WIND POWER – SUMMARY OF SCIENTIFIC RESEARCH

There are many misconceptions about wind power and Gengrowth strongly encourages everyone to find out the facts about wind power for themselves. If you are interested in learning more, please review information on the following topics:

1. **CO_2 Emissions**
2. **Intermittency of Wind Energy**
3. **Sound**
4. **Birds**
5. **Property Values**
6. **Safety**
7. **Tourism**
8. **International Experience with Wind Power**

The summaries, facts and quotes presented from these pages are from leading international studies. Online links to these reports have been provided so that you can read and learn the facts for yourselves.

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CO_2 Emissions

Misconception - 'Dirty' back-up power is required when the wind stops blowing meaning that the CO_2 savings from wind energy is wiped out or worse?

BACKGROUND

Below is a response to this statement put forward by Greenpeace, Friends of the Earth and the World Wild Life Fund in association with the British Wind Energy Association - http://www.yes2wind.com/44_faq.html

"The argument presented by opponents of wind power runs like this:

Because wind power is intermittent (it varies with the weather) it needs dedicated back-up [power] for when the wind doesn't blow. This back up will be coal powered stations that have to be kept 'spinning' (i.e. burning) at low level so they are ready to go immediately when the wind drops. Burning [coal] like this is inefficient so the emissions they make are roughly the same as if they were actually generating electricity [around the clock]. Therefore wind power saves no carbon because the back-up emits the same as if there were no wind turbines in the first place.

This argument is quite simply wrong. The national grid has back-up on it regardless of wind power. Back-up is needed for all forms of energy generation because of unexpected increases in demand (a cold snap for example, or when England plays soccer on television). In fact one of the biggest back-up requirements on the system today is due to Sizewell B nuclear power station - because when it fails (as it does - and has done recently for safety concerns) it knocks out a huge amount of capacity in an instant - unlike wind where any variation is both gentle and very predictable. Only when there is a very large capacity of wind on the system (above 10%) does the variation of the wind even become noticeable over the 'normal' variation on the system. Only then is any of the back-up specifically due to wind power. And only at this point could any carbon emissions from back-up plant be counted against wind power.

It is widely accepted that only very minor levels of back-up are needed for wind up to about 20% wind on the system (much higher levels of wind power are possible, but require a little more back-up). In terms of emissions - even if the back-up was the dirtiest option - coal power - at 10% wind power on the system only 1% of the CO_2 saved by the wind would be emitted from the back-up - and 99% is saved. Coal is not the only option for back-up. Gas is about half as dirty and both hydro power and biomass are renewable

forms of energy that can play the same role. In the future a wide range of renewable energy technologies would compliment one another and offer the chance for completely secure and completely clean energy system - including both primary generation and back-up."

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WIND POWER and CO_2 EMISSIONS

Wind energy is estimated to have reduced global emissions of carbon dioxide (the main anthropogenic greenhouse gas emission) by 90 megatonnes in 2006. In Canada it is estimated that every 1,000 MW of installed wind energy capacity will reduce annual emissions of carbon dioxide by a minimum of 1.2 million tonnes.

WHO SUPPORTS WIND POWER?

- ***National and Local Governments around the World***

  - Installed capacity of wind energy worldwide increased by a record 15,197 MW in 2006 (32%), bringing total wind energy capacity to 74,223 MW – enough to power 22.5 million homes worldwide - Global Wind Energy Council (GWEC)

- ***Leading Scientists and Researchers Investigating Climate Change***

  - Countless environmental organizations such as the David Suzuki Foundation, Greenpeace Canada, Friends of the Earth, The World Wildlife Fund, the National Audubon Society, and the Al Gore Foundation, who all see wind power as part of the solution to reducing CO_2 emissions as well as Sulfur Dioxide and Nitrogen Oxides; which are key components in smog, acid rain, poison for our lakes and global warming.

FOSSIL FUELS AND CO_2 EMISSIONS

- Wind power generation produces **no** CO_2 emissions per kWh
- **Every kilowatt of electricity generated from wind power means that one less kilowatt needs to be generated from a potentially 'dirty' source**

Comparative CO_2 Emissions of Fuel Sources in Ontario

Fuel	CO_2 Emitted Per kWh Generated (in pounds)	kWh Generated 2005 (billions)	CO2 Emitted, Total Generation (billion pounds)
Coal	2.06	30.1	**62**
Natural Gas	1.03	11	**11.33**

- A study commissioned by the Independent Electricity System Operator and the Ontario Power Authority dated October 6, 2006, concluded that **Ontario's current electricity network could accommodate up to 5000 MW of wind** energy without having to:
  - utilize any of the current electricity generators as special back-up power to off-set wind energy's impact on the electricity system; and
  - Build any new back-up power required to balance Ontario's electricity system from the impact of wind energy projects coming on-line.

- **To date Ontario has approximately 413 MW of wind energy installed.** This leaves considerable room to increase wind power capacity in the Province without any impact to the amount of back-up required.

STUDIES

1. The **UK Energy Research Center** (UKERC) convened an expert group that reviewed more than 200 studies on wind power integration and an internationally peer reviewed, comprehensive report**.**

Source:
http://www.ukerc.ac.uk/content/view/259/952 - summary
http://www.ukerc.ac.uk/content/view/258/852 - full report

Key Findings

- The output of fossil fuel plants will need to be adjusted more often to cope with fluctuations in wind output, but any losses this causes are small compared to overall savings in emissions
- Renewable energy, such as wind power, leads to a direct reduction in CO2 emissions

2. **Global Wind Energy Council –** Wind Power key to fight climate change

The report examines the future potential for wind power up to the year 2050 and is an industry blueprint that explains how wind power could supply 34% of the world's electricity by 2050 and 16.5% by 2020. Most importantly, wind power would save 1.5 billion tonnes of CO2 emissions in 2020.

Source:
http://www.gwec.net/index.php?id=30&no_cache=1&tx_ttnews[pointer]=2&tx_ttnews[tt_news]=39&tx_ttnews[backPid]=4&cHash=5f13bb7c6f – brief
http://www.gwec.net/uploads/media/GWEC_A4_0609_English.pdf - report

3. **German Energy Agency Dena** demonstrates that large scale integration of wind energy in the electricity system is technically and economically feasible.

Source:
Planning of the Grid Integration of Wind Energy in Germany Onshore and Offshore up to the Year 2020
http://www.wind-energie.de/en/topics/grids/ - Briefing
http://www.dena.de/fileadmin/user_upload/Download/Dokumente/Projekte/kraftwerke_netze/netzstudie1/dena-grid_study_summary.pdf

Key Findings

- Wind energy annual production can triple by 2015, providing 14% of the German net electricity consumption
- Wind energy does not require construction of additional 'balancing' power stations

- Wind energy has the potential to reduce CO_2 emissions from 302 million tons to 264 million tons of CO_2 by 2015
- Wind energy can help maintain the system security of supply even with a very significant percentage of the power supply

4. **Danish Energy Authority** statistics and **DONG Energy** (Danish utility and successor in part to ELSAM) -

Louise Munter of DONG Energy responds to the misuse of a quote by Flemming Nissen (an employee of ELSAM) by anti-wind organizations. According to Mrs. Munter the statement "Increased development of wind turbines does not reduce Danish carbon dioxide emissions" has been taken out of context by opponents of wind development. The source of the response from Mrs. Munter is found below.

Source:
http://risingwind.blogspot.com/2006/10/wind-power-doesn't-reduce-emissions-12.html

Key Findings and statements from Mrs. Munter

- "Regarding the comments you refer to, it seems that they have been taken out of context."
- "Wind power turbines have played a major role in developing the Danish energy system of today."
- "Denmark has in the period from 1990 until 2005 managed:
    i. To stabilize the national energy consumption
    ii. And at the same time increase the amount of renewable energy production by 250%"
- "The [annual] CO_2 emissions in 1990 were 61 million tonnes compared to 51 million tonnes in 2005".

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INTERMITTENCY

Misconception - Because wind power is intermittent, any significant amount of wind energy fed into the network would result in network destabilization and reduced reliability.

BACKGROUND

Wind power is often described as an "intermittent" energy source, and therefore unreliable. In fact, at a system level, wind does not start and stop at irregular intervals, so the term "intermittent" is misleading. The output of the aggregated wind power capacity is variable, just as the power system itself is inherently variable.

Electricity flows – both supply and demand – are influenced by a large number of planned and unplanned factors. Changing weather makes people switch their heating and lighting on and off, millions of consumers expect instant power for TVs and computers. On the supply side, when a large power station goes offline, whether by accident or planned shutdown, it does so instantaneously, causing an immediate loss of many hundreds of megawatts. By contrast, wind energy does not suddenly trip off the system. Variations are smoother because there are hundreds or thousands of units [i.e. located throughout the Province] rather than a few large power stations, making it easier for the system operator to predict and manage changes in supply. There is little overall impact if the wind stops blowing in one particular place, because it is always blowing somewhere else.

Source:
http://www.gwec.net/uploads/media/GWEC_A4_0609_English.pdf

FACTS

- A recent study undertaken by GE Canada, the Ontario Power Authority and the Independent Electrical System Operator demonstrated that the integration of 5,000MW of variable wind energy production poses no challenges to Ontario's electricity system. This would be the equivalent of 7% of total yearly energy.

- Only when there is a very large capacity of wind power in the system (above 10%) does the variation of the wind even become noticeable over the 'normal variation' on the system.

**Note - Currently, Ontario is getting less than 1% of its power from wind.*

- The electric grid is designed to have more generation sources than are needed at any one time because no power plant is 100% reliable. It is a complicated system designed to absorb many impacts, from electrical generation sources going out of service unexpectedly to industrial customers starting up energy-intensive equipment. The grid operator matches electricity generation to electricity use, and wind energy's variability is just one more variable in the mix.

STUDIES

1. **Ontario Wind Integration Study**, Oct 6, 2006

Source:
http://www.uwig.org/OPA-Report-200610-1.pdf

Key Finding

- Demonstrated that the integration of 5,000MW of variable wind energy production poses no challenges to Ontario's electricity system.

2. A report by the **International Energy Agency** – "Variability of Wind Power and Other Renewables: management Options and Strategies" (2005)

Source:
http://www.iea.org/textbase/papers/2005/variability.pdf
Key Finding

- Confirmed that the barriers to greater penetration of renewables into the existing grid were economic and regulatory rather than technical.

3. The **UK Energy Research Center** (UKERC) convened an expert group that reviewed more than 200 studies on wind power integration and an internationally peer reviewed, comprehensive report

Source:
http://www.ukerc.ac.uk/content/view/259/952 - summaryhttp://www.ukerc.ac.uk/content/view/258/852 - full report

Key Findings

- None of the 200+ studies UKERC reviewed suggested that the introduction of significant levels of intermittent renewable energy would lead to reduced reliability
- 100% 'back-up' for individual renewable sources is unnecessary; extra capacity will be needed to keep supplies secure, but will be modest and a

small part of the total renewables. It is possible to work out what is needed and plan accordingly
- Increased costs of intermittency with a significant amount of renewable energy on the network would only be less than 1% of electrical costs.

4. **German Energy Agency Dena** demonstrates that large scale integration of wind energy in the electricity system is technically and economically feasible.

Source:
Planning of the Grid Integration of Wind Energy in Germany Onshore and Offshore up to the Year 2020
http://www.wind-energie.de/en/topics/grids/ - Briefing

Key Findings
- Wind energy annual production can triple by 2015, providing 14% of the German net electricity consumption
- Wind energy requires only minor expansion of the grid
- Wind energy does not require construction of additional 'balancing' power stations
- Wind energy increases only marginally the cost of electricity for the consumers
- Wind energy can help maintain the system security of supply even with a very significant percentage of the power supply

5. **U.S. utility associations find the impact of wind on operating costs to be incremental and manageable.**

Source:
"Utility Wind Integration State of the Art"
http://www.uwig.org/UWIGWindIntegration052006.pdf

Key Finding
- "At wind penetrations of up to 20% of system peak demand, system operating cost increases arising from wind variability and uncertainty amounted to about 10% or less of the wholesale value of the wind energy."

6. **European Wind Energy Association (EWEA) report:** "Large scale integration of wind energy in the European power supply: analysis, issues and recommendations" – released November 2006

A comprehensive report based on a review of over 180 sources – published data, reports, research findings from all stakeholders across the power industry, operators, utilities and experts.

Source:
http://www.ewea.org/fileadmin/ewea_documents/documents/publications/grid/051215_Grid_report_summary.pdf

Key Findings

- In 2003, the European Commission estimated that wind energy will be the main contributor to meeting the 2010 targets for renewable electricity in the European Union
- When about 10% of total electricity consumption is produced by wind power, the increase in back up power is calculated at only 2-4% of installed wind power capacity – not total electricity consumption.

7. The Minnesota Department of Commerce – "Wind Integration Study"

The purpose of the study was to evaluate the impacts on reliability and operating costs of 1500 MW of wind generation capacity on the Xcel Energy System with a projected 10,000MW of peak customer load in the year 2010.

Source:
http://www.state.mn.us/mn/externalDocs/Commerce/Intro_to_Wind_Integration_120704045253_wolfwhitepaper.pdf

Key Findings:

- Adding an additional 1,500MW (enough energy to meet the needs of more than 400,000 homes) to the system of a major utility, Xcel Energy Minnesota, would require only an additional 8MW of conventional generation to deal with added variability. (less than 0.5% back-up required)
- Groundbreaking Minnesota wind integration study finds up to 25% wind can be incorporated reliably into electric power system.

http://www.awea.org/newsroom/releases/Groundbreaking_Minnesota_Wind_Integration_Study_121306.html

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SOUND/INFRASOUND

Misconception - Wind Turbines are noisy. They produce low frequency sound and infrasound that is dangerous to human health.

Wind turbines are industrial/agricultural machinery and do produce sound, but this output is reasonable, measurable, can be modeled, and is regulated by law to ensure that there is no threat to human health. The Ontario Ministry of Environment has developed specific regulations on this issue and specific setbacks exist for specific turbine models.

BACKGROUND

How is Sound Measured?

Noise is measured in decibels (dB). The decibel is a measure of the *sound pressure level*, i.e. the magnitude of the pressure variations in the air. An increase of 10 dB sounds roughly like a doubling of loudness. Measurements of environmental noise are usually made in dB(A) which includes a correction for the sensitivity of the human ear.

The noise a wind turbine creates is normally expressed in terms of its sound *power* level. Although this is measured in dB(A), it is not a measurement of the noise level which we hear but of the noise power emitted by the machine. The sound *power* level from a single wind turbine is usually between 90 and 100 dB(A) [at the top of the wind turbine]. This creates a sound *pressure* level of 50-60 dB(A) at a distance of 40 metres from the turbine, i.e. about the same level as conversational speech. At a house 500 metres away, the equivalent sound *pressure* level would be 25-35 dB(A) when the wind is blowing from the turbine towards the house. Ten such wind turbines, all at a distance of 500 metres would create a noise level of 35-45 dB(A) under the same conditions. With the wind blowing in the opposite direction the noise level would be about 10 dB lower.

Source and Noise Levels

Source / Activity	Indicative noise level dB (A)
Threshold of hearing	0
Rural night-time background	20-40
Quiet bedroom	35
Wind farm at 350m	**35-45**
Car at 40mph at 100m	55
Busy general office	60
Truck at 30mph at 100m	65
Pneumatic drill at 7m	95
Jet aircraft at 250m	105
Threshold of pain	140

Information taken from The Scottish Office, Environment Department, Planning Advice Note, PAN 45, Annes A: Wind Power, A.27. Renewable Energy Technologies, August 1994

Infrasound & Low Frequency Sound

Terminology: Low frequency pressure vibrations are typically categorized as *low frequency sound* when they can be heard near the bottom of human perception (10-200 Hz), and *infrasound* when they are below the common limit of human perception. Sound below 20 Hz is generally considered infrasound, even though there may be some human perception in that range. Because these ranges overlap in these ranges, it is important to understand how the terms are intended in a given context.

Infrasound is always present in the environment and stems from many sources including ambient air turbulence, ventilation units, waves on the seashore, distant explosions, traffic, aircraft, and other machinery. Infrasound propagates farther (i.e. with lower levels of dissipation) than higher frequencies.

Source:
http://www.ceere.org/rerl/publications/whitepapers/Wind_Turbine_Acoustic_Noise_Rev2006.pdf

FACTS

- Appropriate setbacks and siting of turbines following Ministry of Environment guidelines, municipal bylaws, and working with residents will minimize impact of sound on the community.

- Wind turbines do produce sound but regulations require a wind farm in a rural area not to produce sound levels more than 7dB(A) above standard background levels at any neighbouring point of reception (home, church,

school etc.) for wind speeds 6m/s and above (measured at 10m height) at any time of day.

- While infrasound at high levels can affect human health, and some people are sensitive to infrasound at low levels such that it causes discomfort, numerous studies have demonstrated that these levels are not produced by windfarms

- Once a problem had been spotted, infrasound has been extensively studied and the standard design changed from downwind to modern upwind turbines. All the reports on modern upwind turbines have found that infrasound is not a problem to human health.

- Low Frequency sound emitted from the 'swish' of a turbine's blades as it passes the base is often confused as infrasound

STUDIES

1. **Wind Turbine Acoustic Noise – by Dr. Anthony Rogers of the University of Massachusetts' Renewable Energy Research Laboratory – January 2006**

Source:
http://www.ceere.org/rerl/publications/whitepapers/Wind_Turbine_Acoustic_Noise_Rev2006.pdf

Key Finding

- There is no reliable evidence that infrasound below the audio perception threshold produces physiological or psychological effects.

2. **Lawrence Technological University – Primer for Addressing Wind Turbine Noise –** Revised Oct. 2006

Source:
http://home.nethere.net/dja1701/technical_writing/Papers/AddressingWindTurbineNoise.pdf

Key Findings

- Excessive exposure to noise has been shown to cause several health problems. However, there is no evidence that wind turbines generate the level of noise needed to create these problems.
- "At the base of a 1.8 MW turbine, we measured the noise level at 58-60 dB(A). However, the turbines stand in a corn field, and depending on our position relative to the turbines, it was very difficult to distinguish the sound of the turbine from the rustling of the corn stalks."

3. Infrasound from Wind Turbines – Fact, Fiction or Deception

Source:
Infrasound from Wind Turbines – Fact, Fiction or Deception
http://www.noblepower.com/reference/documents/06-06Leventhall-Infras-WT-CanAcoustics.pdf

Key Finding

- It has been shown above that there is insignificant infrasound from wind turbines and that there is normally little low frequency noise. Turbulent air inflow conditions cause enhanced levels of low frequency noise, which may be disturbing, but the overriding noise from wind turbines is the fluctuating audible swish, mistakenly referred to as "infrasound" or "low frequency noise".

4. HGC Engineering – Environmental Noise Assessment Pubnico Point Wind Farm, Nova Scotia

In response to an individual's concerns of the sound from a nearby windfarm impacting his property, HGC Engineering was retained by Natural Resources Canada to assess the environmental noise impact from the Pubnico Point Wind Farm in Nova Scotia.

Source:
HGC Engineering – Environmental Noise Assessment Pubnico Point Wind Farm, Nova Scotia - www.hgcengineering.com

Key Findings

- Sound at Infrasonic frequencies is not present at perceptible levels near the wind turbine generators. Infrasound is not an issue
- Sound of the wind turbine generators is continually audible at the residence, but much of the time is not appreciably above the numeric criteria derived under the guidelines of the Ontario Ministry of the Environment

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BIRDS

Misconception - Wind Turbines are unusually harmful to birds and disrupt bird migratory patterns.

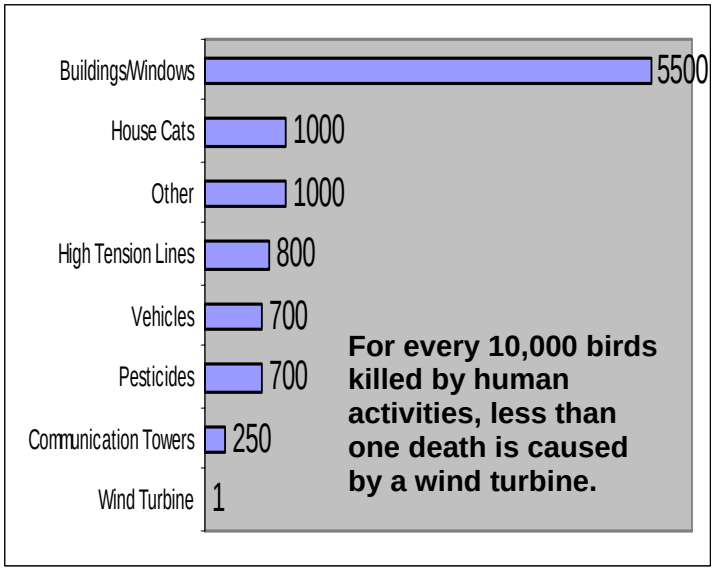
While avian mortality is an issue that demands, and is receiving, continuing attention and mitigation efforts from the wind industry, government and the environmental community, consider the following information.

BACKGROUND

The UK's leading bird protection body, the Royal Society for the Protection of Birds (RSPB), says that the most significant long-term threat to birds comes from climate change. Changes in the climate will in turn change the pattern of indigenous plant species and their attendant insect life, making once attractive areas uninhabitable by birds. According to the RSPB, "recent scientific research indicates that, as early as the middle of this century, climate change could commit one third or more of land-based plants and animals to extinction, including some species of British birds." Compared to this threat, "the available evidence suggests that appropriately positioned wind farms do not pose a significant hazard for birds," it concludes.

Source: http://www.gwec.net/uploads/media/GWEC_A4_0609_English.pdf

FACTS



Data Source: Erickson et al., 2002, Summary of Anthropogenic Causes of Bird Mortality

- For every 10,000 birds killed by human activities including fatalities by collisions with buildings/windows, high tension wires, vehicles, pesticides, communication towers etc., less than one death is caused by a wind turbine.

- Many ornithological organizations have come out in strong support of wind power noting that wind power and other renewable energy sources, such as wind power, help mitigate green house gas emission which poses the most significant long-term threat to birds.

- The ordinary American house cat poses a much greater threat to birds than wind turbines. Housecats are estimated to kill between 100-200 million birds each year in the U.S. compared to 33,000 birds that die from a collision with turbines.

- Improvements in modern turbine design result in more power generation by fewer turbines rotating at lower speeds. These improvements greatly reduce potential risks to birds.

STUDIES

1. **The National Wind Coordinating Committee** completed a report that analyzed all of the avian mortality research conducted to date.

Source:
Avian Collisions with Wind Turbines: A Summary of Existing Studies and Comparisons to Other Sources of Avian Collision Mortality in the United States
http://www.nationalwind.org/publications/wildlife/avian_collisions.pdf

Key Finding

- Wind plant related avian collision fatalities probably represent from 0.01 percent to 0.02 percent of the annual avian collision fatalities in the U.S.
- Data collected indicates an average of 1.83 avian fatalities per turbine for all species and 0.006 raptor fatalities per turbine per year.

2. **The Effects of Wind Turbines on Birds and Bats in Northeast Wisconsin** was carried out by the University of Wisconsin-Green Bay. There two year study involved a 31 turbine wind farm.

Source:
The Effects of Wind Turbines on Birds and Bats in Northeast Wisconsin
http://www.focusonenergy.com/data/common/dmsFiles/W_RI_MKFS_Wind%20turbines%20and%20birds.pdf – summary of the study's findings.

Key Findings

- While bird collisions do occur (with commercial wind turbines) the impacts on global populations appear to be relatively minor, especially in comparison with other human-related causes of mortality
- This is especially true for small scale facilities like the Madison Gas & Electric and Wisconsin Public Service Cooperation wind farms in Kewaunee County. (31 turbines)
- "Previous studies suggest that the frequency of avian collisions with wind turbines is low, and the impact of wind power on bird populations today is negligible. Our study provides little evidence to refute this claim."

3. **Avian Monitoring and Risk Assessment at Tehachapi Pass and San Gorgonio Pass Wind Resource Areas, California:**

Source:
http://www.nationalwind.org/publications/wildlife/avian98/06-Anderson_etal-Tehachapi_San_Gorgonio.pdf

Key Findings

- A 1986 study found that 69 million birds flew though the San Gorgonio Pass during the spring and fall migrations. During both migrating seasons, 38 dead birds were found during that typical year, representing only 0.00006% of the migrating population.

4. Audubon Society Stands Up In Support For Wind Power

John Flicker, President of the National Audubon Society, wrote this column in the November-December 2006 installment of the organization's magazine. The National Audubon Society mission is to conserve and restore natural ecosystems, focusing on birds and other wildlife for the benefit of humanity.

Source:
Wind Power
http://www.audubon.org/campaign/windPowerQA.html

Key Findings

- "When you look at a wind turbine, you can find the bird carcasses and count them. With a coal-fired power plant, you can't count the carcasses, but it's going to kill a lot more birds."
- "As the threats of global warming loom ever larger, alternative energy sources like wind power are essential,"

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PROPERTY VALUES

Misconception - Wind Power will cause property values to decrease.

FACTS

- There is no evidence that the presence of a commercial windfarm within sight of a property systematically decreases that property's value.

STUDIES

1. **The Renewable Energy Policy Project** (REPP) published a study of property values in 2003. REPP evaluated residential property values at 10 wind power projects (10MW and larger) throughout the U.S. built between 1998 and 2001. Property Values in a view shed radius of five miles were compared with property values in nearby communities.

Source:
Renewable Energy Policy Project – "The Effect of Wind Development on Local Property Value"
http://www.efsec.wa.gov/wildhorse/adj/applprefiled/34-gs-t.pdf

Key Findings

- "The Statistical analysis of all property sales in the view shed and the comparable community provides no evidence that wind development has harmed property values within the view shed."
- "For the great majority of projects the property values actually rose more quickly in the view shed than they did in the comparable community. Moreover, values increased faster in the view shed after the projects came online than they did before.
- In the minority of cases where property value decreased, the values decreased slower in the view shed than in the comparable community

2. Public Attitudes to Windfarms: A Survey of Local Residents in Scotland

MORI Scotland was commissioned by the Scottish Executive to undertake a study examining the attitudes of people living close to windfarms in Scotland. It was decided that the research should focus on the larger sites, i.e., those windfarms with nine or more turbines of which there were ten operational in Scotland at the end of 2002.

Source:
Public Attitudes to Windfarms: A Survey of Local Residents in Scotland
http://www.scotland.gov.uk/Publications/2003/08/18049/25580

Key Findings

- Three times the number of residents say that their local windfarm has had a broadly positive impact on the area (20%) than say that it has had a negative impact (7%). Most (73%) feel that it has had neither a positive nor negative impact, or expressed no opinion.
- People who lived in their homes before the site was developed say that, in advance of the windfarm development, they thought that problems might be caused by its impact on the landscape (27%), traffic during construction (19%) and noise during construction (15%). However, only 12% say the landscape has been spoiled, 6% say there were problems with additional traffic, and 4% say there was noise or disturbance from traffic during construction.
- People living closest to the windfarms tend to be most positive about them (44% of those living within 5km say the windfarm has had a positive impact, compared with 16% of those living 10-20km away). They are also most supportive of expansion of the sites (65% of those in the 5km zone support 50% expansion, compared with 53% of those in the 10-20km zone).

3. Fenner Renewable Energy Education Foundation (FREE) released a study examining the impacts on local property values of the Fenner wind farm, NY.

Source:
Impacts of Wind Farm Visibility on Property Values in Madison
http://www.aceny.org/pdfs/misc/Property%20Value%20Study%20One%20Page%20Overview5_24_06.pdf

Key Finding

- The report finds no measurable effects of windmill visibility on property values. This absence of evidence holds even when concentrating on homes within a mile or on those that sold immediately following announcement in 2001

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SAFETY

Misconception - Wind turbines are unsafe. The blades can cause dangerous ice throws or the turbine could collapse.

Wind energy is one of the safest energy technologies, and enjoys an outstanding health & safety record. In over 25 years of operating experience and with more than 85,000 machines installed around the world, no member of the public has ever been harmed during the normal operation of wind turbines. High standards exist for the design and operation of wind energy projects as well as close industry co-operation with the certification and regulatory bodies in those countries where wind energy is deployed. Wind energy is a benign technology with no associated emissions, harmful pollutants or waste products. Part of its popularity can be attributed to its safe and reliable method of operation.

FACTS

General Risks

- The odds of anyone being killed by a wind turbine related accident in the U.S. over his/her lifetime was 1 in 3,777,272. This compares to a 1 in 84 risk of dying in a motor vehicle accident, a 1 in 1,134 risk of drowning, and a 1 in 56,789 risk of dying from a hornet, wasp or bee sting.
  http://www.nsc.org/lrs/statinfo/odds.htm

- To put these perceived risks into perspective, in the over thirty years, and with more than 70,000 turbines now in place world wide (*Please Note: When quote was originally made there were approximately 70,000. Currently there are over 85,000 turbines installed world wide), only 2 members of the public have been killed by wind turbines around the world. One was a pilot committing suicide, the other was a parachuting accident.
  http://www.wind-works.org/articles/breathlife.htlml

Risk of Structural Collapse or Blade Throw

- Utility scale wind turbines are certified to international engineering standards and must meet very strict building codes.

- Blade throws were more common in the industry's early years, but are extremely rare today because better turbine design and engineering

Risk of Ice 'Throw'

- Ice can build up on a wind turbine blade and can be 'thrown off'. However, if ice builds up on a turbine's blades then the turbines production decreases dramatically, slowing down the rotor speed. Usually the turbine's control system will sense the build up and shut the unit down.

- In instances when ice is thrown from a wind turbine, the vast majority of it falls to the ground in a circular area about the base of the wind turbine equal to twice the swept rotor diameter. Typically setbacks used to minimize noise are sufficient to protect against any danger to the public

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TOURISM

Misconception - The presence of wind turbines on the visual landscape negatively impacts tourism

Research from overseas and anecdotal evidence indicates that wind developments do not negatively influence tourism, and may in fact be having a positive effect.

FACTS

- Large turbines have been found more often to be a positive influence on tourism.
- The British Wind Energy Association notes that wind farms in the UK are popular tourist attractions, with thousands of people each year flocking to visit them.
- In Australia, the wind farms are highlighted as one of the attractions for visitors amongst other historical and scenic points of interest.
- A Scottish study found that nine out of ten tourists visiting some of Scotland's top beauty spots say the presence of wind farms makes no difference to the enjoyment of their holiday, and twice as many people would return to an area because of the presence of a wind farm than would stay away.
- Yet another survey of more than 300 visitors to Argyll, Scotland found that 91% of visitors said the presence of wind farms in the area made no difference to whether they would return.

Ontario Experience

Erie Shores Wind Farm – A 66 turbine wind farm using GE 1.5MW machines – Comments below are from Linda D'Hondt-Crandon, Economic Development Coordinator, Norfolk County:

- I frequently talk to residents that have taken a drive to that area of Norfolk just to see the wind turbines, and other that say they are planning to take the drive.
- In addition to the farmers having additional income, the businesses in that remote area of Norfolk County have also seen some benefits.
- Our tourism line was receiving so many phone calls that we prepared a map including driving directions to the shoreline and location of all the turbines located in Norfolk County.

- We included on the map information on restaurants, B & B's, shops etc. in that area. We also printed a supply of these maps and dropped them off to businesses & the tourist information booth in Port Rowan – as they were also being asked how to find them. Information is also on our website.
- There was an increase in traffic in the off season months and winter as well, which made those businesses happy.
- Overall I would say the wind turbines have been very well received and have only had positive impacts on our area.

STUDIES

1. **Tourist Attitudes Toward Windfarms**, MORI summary report, September 2002;

An independent 2002 survey performed by MORI (Market & Opinion Research International) and commissioned by BWEA and the Scottish Renewables Forum provides strong evidence that wind farms do more to benefit than harm tourism. MORI interviewed tourists visiting Argyll and Bute, Scotland, an area chosen because it currently has the greatest concentration of wind farms in Scotland. Furthermore, the area also has a tourism industry reliant on the area's high landscape value.

Source: http://www.bwea.com/pdf/MORI.pdf

Key Findings

- Almost half (48%) of the respondents who came to the area reporting doing so for the scenery (as opposed to 10% who said they came for music festivals, the next most reported reason).
- Forty percent of tourists interviewed were aware of the existence of wind farms in the area and when asked whether this presence had a positive or negative effect
- 43% maintained that it had a positive effect
- 43% felt it made no difference
- Less than one in ten (8%) felt that it had a negative effect
- This means that the majority of tourists who knew about the wind farms came away with a more positive image of the area because of their presence

ADDITIONAL ARTICLES

Danish Wind Industry Association website
http://www.windpower.org/en/faqs.htm#anchor295666

Wind Mountain, Cape Cod Times, May 12, 2002
http://www.capecodonline.com/special/windfarm/windmountain12.htm

Tourism That Blows, Atlantic City Weekly, January 26, 2006
http://www.acweekly.com/view.php?id=3731

Madison County, NY Tourism Website: Attractions – Energy
http://www.madisontourism.com/showmem.php?category=Attractions&subcat=Energy

Nature & Technology in Perfect Harmony – North Cape, Prince Edward Island Tourism
http://www.gov.pe.ca/photos/original/tou_nccd06.pdf

Tourists "Not Aware" of Wind Farms – Ipsos MORI survey for British Wind Energy Assn.
http://www.mori.com/polls/2002/windfarms.shtml

Survey of NEK Visitors Finds Tourism Won't Be Hurt by Windfarm – Renewable Energy Vermont
http://www.revermont.org/press/neksurvey.pdf

Wind Farms and Tourism – Australian Wind Energy Association
http://www.thewind.info/downloads/tourism.pdf

British Wind Energy Association, "Tourist Attitudes toward Wind Farms."
http://www.bwea.com/pdf/mori_briefing.pdf

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INTERNATIONAL EXPERIENCE

Misconception - Countries all around the world are stopping their investment in wind power.

In fact, the complete opposite is true.

World Leaders in Wind Power (2006)

Country	Capacity of Installed Wind Power (MW)	Annual growth in installed capacity	% of Total Power
Germany	20,621	12%	6%
Spain	11,615	15%	8.25%
United States	11,603	27%	0.6%
India	6,270	41%	NA
Denmark	3,136	0.15%	21%

Canada is far behind in regards to the use of wind power with only 1460 Megawatts of wind power installed which accounts for approximately 0.5% of our total power needs.

FACTS

Europe

European Market for Wind Turbines Grows 23% in 2006

- The market for European wind power capacity broke new records in 2006, according to the annual statistics issued by the European Wind Energy Association (EWEA) today. 7,588 MW of wind power capacity, worth some €9 billion, was installed last year in the EU, an increase of 23% compared to 2005.

Germany

- Wind power currently supplies 6% of the country's energy and the German Energy Agency Dena demonstrates that large scale integration of wind energy in the electricity system is technically and economically feasible. Wind energy annual production can triple by 2015, providing 14% of the German net electricity consumption

- Although the rate of development on land in Germany has already started to slow down, mainly due to a shortage of available sites, this is being compensated for by the repowering of older turbines and by a new offshore market in the North and Baltic Seas. A study by the German Environment Ministry (BMU) estimates that offshore wind power could reach a level of 12,000-15,000 MW by 2020.

German Energy Agency Dena - Planning of the Grid Integration of Wind Energy in Germany Onshore and Offshore up to the Year 2020
http://www.wind-energie.de/en/topics/grids/ - Briefing

- Wind energy installations in Germany can expand from almost 17 GW today to 36 GW in 2015, and 48 GW in 2020
- Wind energy annual production can triple from 23.5 TWh in 2003 to 77.2 TWh in 2015, providing 14% of the German net electricity consumption in 2015
- Wind energy requires only minor expansion of the grid
- Wind energy does not require construction of additional 'balancing' power stations
- Wind energy increases only marginally the cost of electricity for the consumers
- Wind energy can help to maintain the system security of supply even with a very significant percentage of the power supply

Denmark

- Danish Energy Authority statistics and DONG Energy (Danish utility and successor in part to ELSAM)
  - Wind power turbines have played a major role in developing the Danish energy system of today now providing 21% of total power
  - Denmark has in the period from 1990 until 2005 managed
    - To stabilize the national energy consumption
    - And at the same time increase the amount of renewable energy production by 250%
  - The [annual] CO2 emissions in 1990 was 61 million tonnes compared to 51 million tonnes in 2005

Spain

- Spain has rapidly increased its wind power capacity since the mid-1990s, encouraged by a national premium tariff and policy based on regional industrial regeneration. In many provinces prospective developers have only been able to access project sites if they first commit to establishing a manufacturing base in the region.
- This has resulted in the relatively poor but windy province of Navarra, for example, achieving major economic development and a contribution from wind power now approaching 60% of its electricity supply. In both the more densely

populated provinces of Castilla La Mancha and Galicia, the level has reached more than 20%.

- Most of the wind turbines deployed in Spain are manufactured domestically. Last year a near record 1,764 MW of wind turbines were commissioned, a 20% increase on 2004, and saving the emission of an additional 19 million tonnes of carbon dioxide. This took the Spanish total to just over 10,000 MW, enough to satisfy 8.25% of the country's electricity demand. The Spanish government's target is to reach more than 20,000 MW by 2010.

Ireland

- Moratorium on wind farm projects has been lifted.
- Ireland set a new record with 250 MW, increasing its total capacity by 50%.

Asia

- Asia has experienced the strongest increase in installed capacity outside of Europe, with an addition of 3,679 MW, taking the continent over 10,600 MW. In 2006, the continent grew by 53% and accounted for 24% of new installations. The strongest market here remains India with over 1,840 MW of new installed capacity, which takes its total figure up to 6,270 MW.

China

- China more than doubled its total installed capacity by installing 1,347 MW of wind energy in 2006, a 70% increase from last year's figure. This brings China up to 2,604 MW of capacity, making it the sixth largest market world wide.
- The Chinese market was boosted by the country's new Renewable Energy Law, which entered into force on 1 January 2006.
    - "Thanks to the Renewable Energy law, the Chinese market has grown substantially in 2006, and this growth is expected to continue and speed up. According to the list of approved projects and those under construction, more than 1,500 MW will be installed in 2007.
- The goal for wind power in China by the end of 2010 is 5,000 MW, which according to our estimations will already be reached well ahead of time," said Li Junfeng of the Chinese Renewable Energy Industry Association (CREIA).

NORTH AMERICA

- 22% of the world's new wind capacity was installed in North America, where the annual market increased by a third in 2005, gaining momentum in both the US and Canada.

U.S.A

- For the second year running, the US wind energy industry installed nearly 2,500 MW, making it the country with the most new wind power.
- "Strong growth figures in the US prove that wind is now a mainstream option for new power generation" said Randy Swisher, President of the American Wind Energy Association (AWEA).
    - "Wind's exponential growth reflects the nation's increasing demand for clean, safe and domestic energy, and continues to attract both private and public sources of capital. New generating capacity worth US$4 billion was installed in 2006, billing wind as one of the largest sources of new power generation in the country – second only to natural gas – for the second year in a row."

Canada

- Canada also had a record year, with the installed capacity more than doubling from 683 MW in 2005 to 1459 MW at the end of 2006.
    - "Wind energy is an emerging Canadian success story and 2006 will be remembered as the year that our country first began to seriously capture its economic and environmental benefits," said Robert Hornung, President of the Canadian Wind Energy Association (CanWEA).
    - "Canada's is on the cusp of a wind energy boom as provincial governments are now targeting to have a minimum of 10,000 MW of installed wind energy capacity in place by 2015."

http://www.ewea.org/fileadmin/ewea_documents/documents/press_releases/2007/070201_Statistics_2006_Press_Release.pdf