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# A call for conservation scientists to evaluate opportunities and risks from operation of vertical axis wind turbines

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## Conservation Scientists and Corporations

A new conservation paradigm (Kareiva and Marvier, 2012) emphasizes the need for scientists to embrace a holistic approach taking into account the social and natural dimensions of conservation in human-dominated landscapes. While there is heavy debate over the new approach (Tallis and Lubchenco, 2014), most conservation scientists seem to agree on to the need to cooperate with corporations when such interaction can benefit people and the environment (Miller et al., 2014; Tallis and Lubchenco, 2014). Cooperation can be most productive when established in the early phases of development, but this requires a high capacity for forward looking pre-emptive action (i.e., anticipating potential forthcoming issues before they arise; Sutherland and Woodroof, 2009). This framework is particularly salient for rapidly developing and expanding technologies such as those for harvesting renewable energy sources. Here the stakes are very high, as they concern mitigating negative consequences to global climate while generating energy without impacting wildlife. In this vein, past experience is instructional. The environmental impacts of biofuels and wind, among others, have been identified and evaluated rather late (Sutherland and Woodroof, 2009), so that implementation of best management practices on existing facilities is now often prohibitively expensive.

Here we call scientists to focus specific attention on a rarely deployed yet recently emerging technology, the vertical axis wind turbine model, which has potential to dominate the wind energy technology in the future (Islam et al., 2013). We identify in this particular type of technology a gap in scientific knowledge with regards to its associated environmental impacts. We also point out the instructional value of past experience with horizontal axis wind turbines, which were assumed to be wholly environmentally friendly and are now seen as valuable but accompanied by risk to wildlife and habitat. We urge that this knowledge gap be filled rapidly in order to exploit potential economic and energy-provisioning opportunities that this technology could offer.

## A Rapidly Emerging Technology

Wind energy generation is among the fastest growing sources of renewable energies (AWEA, 2014; EWEA, 2015), and is rapidly expanding on-land and offshore (REN21, 2014). This trend is projected to continue in the coming decades because wind, as well as other renewable energy sources, can contribute to mitigating global climate change (IPCC, 2011). During the early stages of growth within the wind energy industry in the second half of the past century, both horizontal axis and vertical axis wind turbines were developed (hereafter HAWT and VAWT, respectively; Kaldellis and Zafirakis, 2011). However, only the HAWT models have become mainstream, and they now dominate the global wind energy market (Kaldellis and Zafirakis, 2011). Unfortunately, the environmental impacts (both direct through bird and bat mortality, and indirect via habitat degradation and fragmentation; Northrup and Wittemyer, 2013) of HAWT were identified only after this technology had already entered the energy market. At that stage, there was little opportunity to make improvements that could reduce risk to wildlife while also allowing continued energy generation.

Development of HAWT faces a number of constraints. In particular, the units need to be spaced far apart in order to avoid interference between adjacent turbines (IPCC, 2011; Kaldellis and Zafirakis, 2011; Islam et al., 2013) and to be cost efficient, they need to be mounted far above the ground and in areas with high wind potential. These constraints limit the capacity of HAWT models to make full use of global wind resources (Timilsina et al., 2013; Dabiri et al., in press) and they can also increase potential impacts to wildlife (Northrup and Wittemyer, 2013).

Given the limitations of HAWT, the attention of research and development in the wind energy sector is currently shifting toward VAWT (Islam et al., 2013; Dabiri et al., in press). VAWT can be deployed in decentralized systems with smaller and simpler modules than HAWT. Furthermore, relative to HAWT, VAWT are able to efficiently generate energy in a wider range of wind conditions and could better match local energy demand while requiring less land (Islam et al., 2013; Dabiri et al., in press). As a result, VAWT are likely to grow dramatically in number and they have the potential to dominate the wind energy technology market within the coming decades (Islam et al., 2013).

With regards to impacts on wildlife, it is often stated that VAWT have no or limited impacts on wildlife (Islam et al., 2013; Dabiri et al., in press). Similar claims are made by most companies patenting or already marketing new VAWT modules[1]. However, none of these claims is grounded on evidence from a rigorous scientific assessment. In fact, we could detect only a handful of studies in the gray literature (see http://www.nrel.gov/wind/avian_reports.html) that evaluated impacts of VAWT on birds and bats. One of these studies was performed in the Tehachapi Pass in California, and found similar bird mortality rates between VAWT and HAWT (Anderson et al., 2004). Two other studies were performed in the Altamont Pass in California. One of these found mortality of hawks and eagles from collision with VAWT to be generally lower than that associated with HAWT (Thelander et al., 2004). The other study from the same location (Smallwood and Thelander, 2005) reports that VAWT are also used as perches by some species of diurnal raptors, and thus may be an attractant to those birds.

[1]For examples, see
http://www.technologyreview.com/news/513266/will-vertical-turbines-make-more-of-the-wind/
http://www.sciencedaily.com/releases/2011/07/110713131644.htm
http://www.c-fec.com/turbine/
http://www.silentwindturbine.com/design.htm
http://www.verticalgreenenergy.co.za/all_about_wind_vawt.htm

## An Urgent Need for Collaboration

Past experience with HAWT, statements about the wildlife friendly nature of VAWT and the general lack of scientific evidence for or against these statements suggests real potential for unexpected consequences for large-scale deployment of VAWT. Therefore, we call on conservation scientists to embrace cooperation with local governments and wind corporations in development and testing of different VAWT models and siting configurations, to evaluate and identify possible environmental impacts and to jointly work out solutions. Specifically, cooperation should entail the development of studies with a robust design for data collection and analysis. There are several locations where VAWT are being deployed or planned to be put in place, mostly across North America, where such cooperation could take place. This could be achieved, for example, by first selecting a set of sites with varying environmental conditions (e.g., areas with different density of resident and migratory birds and bats), deploying different types of VAWT at some randomly selected sites, and using other sites as controls. This evaluation program could be conducted within a framework of robust and comprehensive pre- and post-construction monitoring and subsequent rigorous quantitative analyses (e.g., Dahl et al., 2012). This wildlife evaluation could also be conducted in the context of careful measurement of costs and power production efficiency. Moreover, it is fundamental that such collaborative endeavors are rigorously framed with *ad-hoc* legislation. This is relevant in regions and countries where legally protected species (e.g., species under the Endangered Species Act of the US) may be affected. There, legal permits for take of some species could be issued, so that corporations would not be deterred to cooperate due to the fear of sanctions.

The outcomes of these assessments can then serve to inform best management practices that favor both conservation of biodiversity and energy production. The application of best management practices is desirable not only from an environmental ethics viewpoint, but also from a utilitarian perspective. This approach may, in fact, open new avenues in energy markets that could otherwise be obstructed in the legal and social battles that follow negative environmental impacts (e.g., avoiding fines and negative publicity as has occurred recently at several HAWT facilities within the USA[2]).

Increasing global energy production is a key challenge of modern society, and one that can have important consequences on the environment and human health (IPCC, 2011). Wind, if developed in accordance to best management practices to limit impacts on wildlife and the environment, has a role to play in sustainably meeting this challenge (IPCC, 2011; REN21, 2014) and in meeting global biodiversity conservation targets (Secretariat of the Convention on Biological Diversity, 2014). This can only be achieved if a holistic approach is embraced by all parties interested, including the energy sector, scientists, and local

[2]For example, see:
http://www.justice.gov/opa/pr/utility-company-sentenced-wyoming-killing-protected-birds-wind-projects
http://www.justice.gov/opa/pr/utility-company-sentenced-wyoming-killing-protected-birds-wind-projects-0

governments. Embracing such an holistic approach has relevance beyond the case of VAWT, and including the development of HAWT and other energy sources. Past cooperation between scientists and corporations has led to important successes in application of best management practices (e.g., for forestry, grazing, hydropower) to benefit people and the environment (Tallis et al., 2008; Kareiva et al., 2014). A holistic cooperative approach would facilitate effective VAWT development, so that past mistakes are not repeated and joint solutions are sought in order to ultimately achieve development with high standards of sustainability.

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## References

Anderson, R. L., Neumann, N., Tom, J., Erickson, W. P., Strickland, M. D., Bourassa, M., et al. (2004). *Avian Monitoring and Risk Assessment at the Tehachapi Pass Wind Resource Area: Period of Performance: October 2, 1996–May 27, 1998. NREL/SR-500-36416*. National Renewable Energy Laboratory, Golden, CO. doi: 10.2172/15009631

AWEA. (2014). *American Wind Energy Association: US Wind Industry Fourth Quarter 2014 Market Report*. American Wind Energy Association.

Dabiri, J. O., Greer, J. R., Koseff, J. R., Moin, P., and Peng, J. (in press). A new approach to wind energy: opportunities and challenges. *AIP Conf. Proc*. doi: 10.1063/1.4916168

Dahl, E. L., Bevanger, K., Nygard, T., Roskaft, E., and Stokke, B. G. (2012). Reduced breeding success in white-tailed eagles at Smola windfarm, western Norway, is caused by mortality and displacement. *Biol. Conserv.* 145, 79–85. doi: 10.1016/j.biocon.2011.10.012

EWEA. (2015). *European Wind Energy Association: Wind in power. 2014 European Statistics*. Brussels: European Wind Energy Association.

IPCC. (2011). *Renewable Energy Sources and Climate Change Mitigation.* Special Report of the Intergovernmental Panel on Climate Change. Cambridge; New York.

Islam, M. R., Mekhilef, S., and Saidur, R. (2013). Progress and recent trends of wind energy technology. *Renewable Sustainable Energy Rev.* 21, 456–468. doi: 10.1016/j.rser.2013.01.007

Kaldellis, J. K., and Zafirakis, D. (2011). The wind energy (r)evolution: a short review of a long history. *Renewable Energy* 36, 1887–1901. doi: 10.1016/j.renene.2011.01.002

Kareiva, P., Groves, C., and Marvier, M. (2014). The evolving linkage between conservation science and practice at The Nature Conservancy. *J. Appl. Ecol.* 51, 1137–1147. doi: 10.1111/1365-2664.12259

Kareiva, P., and Marvier, M. (2012). What is conservation science? *Bioscience* 62, 962–969. doi: 10.1525/bio.2012.62.11.5

Miller, B., Soule, M. E., and Terborgh, J. (2014). 'New conservation' or surrender to development? *Anim. Conserv.* 17, 509–515. doi: 10.1111/acv.12127

Northrup, J. M., and Wittemyer, G. (2013). Characterising the impacts of emerging energy development on wildlife, with an eye towards mitigation. *Ecol. Lett.* 16, 112–125. doi: 10.1111/ele.12009

REN21. (2014). *Renewables 2014 Global Status Report.* Paris: Renewable Energy Policy Network for the 21st Century.

Secretariat of the Convention on Biological Diversity. (2014). *Global Biodiversity Outlook 4*. Montréal, QC.

Smallwood, K. S., and Thelander, C. G. (2005). *Bird Mortality at the Altamont Pass Wind Resource Area - March 1998 - September 2001. NREL/SR-500-36973*. National Renewable Energy Laboratory, Golden, CO. doi: 10.2172/15020305

Sutherland, W. J., and Woodroof, H. J. (2009). The need for environmental horizon scanning. *Trends Ecol. Evol.* 24, 523–527. doi: 10.1016/j.tree.2009.04.008

Tallis, H., Kareiva, P., Marvier, M., and Chang, A. (2008). An ecosystem services framework to support both practical conservation and economic development. *Proc. Natl. Acad. Sci. U.S.A.* 105, 9457–9464. doi: 10.1073/pnas.0705797105

Tallis, H., and Lubchenco, J. (2014). Working together: a call for inclusive conservation. *Nature* 515, 27–28. doi: 10.1038/515027a

Thelander, C. G., Smallwood, K. S., and Rugge, L. (2004). *Bird Risk Behaviors and Fatalities at the Altamont Pass Wind Resource Area Period of Performance: March 1998–December 2000. NREL/SR-500-33829*. National Renewable Energy Laboratory, Golden, CO.

Timilsina, G. R., van Kooten, G. C., and Narbel, P. A. (2013). Global wind power development: economics and policies. *Energy Policy* 61, 642–652. doi: 10.1016/j.enpol.2013.06.062

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