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

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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 Electrocutations** (especially raptors)
  - Bird-friendly power pole and wire configurations
  - U.S. Avian Power Line Interaction Committee (APLIC) [www.aplic.org](http://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://wwwVOICEFORTHEWILDFORUM/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: $M = O \times A \times S \times R$, 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