Renewable Energy Research Laboratory, University of Massachusetts at Amherst

Wind Power: Impacts and Issues

Wind Power on the Community Scale

Community Wind Power Fact Sheet # 3

RERL—MTC Community Wind Fact Sheet Series

In collaboration with the Massachusetts Technology Collaborative's Renewable Energy Trust Fund, the Renewable Energy Research Laboratory brings you this series of Fact Sheets about Wind Power on the community scale:

1. Technology
2. Performance
3. Impacts & Issues
4. Siting
5. Resource Assessment
6. Wind Data
7. Permitting

Case Studies

Energy Matters

The production and use of energy has more impact on the environment than any other human activity. Wind power is considered one part of the solution to this issue because it is one of the lowest–impact forms of electricity available to us. Still, it does affect the natural and human environment.

Wind power raises interesting ethical questions because while the benefits of clean power are global and regional, the impacts are local. Local decisions about wind power must be made with these global issues in mind.

The main impacts of wind power are visual, auditory, and wildlife effects. This Fact Sheet introduces information on the form and extent of these impacts. It also lists some of the impacts of fossil-fuel-generated electricity for comparison. Sources for more in–depth information are also offered on the last page.

Inside this Edition: Impacts

Why Wind Power?

Wind power is the world's fastest growing electric power source because it makes clean, emission–free power and is increasingly economical.

Making electricity is the largest source of US industrial air pollution today, according to the EPA. In the US, power plants make 1/3 of greenhouse gas CO_2 emissions in the US, 1/4 of the smog– and asthma– causing NO_x, and 2/3 of acid-rain-producing SO_2. Coal plants emit significant amounts of mercury and dioxin into the air; mercury, for instance, accumulates in fish, and causes brain damage in children, and dioxin causes cancer. Mining and drilling of fossil and nuclear fuels scars vast areas of land in the US and around the world. The environmental and health impacts of our electricity today are real and serious issues.

Renewable energy is one of the primary tools to combat the impacts of our energy use, and wind power is one of the few renewable energy technologies that is feasible for widespread use today and in the near future.

For more details on the impacts of our electricity generation, see page 4.

Land Use, and Wind Power's Impacts on the Natural Environment

The focus of this series of Fact Sheets is medium– and commercial–scale wind power.

Other than the impact on birds and bats discussed on below, the negative environmental impacts of wind power come from the change in habitat that results from the clearing of the land.

Land use requirements: The direct footprint of a wind turbine is relatively small—the base of the tower is typically about fifteen feet across. The immediately surrounding area must be kept free of trees. Power lines are buried in the immediate area, but remote locations may require overhead lines elsewhere, which require clearing.

Spacing: Wind turbines must be spaced at least 2-5 rotor diameters apart to avoid reduced performance and increased wear. This translates to a typical spacing of between 500 and 1000 feet along a ridge line for a full-scale wind turbine.

See Fact Sheet 4, "Siting in Communities" for more discussion on wind turbine siting.

Birds, Bats and Wind Power

While it is easy to conjure images of large wind turbines harming small birds, in fact this is not the problem that many people imagine. Modern wind turbines kill on average one to two birds per turbine, per year. With proper siting, these risks can often be reduced further.

Bat collisions have not been quantified as thoroughly, but so far bats do not appear to be at greater risk than birds.

The bird collision problems that arose at Altamont Pass, CA in the turbines from the 80's and 90's, have been exhaustively studied by biologists; the risk factors they identified (see table on page 2) largely do not exist in New England, and the problem has not arisen to the same magnitude elsewhere in the US.

A Phase One Avian Risk Assessment Study, performed by wildlife biologists looks at the avian collision risk factors discussed in the table below. In weighing the risks and benefits of a wind plant, against the "no–action option" – i.e. no wind turbines – is not benign; it also carries inherent risks to birds (and the rest of us) as well, though the broad risks to birds of fossil fuel combustion has not been as well quantified.

Avian Collision Risk Factors

(source: Kerlinger & Curry)

#	Known or Suspected Risk Factors for avian collision	Altamont Pass, California	Typical Modern Wind installation in New England
1	Large concentrations of turbines	5,400 (in 2001)	1–40
2	Lattice towers allow raptors to perch	Lattice	Tubular towers do not attract perching
3	Fast Rotating Turbine Blades	50–72 rpm	Slow Rotating Blades ~12–18 rpm
4	Closely Spaced Turbines	80–100 feet (<30 m)	Widely Spaced Turbines >650+ feet (>200 m)
5	Turbines in Steep Valleys or Canyons	Steep Valleys & Canyons	Turbines on flat terrain, rolling hills, or ridge tops (no steep hills except sides of ridges)
6	Prey base to attract raptors	Large	*
7	Raptor & Susceptible Species	Present	*
8	FAA lighting attracting night–migrating birds	Often unlit	Risk is present and may account for the majority of night–time avian collisions with modern turbines.

* The magnitude of these risks at a particular site would be addressed in a phase 1 avian risk study

Impacts on the Human Environment

Visual

The primary impact of wind power is visual. Because wind turbines must be exposed to the wind, they are usually in prominent locations.

Aesthetic considerations are impossible to quantify and difficult to discuss. Some people like seeing wind turbines; some people don't. The question of whether a community is willing to accept a visual impact in return for making clean power is an issue for public policy and planning.

FAA Lighting

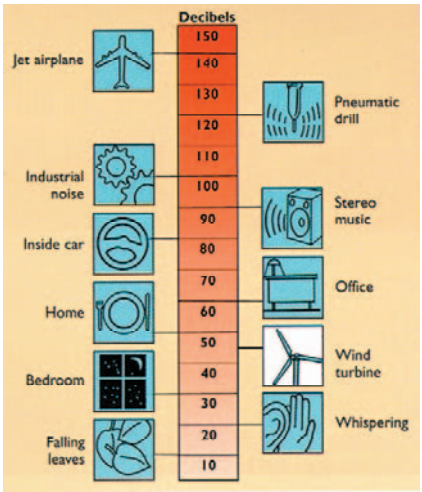
The FAA requires objects over 200 feet tall — i.e. all commercial–scale wind turbines — to be lit. Specific lighting requirements vary from site to site; lights may be red or white, constant or flashing.

Property Values & Tourism

The Renewable Energy Policy project studied 25,000 property transactions in view shed of wind projects, compared to similar sites, and did not find evidence of wind power reducing property values.

Noise

Wind turbines are relatively quiet. While the way sound carries depends on terrain and wind patterns, wind turbines should, as a rule of thumb, be about three times the hub height or more from residences. From a distance of several hundred feet, wind turbines can be compared to the sound level of a refrigerator.



TV interference

In the past, metal–bladed wind turbines could cause "ghosting" on TV screens. The fiberglass composite of modern wind turbine blades is unlikely to cause any interference with broadcast signals.

Urban-sited community wind, Toronto's WindShare project

Compatibility with other human land uses

Today, modern wind turbines around the world coexist safely with many land uses, including schools, highways, hiking trails and farms. Fact Sheet 4, "Siting in Communities" discusses setbacks that are appropriate under various conditions.

School-yard community wind, Spirit Lake, IA

Photo& graphic credits: Spirit Lake: NREL. Toronto: Toronto Hydro. Sound graphic: AWEA.

Renewable Energy Research Laboratory

University of Massachusetts at Amherst

160 Governors Drive
Amherst, MA 01003
413–545–4359
rerl@ecs.umass.edu
www.ceere.org/rerl/

MASSACHUSETTS TECHNOLOGY COLLABORATIVE
RENEWABLE ENERGY TRUST

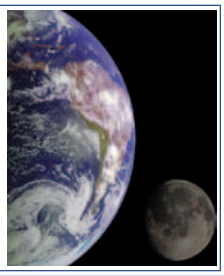
Mass. Technology Collaborative
Mass. Renewable Energy Trust
75 North Drive
Westborough, MA 01581
508–870–0312
www.mtpc.org/RenewableEnergy/index.htm

15% of babies born in the US had a dangerous level of prenatal exposure to mercury.

Impacts of Fossil Fuel Electricity Generation

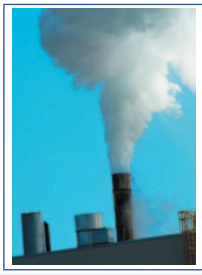
Overall air quality in the US has improved since the Clean Air Act of 1970, but our growing appetite for energy continues to harm us and the environment. We make most of our electricity from fossil fuels, emitting:

CO_2 Carbon Dioxide



40% of man-made CO_2 emissions are from fossil fuel-fired power plants. Fossil fuel combustion has disrupted the earth's carbon cycles, sending much more CO_2 into the atmosphere than is normal. CO_2 is the predominant greenhouse gas.

Environmental Impacts: Global climate disruption



SO_2 Sulphur Dioxide

67 % of the USA's SO_2 emissions are from fossil fuel power plants. SO_2 causes acid rain & smog

Health impacts: smog triggers asthma attacks

Environmental Impacts: acid rain harms lakes & streams and can damage trees, crops, historic buildings, and statues. Reduced visibility.

NO_X Nitrogen Oxides

23% of NO_X emissions are from fossil fuel power plants. NO_X causes ground-level ozone (smog) and acid rain.

Health impacts: smog triggers asthma attacks

Environmental Impacts: acid rain, reduced visibility

And...

Mercury - brain damage, fetal damage.
Dioxin - Liver damage, immune deficiency.
Carbon monoxide - poisonous; greenhouse gas.
Particulates, arsenic, lead, cadmium.
Cooling water heats rivers & lakes.
Oil Spills, mountain top removal, ash, sludge, etc.

These are just some of the effects of conventional electricity generation, explaining why all major environmental groups support wind power as one of the tools to reduce our energy's impacts.

For More Information

The National Wind Coordinating Committee has more in–depth information on the impact of wind power: http://www.nationalwind.org/

The Renewable Energy Policy Project studied impacts on land values: http://www.repp.org/articles/static/1/binaries/wind_online_final.pdf

Wind Energy Explained: Theory, Design and Application, Manwell, McGowan, & Rogers, Wiley, 2002

The websites of following organizations discuss the impacts of the generation of electricity: Union of Concerned Scientists, Conservation Law Foundation, American Lung Association, Environmental Defense Fund, and the Environmental Protection Agency.

For the on–line version of this Fact Sheet with the complete set of links, see RERL's website: www.ceere.org/rerl/about_wind/

Credits: Earth & moon photo: NASA. Oil soaked bird photo: Anchorage Daily News. Prenatal mercury exposure reference: Sierra Club.