ENVIRONMENTAL IMPACTS OF WIND POWER: BIRDS, BATS, AND NATURAL HABITATS

George C. Ledec
Lead Ecologist, Africa Region
The World Bank

For further information, contact gledec@worldbank.org

Isn't Wind Power Already Green?

- **YES**, in terms of carbon emissions and renewability:
  - Fully renewable, near-zero carbon emissions, very low water use.
  - Wind power considered key part of a climate-friendly, low-carbon energy future.

- **BUT**, there are important environmental and social impacts nonetheless:

- To be fully sustainable, wind power needs to become even Greener by addressing these impacts.

Main Environmental and Social Impacts of Onshore Wind Power

- Biodiversity Impacts--birds, bats, and natural habitats.
- Local Nuisance Impacts—visual, noise, interference with radar, telecommunications, aviation, etc.
- Socio-economic and Cultural Impacts—land acquisition, local incomes (benefits-sharing), indigenous and traditional communities, physical cultural resources.

Besides wind farms, need to consider complementary infrastructure: transmission lines and access roads.

Bird Collisions with Wind Power Equipment

- Mostly with wind turbine rotors; some with turbine towers or masts with guy wires.
- Rotor tip speed is very high (even if low RPM); birds get hit by surprise.
- Some bird species are especially collision-prone, e.g. large soaring birds.
- As an example, watch brief video of Eurasian Griffon Vulture struck by wind turbine in Crete, Greece: http:youtu.be/9srPoOU6_Z4

Are Wind Turbine Collision Impacts on Birds Really Significant?

Overall, wind turbines kill far fewer birds than other types of human-caused direct mortality, including:

- Collisions with buildings (especially glass)
- Vehicles
- Telecommunications towers
- Outdoor domestic cats
- Pesticides
- Hunting

But, wind turbine mortality still really matters because:

- Wind turbine mortality can be disproportionately high for vulnerable species (eagles, vultures, storks, etc).
- Cumulative impacts of numerous wind farms along bird migration flyways.
- As wind power scales up quickly, so does bird mortality (without effective mitigation)

Examples of Problematic Wind Farms

Altamont Pass, California, USA

Over 1,000 raptors killed each year (2/MW/year), including about 67 Golden Eagles. “Population sink” for these species.

Examples of Problematic Wind Farms

• Smola Islands, Norway: Had highest concentration of nesting White-tailed Eagles in Europe—breeding population collapsed after 68 turbines installed; 38 dead eagles found 2005-2010.

• Navarra, Spain: Two wind farms (~400 turbines) studied. Unsustainably high mortality of Eurasian Griffon Vultures, estimated at 8/turbine/year.

• Many wind farms (e.g. Foote Creek Rim, Wyoming, USA) are documented to have fairly low bird mortality.

• For many other wind farms (e.g. in Texas, USA), bird impacts unknown because no monitoring, or data not disclosed.

Other Impacts of Wind Power on Birds

Displacement from otherwise suitable habitat by tall structures and/or human presence:

- Naturally treeless habitats (natural grasslands, shrub-steppe, etc.).

- Affects prairie grouse; perhaps bustards, other birds of conservation concern; also shy wild mammals.

Impacts of Wind Power on Bats

• Collision problem probably worse for bats than for birds, because many bats appear attracted to moving rotor blades (for unknown reasons).

• Bat fatalities often higher than bird fatalities at well-monitored wind farms (Mexico La Venta II)

• Bats have naturally low reproductive rates, so scaled-up wind power in sensitive sites could threaten some species

Impacts of Wind Power on Natural Habitats

•Land Clearing (~1-2 ha/MW) for turbine platforms, access roads, construction staging areas, etc.

•Habitat Fragmentation from rows of turbines and connecting roads.

•Special Cases:

– Specialized, endemic ridge-top vegetation may be disproportionately affected (especially in tropics).

– Downwind sand dunes might be altered.

Biodiversity Impacts of Ancillary Facilities: Transmission Lines

- Bird Collisions (large-bodied, fast-flying species)
  - Serious threat to some species, e.g. Ludwig's Bustard (Karoo plains of South Africa, Namibia)
  - Wetland sites (bird concentrations)
  - Mitigated through careful alignment; use of BFDs
- Bird Electrocutions (especially raptors)
  - Bird-friendly power pole and wire configurations
  - U.S. Avian Power Line Interaction Committee (APLIC) www.aplic.org
- Bird Perching and Nesting (mostly benign)
- Forest Fragmentation

Biodiversity Impacts of Ancillary Facilities: Access Roads

Induced Impacts (from increased human access):

- Deforestation or other land clearing
- Excessive wood cutting
- Hunting of vulnerable species

Direct Impacts (from civil works):

- Direct loss of natural habitats (ROW, etc.)
- Fragmentation of natural habitats
- Altered drainage patterns
- Pollution or sedimentation of aquatic ecosystems
- Disturbance from construction workers
- Wildlife road kills

Effects on Another Type of “Bird”

Aircraft Safety

- Airport runways and approach paths (existing and future)
- Crop spraying

Radar and Telecommunications Interference

- Likely problem if within line-of-sight

Civil and Military Installations

Key Environmental and Social Mitigation / Enhancement Measures

PROJECT PLANNING

•Location, location, location: Careful site selection of wind farms and transmission lines.

•Stakeholder engagement to increase local acceptance and plan compensation and benefits-sharing arrangements.

•Wind power equipment (turbines, masts, lights, transmission lines, power poles): Consider models with reduced biodiversity and/or visual impacts.

•Potential conservation offsets.

Location, Location, Location: Site Selection of Wind Power Facilities

•Careful site selection is most important tool for minimizing biodiversity and local nuisance impacts, and optimizing social benefits.

•Commercial-scale wind farm locations need good wind conditions and proximity to electric grid. After that, look for sites that avoid or minimize problems with:

–Bird or bat mortality; damage to natural habitats
–Adverse visual impacts or shadow flicker
–Noise (proximity to dwellings)
–Radar, telecommunications facilities, or airports (existing or planned)
–Physical displacement or loss of livelihoods
–Socially conflictive situations
–Physical cultural resources

First-Approximation Bird and Bat Risks of Wind Power Sites

Higher-risk sites:

- –Shorelines (ocean and lake)
- –Small islands
- –Wetlands
- –Migratory bird flyways
- –Mountain ridge-tops
- –Wooded areas
- –Native grasslands
- –Near caves

Lower-risk sites:

- –Most agricultural land
- –Non-native pastures
- –Deserts (away from coastlines and oases)
- –In general, areas that lack important bird or bat concentrations.

Site Selection Planning Tool:

STRATEGIC ENVIRONMENTAL ASSESSMENT

- Different names, e.g. Regional, Programmatic, Sectoral EAs
- Usually at level of country or wind resource area
- Facilitate stakeholder participation in analysis of alternatives
- Can assess cumulative impacts of multiple wind farms
- Produce overlay maps of environmental sensitivity data on top of wind resource data
- Can produce zoning maps that direct wind power investments to less sensitive or conflictive sites
- Interesting recent example: *"Wind Power in Wyoming: Doing it Smart from the Start"* identifies Red exclusion zones, Yellow precautions zones, and Green promotion zones for wind power. (http://www.voiceforthewild.org/WindPowerReport.pdf)

Project Planning Tool:

ENVIRONMENTAL IMPACT ASSESSMENT

- Standard project-specific tool to assess environmental (including social) impacts.
- Pre-construction bird and bat studies, especially important at higher-risk sites.
- Enables micro-level turbine site selection to avoid areas of highest bird use (also dwellings, physical cultural resources, shadow flicker).
- Environmental Management Plan: Mitigation/enhancement actions, implementation schedule, budget (investment and recurrent costs), funding commitment.

Key Environmental and Social Measures: Project Construction

- Turbine installation, staging areas, transmission lines, new or improved access roads.
- Environmental rules for contractors:
  - Minimize clearing of natural vegetation.
  - Proper waste disposal.
  - No contamination of waterways.
  - Chance finds procedures for physical cultural resources
  - No hunting, vegetation burning, off-road driving, speeding, improper behavior towards local residents.
- Bidding documents and contracts should include key environmental requirements.
- Diligent field supervision--you get what you INSPECT, not what you EXPECT!

Key Environmental and Social Measures: Project Operation

- Post-construction monitoring of birds and bats.
- Operational curtailment:
  - Increased cut-in speeds
  - Short-term shutdowns
- Wind farm land management for pre-existing uses, species of conservation concern, other objectives.
- Managing human access: Local residents, tourists, other visitors; restricting firearms.
- Equipment maintenance (e.g. capping nacelle holes to keep birds out).

Post-Construction Monitoring: Why Do It?

POST-CONSTRUCTION MONITORING IS AN INDISPENSABLE ENVIRONMENTAL MANAGEMENT TOOL FOR WIND PROJECTS:

- Only real way to know if significant problem exists.
- Enable adaptive management of wind farm operation.
- Predict likely impacts from scaling-up in the area.
- Advance scientific knowledge (steep learning curve).

Do it for 2-3 years, longer if problems found.

Post-Construction Monitoring: Correction Factors

- Key correction factors between observed and actual bird and bat fatalities
- Equation: **M** = **O** x **A** x **S** x **R**, where:
  - **M** = Real # Fatalities
  - **O** = Observed Fatalities
  - **A** = Area Not Searched
  - **S** = Searcher Efficiency
  - **R** = Scavenger Removal
- **M**/**O** is small (near 1) for very large birds (vultures, eagles, pelicans) but can be much greater (perhaps up to 50) for small birds and bats.
- Estimate **S** and **R** through experimental trials or from other projects at similar sites.

Increased Turbine Cut-In Speed (for Bats)

• Cut-in speed is the lowest wind speed at which turbines spin and generate power for grid.

•Bats fly around mainly during low winds and at night; low wind speeds yield little electricity.

•Recent “cutting-edge” research from USA (PA), Canada (AB), and Germany shows that increasing the cut-in speed from the usual 3-4 m/s to about 6 m/s reduces bat mortality by 44-93% and power generation by only ~1%.

•Where bat mortality is of concern, raising cut-in speeds at night may be cost-effective mitigation.

Short-term Shutdowns (for Migratory Birds or Bats)

- During short-term shutdowns, turbine rotor blades are feathered (do not spin).
- Short-term shutdowns can be:
  - Seasonal (during peak migration).
  - Time of day (when birds fly by at rotor-swept height).
  - On-demand in real time (using human spotters, also radar); and/or
  - After maximum "kill quota" is reached.
- Most cost-effective for migratory species that spend small portion of year at the wind farm.
- Technical and financial feasibility has been demonstrated at La Venta II (Mexico) and other wind projects.

Conservation Offsets

- Off-site conservation investments can:
  - Usefully mitigate adverse biodiversity impacts of wind projects.
  - Conserve natural habitats of similar or greater conservation value than those affected by project.
  - Enhance populations of project-affected species , e.g. Hawaiian Petrel; Lesser Prairie Chicken (Oklahoma).
- Need clear implementation responsibilities and adequate funding as part of the wind project.

NO Free Lunch!

All large-scale power generation technologies pose environmental and social challenges:*

- Coal
- Petroleum
- Natural Gas
- Nuclear
- Hydroelectric
- Biomass
- Solar
- Geothermal
- Wind

*see *Greening the Wind* (Full Report, Table 2.1) for details.

Sustainability Challenges for Wind Power Development

- Low carbon does NOT mean low overall environmental or social impacts.
- Key challenges for scaled-up wind power development:
  - Avoid significant harm to biodiversity.
  - Manage local impacts in ways acceptable to most stakeholders.
  - Promote equitable distribution of economic benefits and costs.
- Many feasible mitigation and enhancement measures exist to make wind an even greener energy source.

WORLD BANK STUDY NOW AVAILABLE:

Greening the Wind: Environmental and Social Considerations for Wind Power Development

by George C. Ledec, Kennan W. Rapp, and Roberto G Aiello

FREE DOWNLOAD:

- **Concise Synthesis Report for convenient field use:**
  www.tinyurl.com/GreeningTheWind2
- **Full Report with case studies and detailed analysis:**
  www.tinyurl.com/GreeningTheWind

- **Both volumes include handy Table of Environmental and Social Impacts and Corresponding Mitigation or Enhancement Options**