements of the red kite flight speed (at an altitude of less than 200 meters) resulted in a median flight speed of 8.4 meters per second. In order to fully cover all flight events recorded for this purpose, maximum flight speeds of up to 20 meters per second had to be taken into account. If you multiply the flight speed of 20 meters per second by an assumed shutdown time of the wind turbine of 30 seconds, the required detection range of 600 meters results.

When determining the detection rate, only those flights were taken into account that were within a 750 meter radius and not directly in front of a background such as a sky. B. Forest, took place. The comparison of the system data with the reference data from the laser range finder and the GPS resulted in a detection rate of between 92 and 96 percent. Only at the Bütow site was it lower at 85 percent. On the one hand, this is due to the fact that it was sometimes difficult to judge whether a bird should have been visible for IdentiFlight®. On the other hand, there was very high flight activity at the site. Birds flying at the same time could not be detected.

The first version of the neural network[7] applied in 2018 and 2019 yielded a classification rate of 79.4 percent out to 750 meters for the red kite. After training the neural network with more images of red kites, it was over 95 percent in 2020. Furthermore, the rate of timely shutdowns is 77 to 91 percent. In order to determine this, it was examined whether the system reaction, or the switch-off signal, occurred in good time, i.e. when the bird entered the inner cylinder. When flight activity was high, birds were sometimes only recognized inside the inner cylinder and thus too late.

dr Reers pointed out that flight activity in the inner cylinder and the number of shutdowns would inevitably be high if a wind turbine were too close to an eyrie.

He therefore recommended IdentiFlight® with a high rotor edge and 400 to 500 meters to combine nest distance. These are limiting conditions that need to be taken into account.

dr Reichenbach summarized that IdentiFlight® achieves a very high level of protection for the red kite and that this is above the minimum requirements recommended by the KNE. The system is legally effective for the red kite and ready for practical use. He recommended carrying out a short validation phase on site in each application. The system will be further developed for use in white-tailed and lesser spotted eagles.

5. Development and validation of bird protection systems

Andreas Schneider, TÜV Nord, accompanied the testing of IdentiFlight®. In his contribution, he addressed the role of TÜV in relation to a validation process for bird protection systems[8] a. In addition, he explained the need for validation he saw with regard to the behavior of the system, taking into account external influences.

At the beginning, Schneider stated that uniform technical standards for the validation of the performance of bird protection systems are necessary to ensure the comparability of test results. A particular challenge is that

[7] (Artificial) neural networks are algorithms used to solve complex problems such as pattern recognition (here: automated image analysis) can be used (Spektrum 2021).

[8] Synonymous with anti-collision systems.

AI-supported systems that enable species identification largely represent a black box[9]. Validation must refer to this black box. Also be the basic Answer the question of how to deal with future modifications (further developments, updates) of the hardware and software of validated systems. Modifications could lead to that the validation of the initial system is outdated. Uniform requirements and standards are also required for the interfaces between the systems and the wind turbine (operational control).

A specific standard would have to be developed for the functional **electronic safety** of bird protection systems. As long as no Type C standard[10] exists for these systems, the Type A standard[11] of functional safety IEC (International Electrotechnical Commission) 61508 could be used. This standard relates to the functional safety of electrical, electronic and programmable electronic systems to protect people and the environment. The requirements of the standard must be met continuously over the entire life cycle of a bird protection system.

In the case of bird protection systems, a distinction must be made between the validation of external influences and the validation of the system behavior. In order to **validate external influences,** the factors influencing the functionality of the system must first be determined. In the case of camera systems, this includes, for example, precipitation, insufficient brightness or backlighting. These influences are evaluated in terms of their intensity in order to identify the relevant influencing factors. If necessary, relevant influencing factors can be analyzed by means of targeted tests. Finally, the tests should be evaluated and the probability of occurrence of the influencing factors should be quantified. Schneider demonstrated the impact analysis when testing IdentiFlight®.

To **validate the system behavior,** comparison data must be collected in the field. For a realistic analysis, the determined influencing factors must be included as far as possible. During the IdentiFlight® test, observers collected comparative data using a laser range finder, which – like the system data – was stored on a TÜV server with hash values and protected against forgery. According to the concept of neutrality, the evaluating parties only had read rights for the data mentioned. Mr. Schneider confirmed the manipulation-free evaluation of the IdentiFlight® data. He pointed out that

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[9] “A black box is […] a (possibly very complex) system of which only the external behavior should be considered in the given context […]. The investigation and description is limited to the measurement of the input-output relationships" (Wikipedia 2021).

10 Standard for specific machines or groups of machines.

[11] basic safety standards.

in the absence of a special standard, accredited certification of bird protection systems is not yet possible.

Basically, it should be noted that the term 'certificate' is not protected. Only certificates from a certification body accredited by DAKKS (German Accreditation Body) for a specific standard are meaningful. He submitted an application to the DKE (German Commission for Electrical, Electronic & Information Technologies) to create a standard for bird protection systems.

6. Planned and ongoing trials

Further system tests are planned in Germany and Austria. Robert Sing (Ingenieurbüro Sing GmbH) presented the **research project in Fuchstal (Bavaria) ,** which is funded by the Bavarian Ministry of Economic Affairs. The engineering office Sing GmbH is planning three new wind turbines in the forest together with the municipality of Fuchstal. By means of two camera-based detection systems[12] mounted on a mast that towers above the treetops, bird monitoring will initially be carried out in 2022 and 2023 without wind turbines. The focus is on the red kite. The monitoring should provide information about the activity and use of space by the birds at the unaffected site. The three wind turbines will then be erected and put into operation. Bird monitoring will be carried out again by 2026. It should examine whether the flight behavior changes.
At the same time, the focus is on the technical performance and thus the prevention effectiveness of the systems at this forest site.

Henrike Schröter (Wpd AG) reported on a **validation project of the Wpd AG in Baden Württemberg.** At a forest location near Laichingen, the camera system IdentiFlight® come into use. Due to an occurrence of red kites, two planned wind turbines could not initially be approved without further ado. The camera system is installed on a mast that rises above the treetops. It is to be investigated whether the detection performance determined so far (see p. 10 ff.) can also be provided under these special conditions (forest location). Testing is scheduled to start in 2022 without wind turbines and continue with wind turbines the following year.

[12] Subsequent information: This will be the IdentiFlight® camera system.

dr Frank Musiol (ZSW) reported that the Bioseco® and IdentiFlight® systems are already being tested on the **Geislingen wind energy test field in Baden-Württemberg** (NatForWINSENT). had been. The Swiss Ornithological Institute led the bird research in each case. He offered other system manufacturers the opportunity to test their systems there. The high density of red kites at the site and the presence of tagged specimens offer good starting conditions.

Eva Schuster (University for Sustainable Development Eberswalde/HNEE) gave insights into a **research project to test AKS in Brandenburg.** It is funded by the Brandenburg Ministry of Economic Affairs. In 2022, a camera and a radar system are to be tested in two landscape areas representative of Brandenburg. The aim is to determine the possible uses in complex terrain, to close gaps in knowledge and to work out the need for further development. Red kites and white-tailed eagles are the focus of the project.

Alwin Bubendorfer (Windsfeld GmbH) reported on the development of a wind farm in the **complex alpine terrain of Salzburger Land in Austria.** Among other things, the bearded vulture found at the site is affected. Various bird detection and monitoring systems are to be tested as part of a research project. Various system manufacturers have already expressed interest. The concept is similar to that of Nat ForWINSENT. In order to be able to achieve sufficiently high random sample numbers, falconry birds of prey should also be used. However, the tests have not yet started
with.

This overview (which does not claim to be exhaustive) shows that further knowledge about the effectiveness of anti-collision systems, their applicability under special operating conditions and for other bird species can be expected in the future.

7. Conclusion and outlook

The presented anti-collision systems show different stages of development: Some Systems or system versions are in the development and optimization phase, others have already undergone tests at various locations and
delivered promising results. So far, IdentiFlight® is the only system that has undergone systematic testing to prove its performance at six locations. The test report has not yet been published. According to the statements of the experts, it can be assumed that IdentiFlight® has empirically proven its practicality at locations with sufficient visibility. The detection and classification performance against background (forest, trees) and at high flight density is still too

improve and validate through testing. Further evidence of use in complex terrain, especially in forest locations, is planned.

From the point of view of the approval authorities, it is important for the use of anti-collision systems in regular approval practice that anti-collision systems are recognized as a technically suitable measure. Such recognition can currently only be granted by the federal states, for example by including anti-collision systems there as technically suitable and effective protective measures in the species protection guidelines.

dr Ulrich Bangert, Saxon State Ministry for Energy, Climate Protection, Environment and Agriculture (SMEKUL), gave an example of how this is provided for in the Saxon draft guidelines (SMEKUL 2021). According to this, proof of the technical reliability and performance of the systems is a prerequisite for practical use (ibid., p. 27 f.).13

The performance characteristics (range, acquisition rate, recognition rate) determined through testing are system-specific. The system as such does not have to be tested many times to verify these characteristic values - but its application must be checked in different location and visibility conditions. For a high level of prevention effectiveness, it is important that the systems are used under comparable conditions, i.e. with comparable visibility and coverage. Before applying an anti-collision system to a different location, it should always be checked whether the system can also provide its performance under the conditions of use on site.

After numerous tests at open country locations with good visibility, it is also necessary to explore the limits of the applicability of anti-collision systems, for example in moving terrain and over forest.

In addition to reliable detection, the reliable system-side reaction is also important for the effectiveness of anti-collision systems. The latter has so far been less the focus of discussions. Here, too, it must be possible to prove for the application that the signal transmission from the system to the wind turbine takes place reliably and in the shortest possible time. The systematic determination of transferrable, system-specific curtailment times (time until idle operation is reached) is still pending. Furthermore, it should be examined whether a throttling of the speed as a preliminary stage of the shutdown is technically feasible and contributes to the avoidance of unnecessary shutdowns.

The KNE will continue to collate the developments relating to anti-collision systems, provide advice on possible uses and enable specialist exchanges on open questions.

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13 In addition to Saxony, Thuringia, Baden-Württemberg and Schleswig-Holstein are also currently working on including or amending a regulation on anti-collision systems in their guidelines. The Hessian guidelines already contain a corresponding regulation.

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