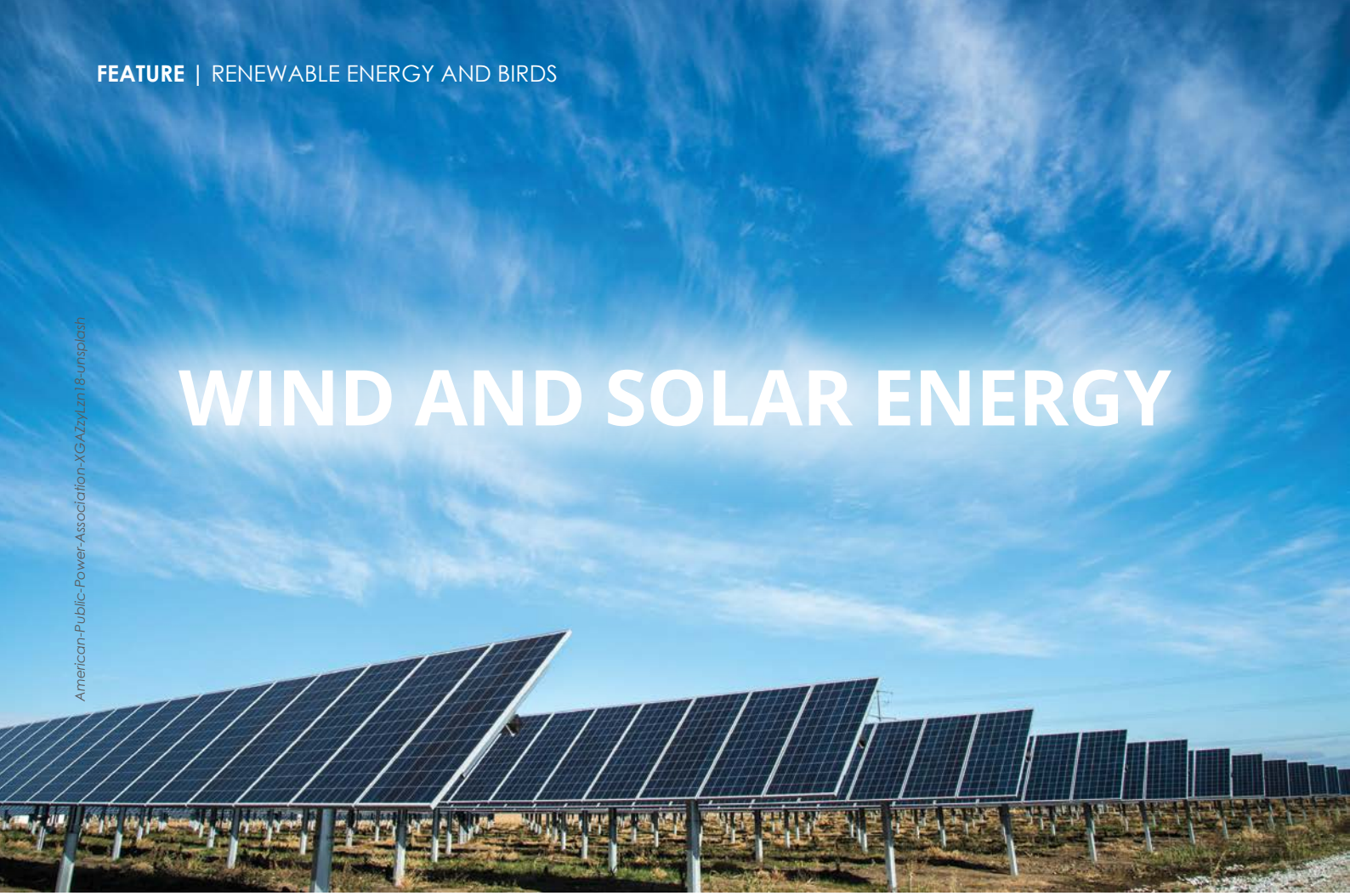

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WIND AND SOLAR ENERGY

More facilities on the way, but what about the impacts on birds? Quest reports on some recent research.

On 25 September 2020, the Minister of Mineral Resources and Energy, Gwede Mantashe, gazetted the determination in accordance with the Electricity Regulation Act (2006) to procure new generation capacity amounting to 11 800 megawatts (MW). This is needed to contribute towards South Africa's energy security, and will be procured from Independent Power Producers (IPPs).

Of this total, 6 800 MW will be from renewable energy sources – specifically wind and solar photovoltaic (PV) – and the rest from gas, coal and storage. In line with the Integrated Resource Plan (IRP2019) published in October 2019, the renewable energy sources will be split into 4 800 MW from wind and 2 000 MW from solar PV. The new capacity will be procured through Bid Window 5 of the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). During the first four bid windows between 2011 and 2018, more than 100 projects with capacity to produce a total of 6 400 MW were approved.

In July, Minister of Environment, Forestry and Fisheries, Barbara Creecy, called for public input on the geographical areas identified as renewable energy development zones (REDZ) for large-scale wind and solar PV. These zones were determined through three strategic environmental assessments (SEA) undertaken between 2016 and 2019. Public input was also requested on the identification of procedures to be followed when applying for, and deciding on, environmental authorisation applications for REDZ activities.

May et al. 2020, Ecology and Evolution, https://doi.org/10.1002/ece3.6592

A study in Norway showed that the annual fatality rate at wind turbines with one blade painted black was reduced by more than 70% compared to neighbouring turbines.

One of the main concerns raised in environmental impact assessment (EIA) processes for wind and solar energy facilities is the effect on birds. Here, *Quest* explores the issue, drawing on local and international research.

Wind energy

BirdLife South Africa published its position statement 'The effect of wind energy facilities on birds' in January 2019, and over the past few years has produced a number of guideline documents relating to wind energy. Most recently, in July 2020, Samantha Ralston-Paton – the organisation's Manager: Birds and Renewable Energy – co-authored a paper with Vonica Perold and Prof. Peter Ryan of UCT's FitzPatrick Institute of African Ornithology titled 'On a collision course? The large diversity of birds killed by wind turbines in South Africa'.

The paper, published in *Ostrich: Journal of African Ornithology*, reported on the results of monitoring conducted at 20 'wind farms' in the south-western parts of South Africa. Between 2014 and 2018, 848 bird carcasses of 130 different species were found during this monitoring. This translated to about one bird per turbine per year at the 16 facilities that had at least a year of post-construction monitoring. However, once the figures had been adjusted to take into account the carcasses that might not have been detected or had already been eaten by scavenging animals, the mortality estimate increased to 4.6 birds per turbine per year. Calculated according to the megawatt capacity of the facilities, this translates to 2.0 fatalities/MW/year. Raptors (birds of prey) that hunt during the day were the bird group most frequently killed, making up 36% of carcasses, closely followed by passerines (perching birds).

ZX Lidars

Lidar on wind farms

Doppler lidar is increasingly being used by wind farms, from the planning stages to optimise the siting of turbines, to post-installation for turbine rotation (yaw adjustment) that takes wake flows from neighbouring turbines into account, and even during ongoing operation for activating the turbines or adjusting rotor speed or blade angle (pitch adjustment). The aim is to ensure efficient performance that maximises energy output while also controlling the load on the turbines, to minimise maintenance costs and extend the lifetime of the components.

Initial systems were mostly ground-based, but nacelle-mounted systems are gaining in popularity. The most recent models can measure wind speed, direction and turbulence intensity from as much as 700 m in front of the blades.

Derek Keats, CC BY 2.0

Wind farms sited along rocky ridges and escarpment edges may put the Verreaux's Eagle, previously known as the Black Eagle, at risk.

At around the same time, a team from the Norwegian Institute for Nature Research published their paper in *Ecology and Evolution*, detailing an experiment conducted at a wind farm in Norway. They selected four of the Smøla facility's 68 wind turbines, and arranged for one of their three rotor blades to be painted black. This simple measure decreased annual bird mortality by 70% overall, with raptor fatalities being most reduced. They also painted the lower half of 10 turbines black, and this reduced the mortality for willow ptarmigan – a ground-dwelling grouse that is prone to flying into the turbine towers rather than the higher blades – by almost 50% compared to unpainted turbines in the same area.

The Norwegian researchers also noted that wind energy facilities can be made more bird-friendly by avoiding installation of the wind turbines within strong updraft areas. Soaring raptors are naturally attracted to such areas, which include ridges with high orographic uplift or flat terrain with high thermal uplift, and the collision rate is known to be higher there.

This recommendation is similar to one made in Birdlife South Africa's 2017 document 'Verreaux's Eagle and wind farms: Guidelines for impact assessment, monitoring, and mitigation', which states that siting wind turbines along escarpment edges, ridge tops, cliffs, steep slopes and particularly slopes that are perpendicular to the prevailing wind direction should be avoided. Previously known as the Black Eagle, this distinctive raptor is found mainly in mountainous, rocky habitat and is already considered regionally vulnerable, so poorly planned wind farms could pose a threat to local populations of the species.

Solar PV

Bird mortality at photovoltaic solar energy facilities has not been as well studied as that at wind farms. Indeed, an open-access paper published in *PLoS ONE* in April 2020 by Kosciuch and co-authors notes that only one paper in the peer-reviewed literature provides fatality information from a monitoring study at such a facility – and that was another by a team from the Birdlife South Africa–UCT Fitzpatrick Institute collaboration.

However, mortality data can also be found in the 'grey literature' of organisation reports, so the *PLoS ONE* paper, 'A summary of bird mortality at photovoltaic utility scale solar facilities in the Southwestern U.S.', synthesised results from

SolarReserve

The Jasper solar PV facility near Postmasburg in the Northern Cape consists of more than 325 000 photovoltaic panels. According to the 'lake effect' hypothesis, birds may collide with photovoltaic panels when they mistake large areas of them for waterbodies.

fatality monitoring studies at 10 solar PV facilities across 13 site-years in California and Nevada. About 54% of the 'carcasses' reported in those earlier studies were only 'feather spots', which can be any of the following: at least five tail feathers, or two primary feathers, or a total of at least 10 feathers with no attached bone or tissue, within five metres of each other. This clearly introduces some uncertainty into the interpretation of fatality estimates. Nevertheless, the authors calculated the average annual fatality estimate for known and unknown cause to be 2.49 fatalities/MW/year.

Addressing the 'lake-effect' hypothesis, which suggests that collisions may occur because birds are confused by polarised light pollution from the rows of PV panels and mistake them for waterbodies on which they can land, the authors note that the earlier studies had not collected data to investigate causal mechanisms. But the synthesised results did show that fatalities of water-obligate birds, which rely on water for take-off and landing, occurred at 90% of site-years at facilities in the Sonoran and Mojave Deserts Bird Conservation Region. The Salton Sea in this region is an important stopover and winter habitat for an abundance of water obligates, such as loons and grebes.

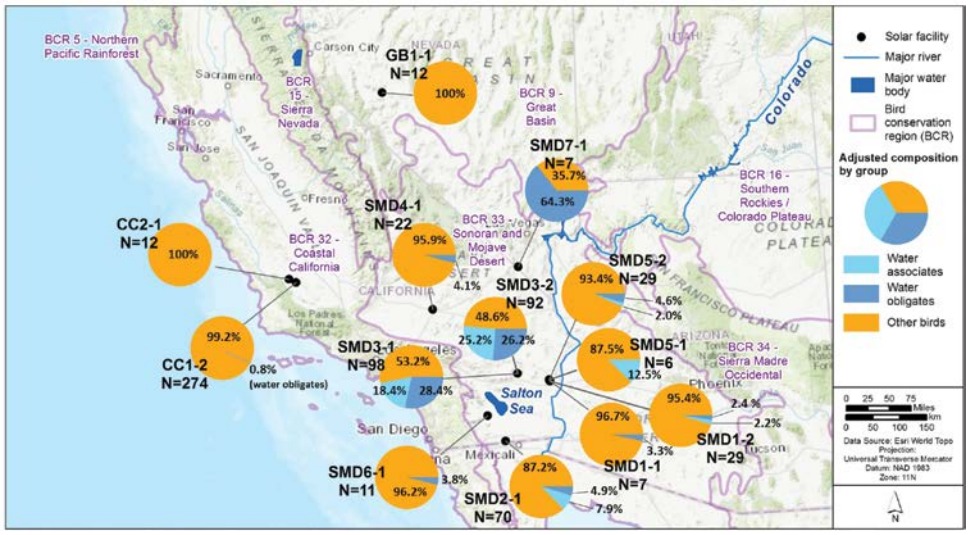
The South African paper, 'Assessing the impacts of a utility-scale photovoltaic solar energy facility on birds in the Northern Cape, South Africa', was published in the journal *Renewable Energy* in 2019. Lead author, Elke Visser, conducted the study for her Conservation Biology MSc degree, the Fitzpatrick Institute's intensive coursework programme that includes a six-month research project. As such, the study involved only three months of surveys – from September to December 2015 – at the 96 MW Jasper PV facility near Postmasburg. Apart from searching for carcasses and feather spots, the solar panels were checked for smudge marks and feathers, both considered evidence of collisions. Only eight fatalities were detected from these methods, which the authors extrapolated to an annual mortality of 435 birds for the entire facility, or 4.5 fatalities/MW/year.

The paper also discusses the facility's impact on the avian community through habitat loss, since bird species richness and density within the facility were found to be lower than areas in its boundary zone or in the adjacent veld. As noted in BirdLife South Africa's 'Best Practice Guidelines: Birds & Solar Energy', the removal of vegetation from the development footprint of solar PV facilities – and the resulting loss, degradation or fragmentation of habitat – has generally been considered the most significant impact of such facilities on birds.

Solar tower CSP

Concentrated solar power (CSP) systems have highly reflective mirrors that concentrate the sun's light energy, so that the heat created can be used to drive a steam turbine coupled to a generator, which produces electricity. In CSP tower systems, the mirrors are flat panels called heliostats, which track the sun's movement and focus the reflected sunlight onto a receiver at the top of a tower.

Birds may get potentially fatal burn injuries or feather singeing when flying through this concentrated reflected sunlight, known as the solar flux, and may also collide with the mirrors and other infrastructure on the site. CSP facilities are therefore considered more detrimental to birds than solar PV facilities. In its position statement 'The



An analysis of bird mortality data from solar PV facilities in California and Nevada, USA, showed that there was a greater proportion of fatalities of water associates and water obligates at facilities close to inland waterbodies. Water associates are species that rely on water for foraging, reproduction, and/or roosting, while water obligates are species that cannot take flight from land. N = total number of detections for each site-year (e.g. CC2-1) represented on the map.

Kosciuch et al. 2020, PLos ONE, https://doi.org/10.1371/journal.pone.0232034.g004

Abengoa

The 50 MW Khi Solar One near Upington is South Africa's only concentrated solar power (CSP) tower facility, operational since late 2016. Unlike most CSP tower facilities that use molten salt as the heat transfer fluid, Khi Solar One relies on superheated steam technology.

effect of concentrated solar power (CSP) tower facilities on birds', dated January 2019, Birdlife South Africa supports the responsible development of CSP facilities, but acknowledges that they could be hazardous to birds and their habitats. It recommends that the impacts of operational CSP tower facilities on birds should be monitored according to BirdLife South Africa's 'Best Practice Guidelines: Birds & Solar Energy', published in 2017.

An earlier version of the guidelines was used by HP van Heerden, who studied Khi Solar One's effects on birdlife for his MSc in Conservation Ecology, recently awarded by Stellenbosch University. Van Heerden began his monitoring in mid-2015, initially conducting short surveys in both winter and summer to get an idea of the area's bird community. Overall, he counted 2 380 birds from 57 different species, with only one being of conservation importance – the lanner falcon, which is listed as a vulnerable species. Most of the species were recorded from the surrounding Nama Karoo veld, rather than the solar tower site itself, but development of the facility did influence the composition of bird species typically found in the area. Its evaporation ponds attracted waterbirds such as flamingos, which had not previously been found on the farm where the facility was built, and species usually found in urban areas are nowadays found in greater numbers around the tower area.

Van Heerden then began monitoring more intensively from mid-2016, conducting weekly surveys of areas within the development footprint for an entire year. During this time, he recorded 324 injured or dead birds from 34 different species. Some 61% of these injuries and mortalities could be attributed to collisions with structures, and 14% to being singed.

Most of the dead birds were seedeaters such as the red-billed quelea and lark-like bunting, which are quite common in the area. The only casualties of conservation importance were one lanner falcon and one white pelican.

Van Heerden found that collisions were primarily against the lower part of structures in the heliostat area, within a few metres of the ground, corresponding to the normal flight height of the seedeaters. The majority of incidents occurred around sunrise or sunset, when birds are most active, but this is also when the heliostats stand at a 90° vertical position, creating an almost continuous mirror image. This may confuse the birds into thinking they are flying through an unbroken landscape, with no obstacles.

Arthur Chapman, CC BY-NC 2.0

Derek Keats-CC BY 2.0

Seedeaters such as the red-billed quelea and lark-like bunting made up most of the bird mortalities at Khi Solar One.

In the case of singeing, migrating birds and species that hunt their prey in the air accounted for most of the mortalities. The bright light radiating from the tower's mirrors attracts insects, which in turn attract insect-eating birds.

Based on these findings, Van Heerden recommended that heliostats should not be positioned at exactly 90° during early mornings and late afternoons, when birds are most active, and should preferably be set in a horizontal position when solar power is not being generated by the facility. In this way, the intensity of the solar flux would be reduced when the heliostats are in standby position.

- Although many birds are killed by wind and solar energy facilities, this needs to be considered in context of the thousands that are killed countrywide through collisions with buildings and vehicles or through encounters with pets, particularly cats. Electricity generation by these facilities also does not result in emissions of greenhouse gases and other pollutants associated with coal-fired power stations.

CURRICULUM CORNER

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Non-conventional energy sources

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2020-11-30

Quest Volume 16 Number 4 2020

Academy of Science of South Africa (ASSAf)

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