Innovative technology enabling the operation of wind farms in bird sensitive areas

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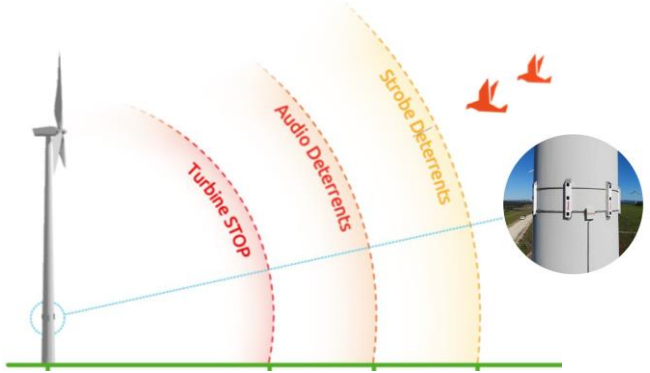
The main questions and concerns about detection-reaction systems

- ✓ How does it work?
- ✓ What is the effectiveness in detecting “key” bird species?
- ✓ At what distance birds are detected by the system?
- ✓ Efficiency in protecting birds against collisions?
- ✓ There are limited data about effectiveness of such systems and only from some providers
- ✓ The actual number of turbine stops per day
- ✓ Loss of energy production due to turbine downtime
- ✓ The number of false positives detections

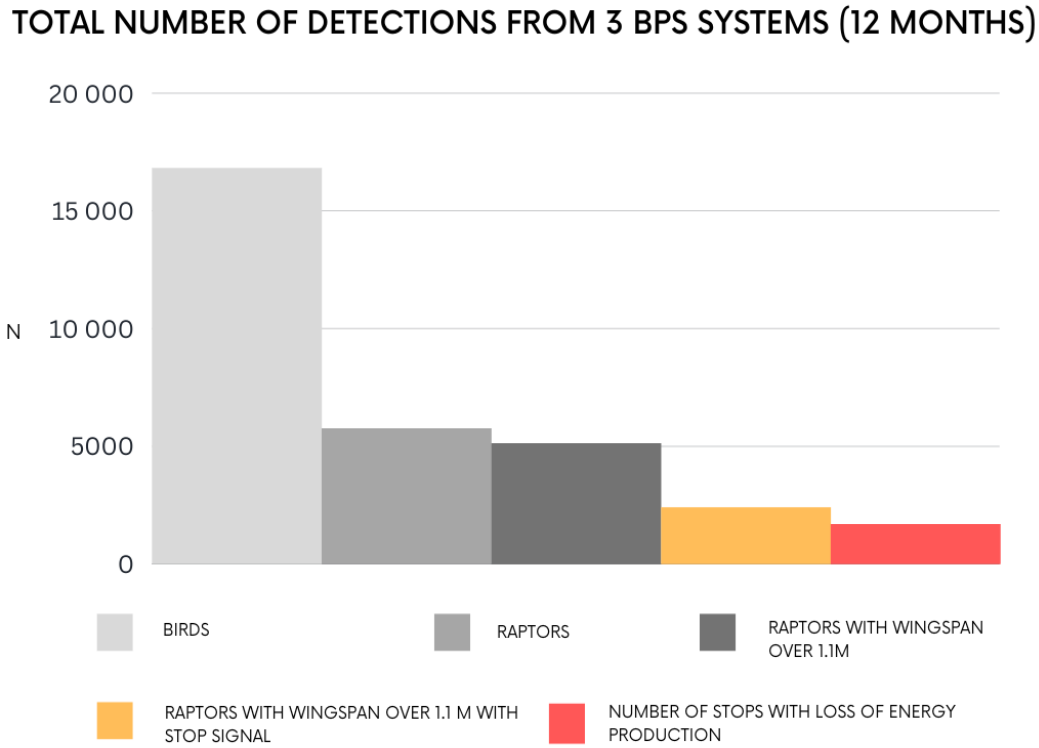
Bioseco Bird Protection System (BPS)

- ✓ Fully automatic stereovision based system
- ✓ Equipped with recording cameras with AI-based software
- ✓ Monitors area of 360 degrees around the turbine
- ✓ Estimates distance and alttitude of bird approaching the turbine
- ✓ Estimates and classifies the size of the detected bird
- ✓ Undertakes various actions depending predefined triggers
- ✓ > 100 WTGs with BPS in Spain, France, Germany, Poland since 2020.
- ✓ Rapid expansion. Working with main wind industry players.
- ✓ System validated in-situ campaigns.
- ✓ Documentation published publicly and on request.



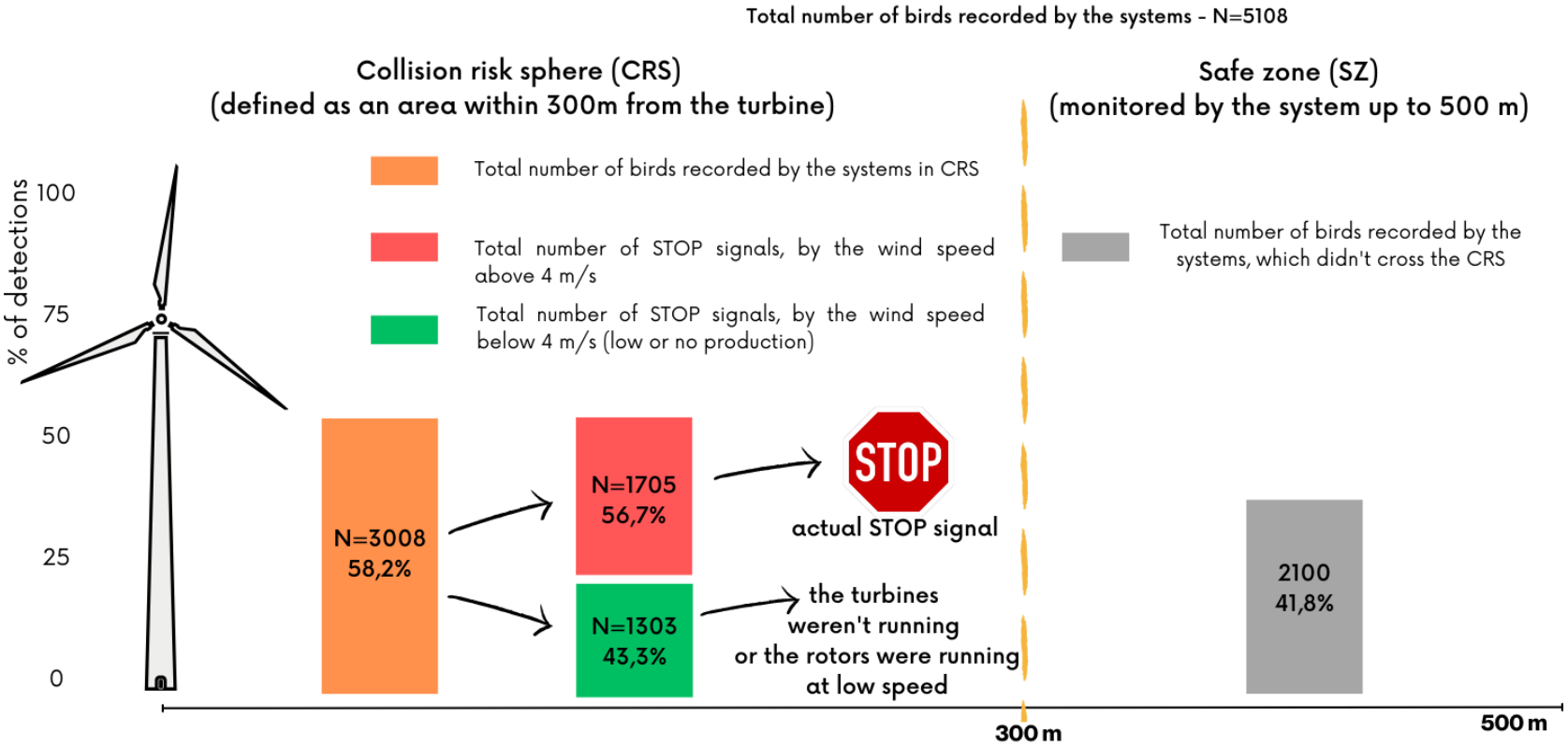
THE SCOPE OF ANALYSIS

- ✓ WF in Castilla la Mancha, Albacete region, 3 WTG, 3 BPS Standard Plus version,
- ✓ Data recorded in the period: 01.07.2021-30.06.2022
- ✓ Systems detection data:
  - timestamp
  - distance, altitude
  - size class
  - turbine curtailment (times)
  - flight path
  - videos and photos
- ✓ All birds recorded by the systems have been tagged to species/group of species by qualified ornithologists
- ✓ For the final analysis we used data with large raptors (wingspan > 1,1 m)



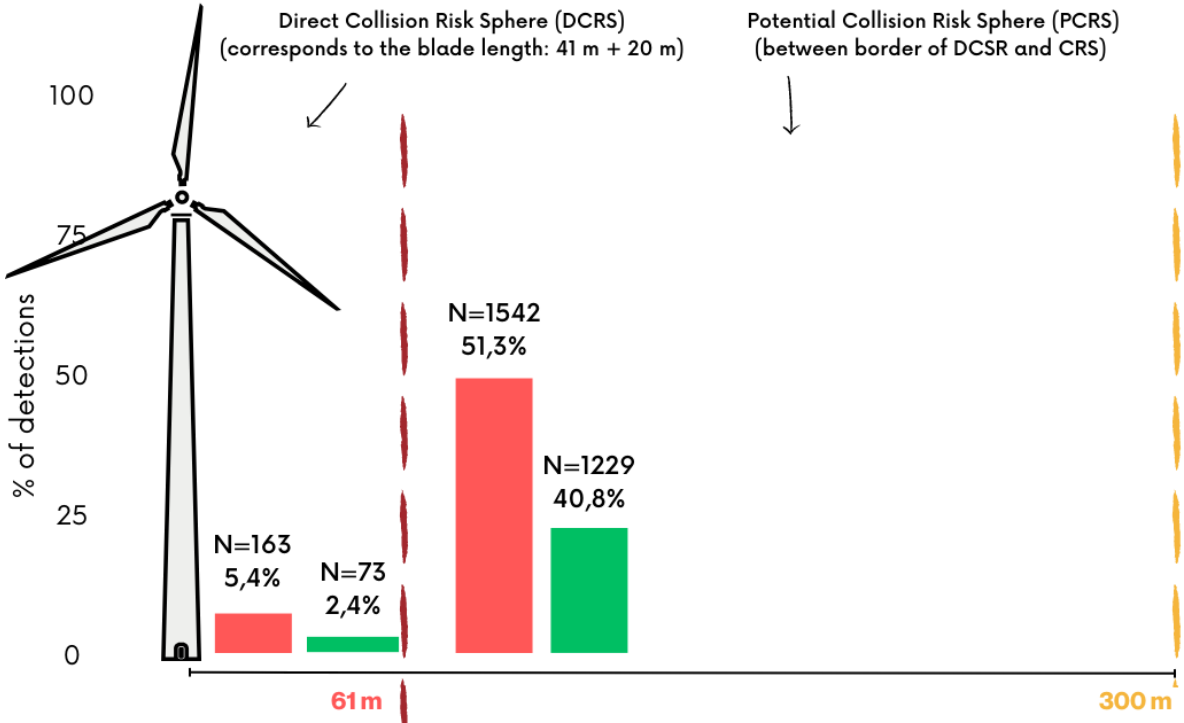
BIRD ACTIVITY IN 500M RADIUS

BIG RAPTORS RECORDED IN INDIVIDUAL SPHERES



BIG RAPTORS PROTECTED BY THE SYSTEMS AGAINST COLLISION

Collision risk sphere (CRS)
(defined as an area within 300m from the turbine)



Total number of STOP signals recorded in PCRS/DCRS by the wind speed above 4 m/s

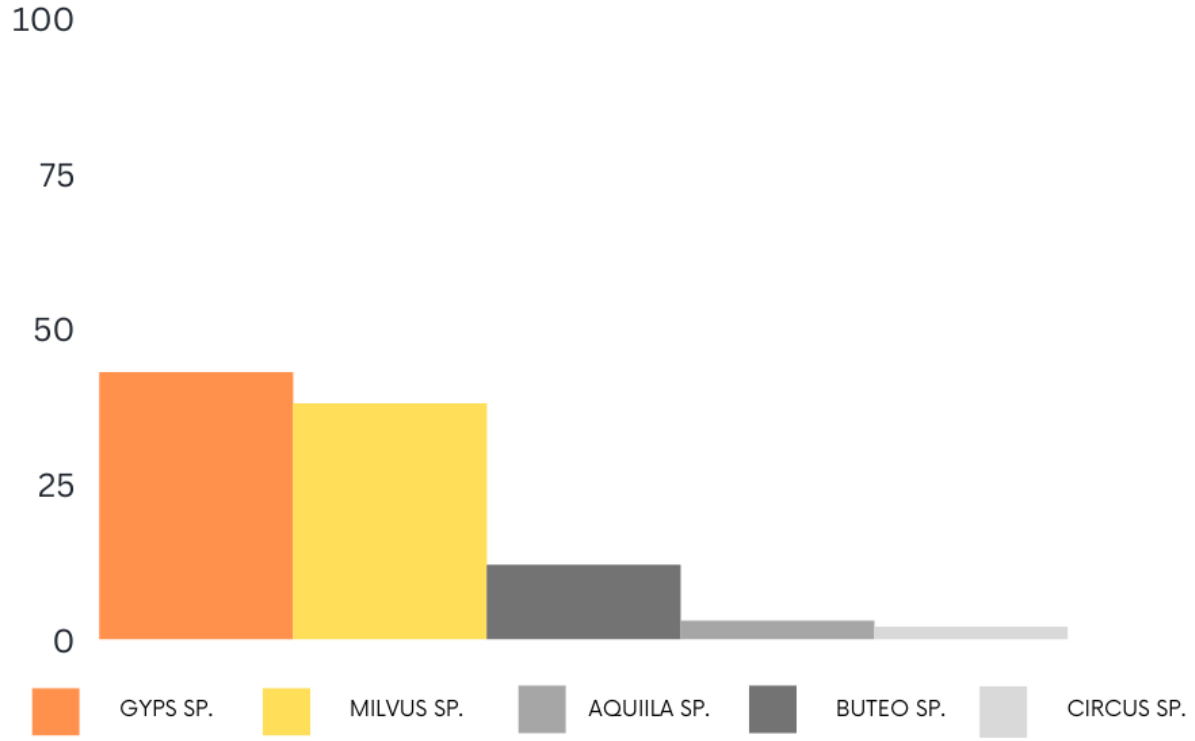
Total number of STOP signals recorded in PCRS/DCRS by the wind speed below 4 m/s (low or no production)

5,4 % of all big raptors flew over DCRS safely after stopping the turbine

51,3 % of all big raptors was protected against potential collision during flight in PCRS

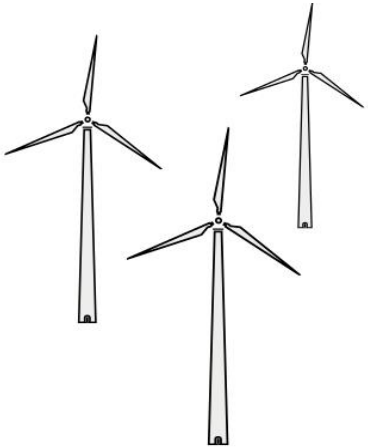
BIRD ACTIVITY BY SPECIES

THE SHARE OF ACTUAL STOP SIGNAL BY GROUP OF SPECIES



NUMERIC SUMMARY

SUMMARY



over 16,8 K detections
for 3 WT during 1 year

over 5,1 K detections
with large raptors
(wing span over 1,1m)

The total number of false positives
turbines stops was less than 2 %

58,2 % of all large raptors
detected by the system
was in CRS

5,4 % of all large raptors
detected in DCRS
were at risc of collision

56,7 % detections
of large raptors in CRS
- actual STOP

the systems have protected:
5,4% (N=163) of the birds in the DCRS
51,3 % (N=1542) of birds from PCRS

ca. 1,5 of actual stop
per turbine per day
ca. 5 minutes of turbine shutdown per day

ca. 0,7 of false positive
turbine stop per 1 system per day.

The actual losses of energy production
were minimal and below 1% of AEP.

CONCLUSIONS

- ✓ We analysed data from 3 operating Bioseco BPS systems in Spain in period of 1 year
- ✓ The systems detect and stop the turbines when large birds cross the danger zone of 300m
- ✓ Many large birds (ca. 42 %) do not approach below 300m, very few of those approaching have entered the collision risk zone, but the turbine received a signal to stop earlier
- ✓ Stoppages due to the operation of BPS at wind > 4 m/s were relatively few ca. 1.5 stops (= ~ 5 min)/day/WTG
- ✓ Low number of false detections causing curtailment (ca. 0.25 stop/day/WTG), confirmed by video analysis of all recordings
- ✓ BPS can minimise bird mortality and enable the development of wind energy in sensitive areas
- ✓ The number of shutdowns depends on the activity of birds, while systems equipped with stereovision allow for better adaptation of the strategy to minimize the risk of collision while limiting the need for shutdowns
- ✓ In the analysed case, deterrent systems were not active, while those could additionally reduce the number of flights directly in the DCRS zone
- ✓ **According to information from on-site personnel, no raptor collision was detected**