a darker shade of GREEN

BIRDS & WIND FARMS

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A Common Tern, victim of turbines in Belgium.

Oil and coal have long powered transportation and electricity generation. In the 21st century, the impact of our excessive use of these non-renewable fossil fuels is fast becoming evident, with increasing atmospheric carbon dioxide levels providing the trigger for rapid climate change. In response, there is a gradual, but accelerating, movement towards renewable energy sources that do not add further greenhouse gases to an already altered atmosphere. One of the most attractive alternatives is wind-generated electricity: it is relatively cheap, environmentally benign and without the real and perceived hazards of nuclear reactors.

There is, however, a catch. To generate meaningful amounts of electricity, wind farms consisting of large numbers of turbines are required. Most turbines extend more than 50 metres above ground level, with some models being in excess of 100 metres. The rotating blades represent a potential hazard to birds flying through the area, and avian injuries and deaths associated with collisions are now well documented. Although the strike rate per individual turbine is usually low, large numbers of turbines mean that the overall effect can reach significant and, in some cases, disturbing levels.

A particularly sobering case study is provided by northern California's massive Altamont Pass Wind Resource Area, which covers 165 square kilometres and contains more than 5 000 turbines. In the early 1990s, it was thought that between 100 and 300 raptors were killed each year at this site.

The impacts of wind-generated electricity on birds present humans with a moral dilemma

However, a study published in 2008 paints a grimmer picture, estimating that these turbines kill an average of 2 700 birds annually, of which 1 100 are raptors. The most severely affected species are Golden Eagles (average of 67 killed per annum), Red-tailed Hawks (188 per annum), American Kestrels (348 per annum) and Burrowing Owls (440 per annum). A key aspect of the study was that, in order to account for bird carcasses that were scavenged and hence not detected by the researchers, it incorporated information on the rate at which scavengers removed bird carcasses from an area.

The mortality rates at Altamont Pass are unusually high, but unfortunately not unique. Across the Atlantic, Spain's Navarre and Tarifa wind farms have also proven deadly, with more than 400 Eurasian Griffons thought to have collided with turbines at Navarre. Studies at Altamont Pass, Navarre, Tarifa and elsewhere have highlighted the fact that raptors suffer disproportionately high collision rates. One reason may be that birds that are focused on prey while hunting are less likely to notice the blades. In the case of large, rare species that reproduce slowly, like many eagles, the mortality associated with wind farms can be of significant conservation concern.

The impact of offshore wind farms has been much more difficult to quantify, because the turbines are located over water. At three sites in Belgium, mortality rates ranged from four to 23 birds per turbine per year, with ducks, gulls and terns being the major casualties. At the Blythe offshore wind farm in the UK, an average of six Common Eiders collide with each turbine per year. Fortunately, these wind farms involve relatively small numbers of turbines, and there have been no detectable negative trends in local bird populations.

The location of turbines within a landscape, the spacing between them, and the pattern in which they are arranged often play a pivotal role in reducing collision risk. Various other mitigation measures have been proposed. One possibility is to increase the turbines' visibility, at least during good weather, by painting bright, high-contrast patterns on the blades. A related suggestion, which takes advantage of the fact that birds can see ultraviolet light that is invisible to humans, is to use UV-reflective paint on the blades and thereby avoid the aesthetic issue of psychedelic turbines dotting the landscape.

Various high-tech methods are currently being employed to investigate how birds respond to wind farms. Radar is now often used to track flying birds in the vicinity of turbines, and has yielded vital insights into how wind farms affect migrants. One key observation has been that wind farms often result in a barrier effect, with flocks detouring from established flyways to avoid them. While these findings are encouraging in the sense that they show that birds sometimes actively avoid flying in the vicinity of turbines, they also reveal the potential for badly placed wind farms to force birds to follow longer flight paths, thereby increasing their energy expenditure. Other new technologies are also emerging. Thermal animal-detection systems mounted on turbine masts allow computerised recording of the species and numbers of birds flying in the vicinity, and the use of vibration sensors within turbine blades to detect bird strikes is being explored.

In Africa, wind-generated electricity is in its infancy. Several hundred turbines are in use in North Africa, most notably Morocco and Egypt. Africa's largest wind farm is located at Zarafarana in Egypt, with the first of two phases consisting of 105 turbines specifically designed for hot, dry climates.

South of the Sahara, the most significant developments consist of four turbines producing 5.2 megawatts near Darling in the Western Cape, and three turbines producing 3.2 megawatts at the Klipheuwel Demonstration Wind Farm, also in the Western Cape (see volume 7, number 6, pages 20–21). The Klipheuwel site has been operational since 2002, and its impacts on birds have been carefully monitored. Although White Pelicans regularly fly through the area, and Blue Cranes, Secretarybirds and Peregrine Falcons all breed within a few kilometres of the site, no collision-related mortality has been reported for these species.

Given the current electricity crisis in South Africa, and the global movement towards tighter control on carbon emissions through mechanisms such as the Kyoto Protocol, the limited scale of wind-generated electricity in the region may soon be a thing of the past. A 100-megawatt farm, considerably larger than the Klipheuwel and Darling sites, is being planned for a location near Vredendal in the Western Cape. Another four similarly sized wind farms are in the pipeline, although their locations have not yet been decided. To minimise the impact of these farms on birds, it is vital that careful environmental impact assessments are carried out, and that the turbines are placed in areas where they are least likely to affect resident or migrating birds.

The impacts of wind-generated electricity on birds present humans with a moral dilemma. There is no question that wind farms can negatively affect bird populations. A proposal to build one of Europe's biggest wind farms was recently rejected by the Scottish government, partly on the grounds that it would threaten several endangered bird species. On the other hand, as Tim Flannery has pointed out in *The Weather Makers*, the long-term impacts of continuing to burn vast amounts of coal to produce electricity are so far-reaching and will devastate so many species that the birds killed or injured by turbine blades may ultimately be a relatively small price to pay for reducing our dependence on fossil fuels.

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