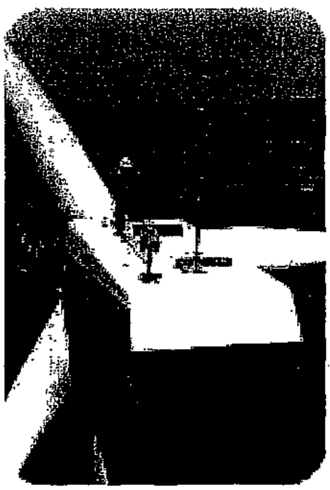
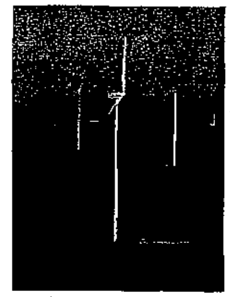


Baileyville Wind Farm Development Issues

Tom Hewson
Energy Ventures Analysis Inc
Arlington Virginia

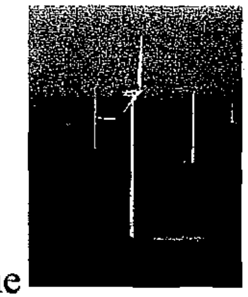
November 30, 2005

Baileyville Wind Farm



- **Large footprint, small power output**
- **Wind- Green but high cost power alternative**
- **Highly Visible**
- **Small contribution to county property taxes**
- **Impact on local property values**
- **No air emissions but may pose other environmental health & safety challenges**
- **Wind generation environmental/economic benefits**

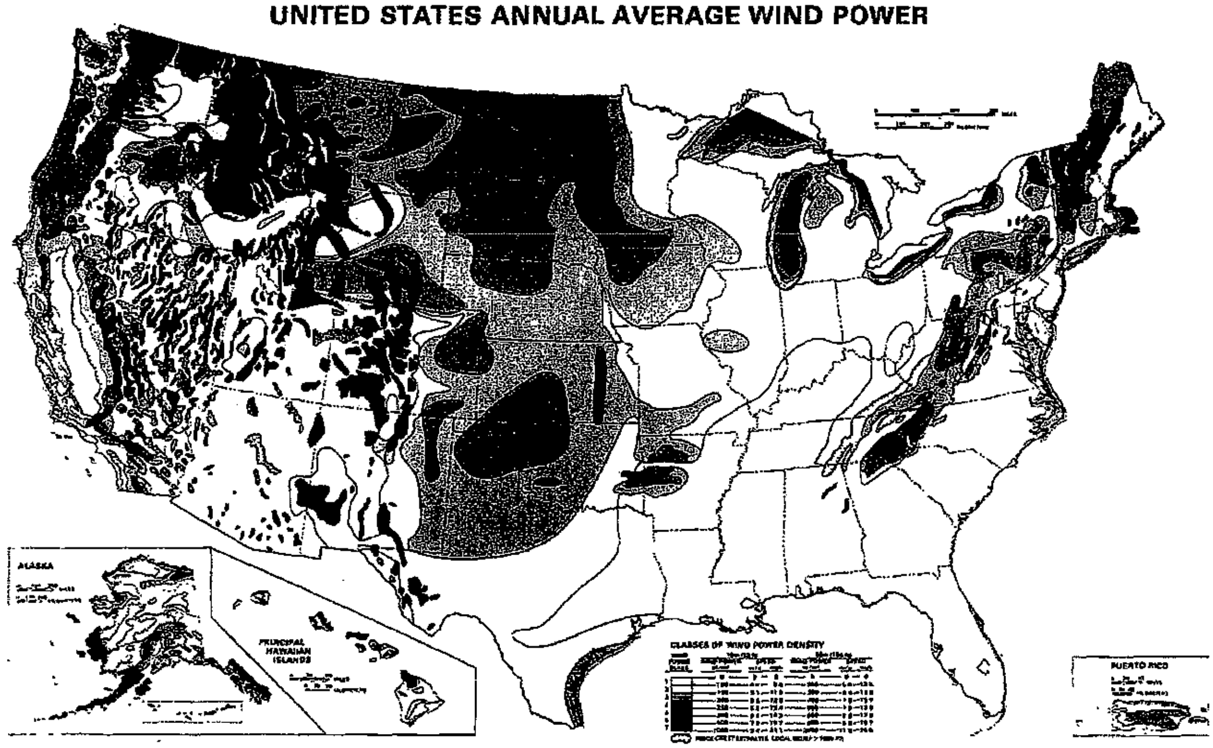
Baileyville Wind Farm



- **Large footprint, small power output**
  - Project covers approximately 5000 acres—125 acres/turbine
  - Rule of thumb had been 40 acres/turbine to avoid wind turbulence interference. AWEA believes 75 acres/turbine required for larger new turbine designs. Would take more than 18 Mendota Hills projects (covering 73 sq-mi) to produce same energy as smallest Illinois coal-fired powerplant in 2005 (Meredosia).
  - Projected 210,000 MWh (30%); far greater than reported 2004 performance from Mendota Hills (17.7%CF)
- **Wind- Green but high cost power alternative**
  - High capital cost ($90 million), low capacity utilization (30% projected), little capacity credit (<=20%)
  - DOE/NREL studies show Ogle County has relatively poor wind resources
  - Heavily dependent upon large ratepayer & taxpayer subsidies to compete against conventional electrical power sources

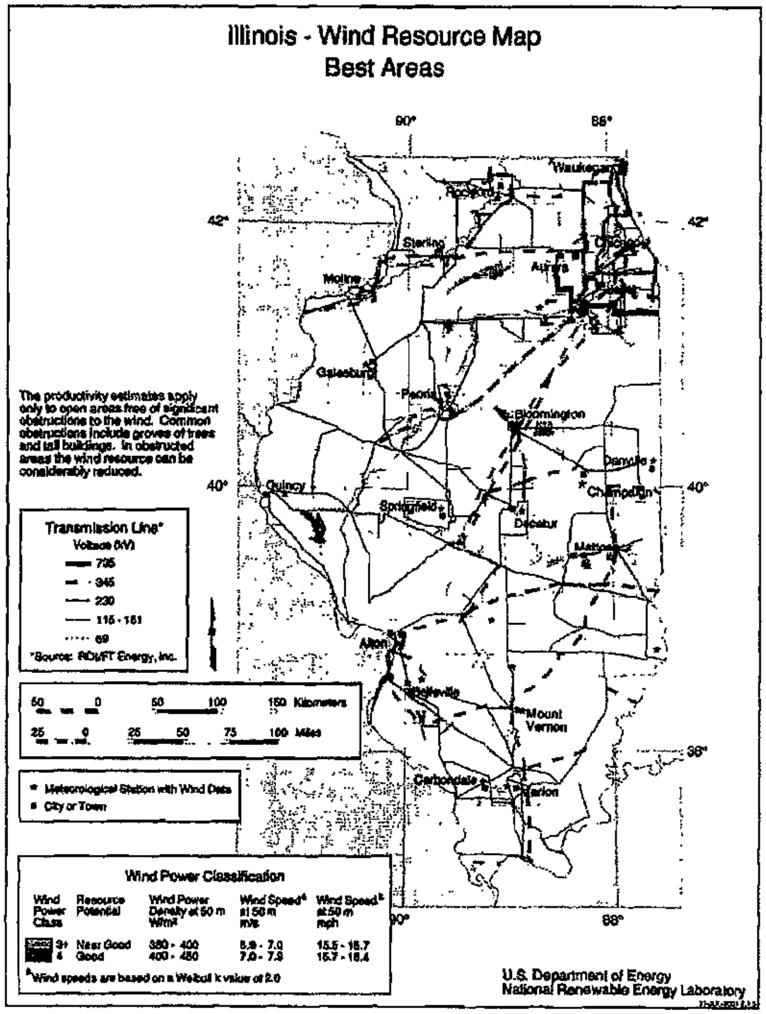
US Wind Resources-

The higher the wind class, the lower the projected production cost
DOE's NEMS Model considers Class 4 or higher winds needed



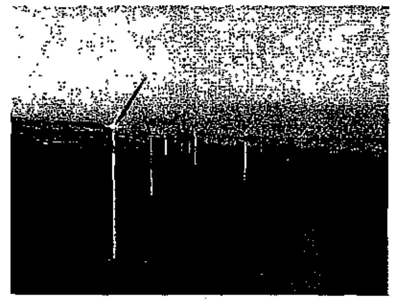
Energy Ventures Analysis Inc Source: *Wind Energy Atlas of the United States* (NREL)

DOE Illinois Wind Map Suggests that Ogle County Has poor wind resources



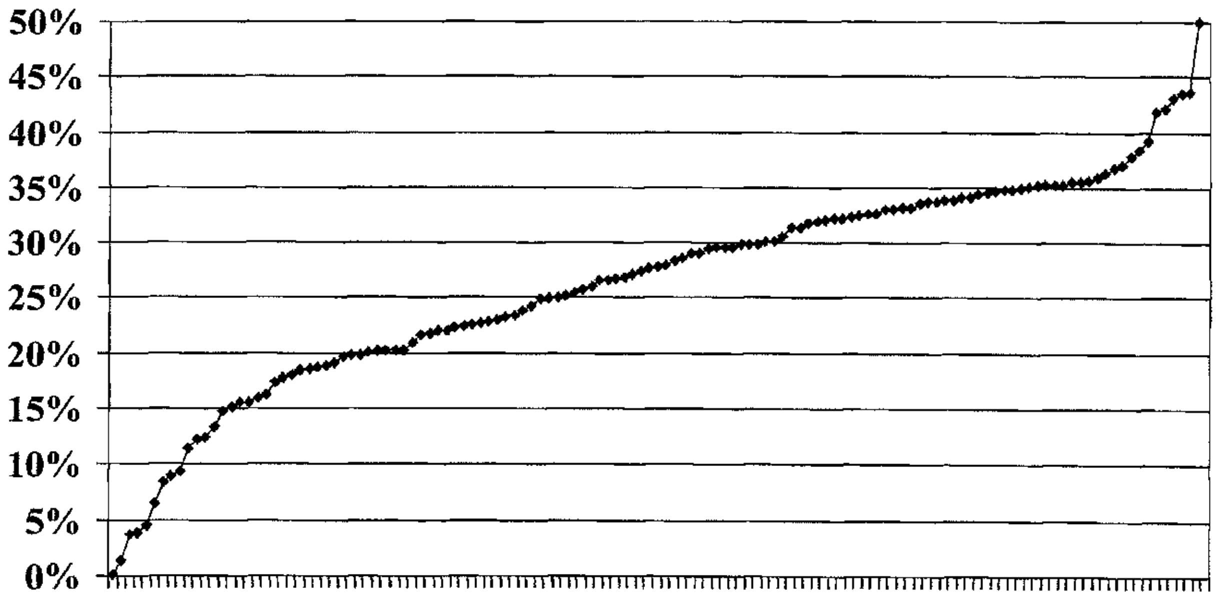
http://www.eere.energy.gov/windandhydro/windpoweringamerica/where_is_wind_ .inois.asp

Wind- A High Cost Alternative



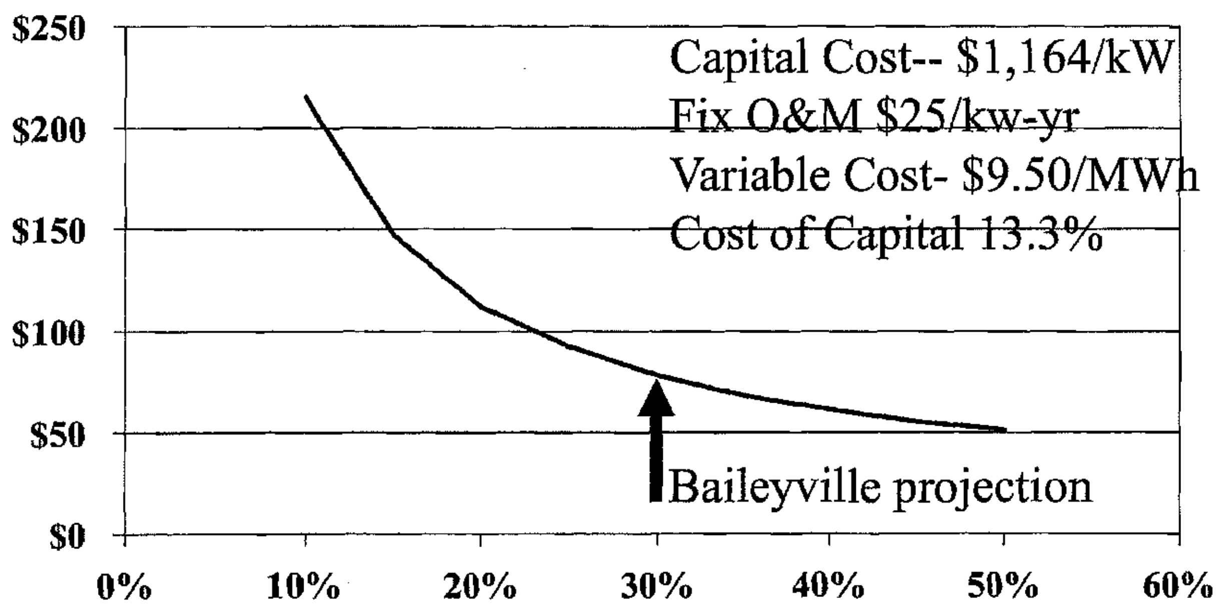
- High Capital Cost-$90 Million
  - $1,164/kW (2004), $1,084/kW (2003), $1,233/kw (2002)
  - Mendota Hills 11/04- $1,111/kW, Baileyville-$1,125/kW
  - Transmission system upgrades are often required
- Poor Capacity Utilization- 30% projected
  - 26.9% in 2003 average for 137 reporting US wind projects
  - 28.0% in 2004 average for 83 reporting projects
  - 17.7% Mendota Hills 2004 reported capacity factor
- Small PJM Generation Capacity Value
  - Initially set at 16 MW but will be changed based upon summer operating experience. May reduce new generation capacity investment by <$10 Million .

US Wind Project Capacity Factor



Energy Ventures Analysis Inc

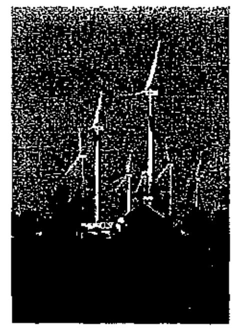
Wind Production Cost Before Incentives

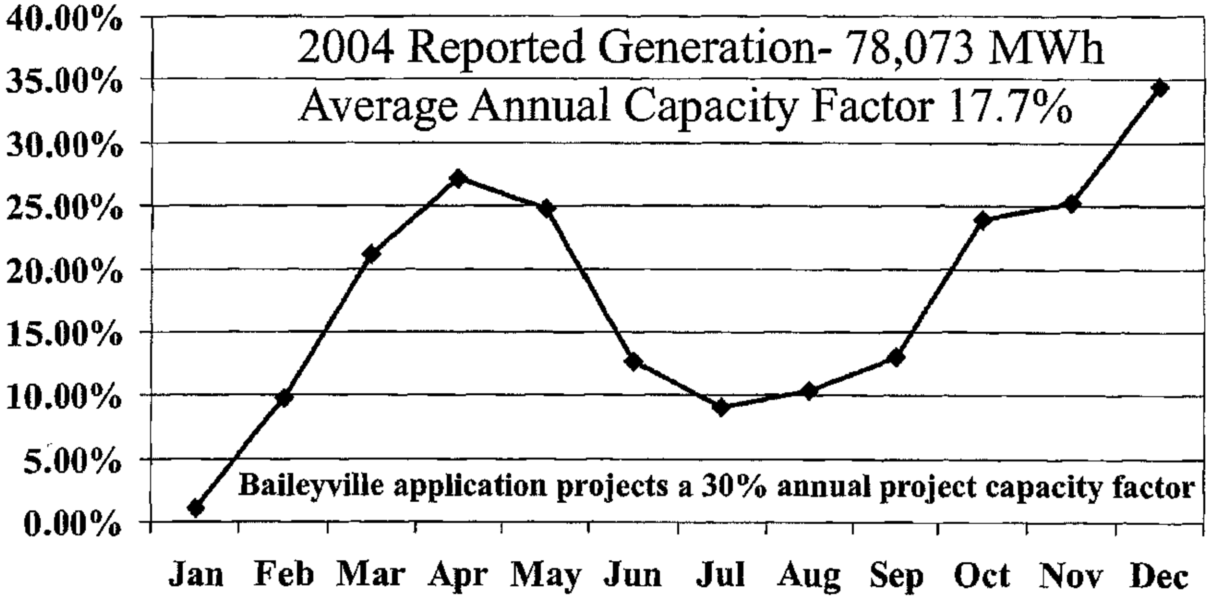


Energy Ventures Analysis Inc

Mendota Hills Wind Project
Performance –2004

Lee County, Illinois

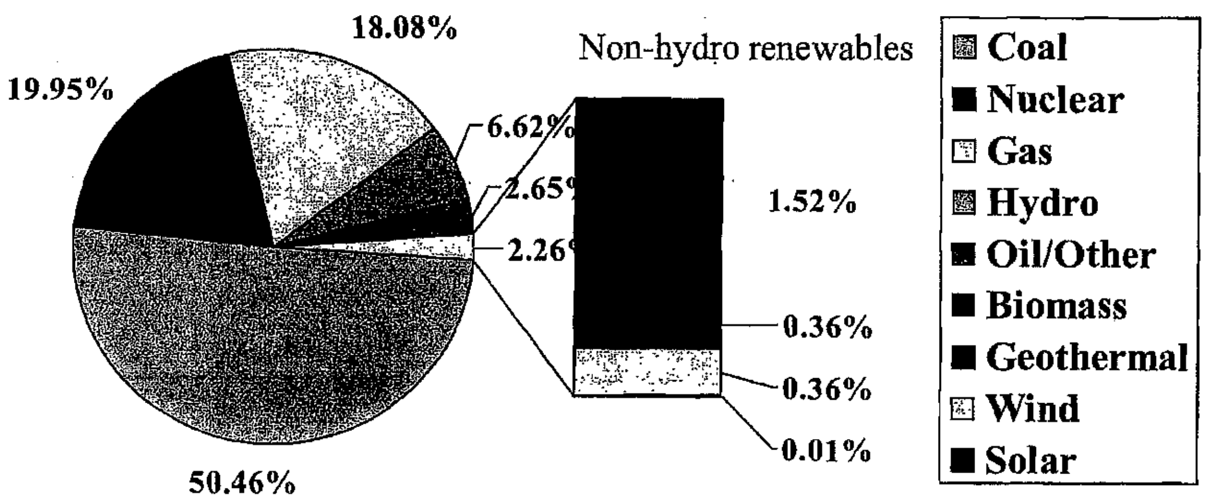




Energy Ventures Analysis Inc

Source: DOE-EIA Form 906 Data reports

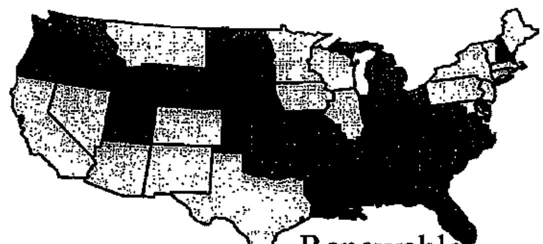
Wind Power
Only 0.36% of 2004 US Generation



Source: _Electric Power Monthly March 2005_ (EIA-DOE)

Energy Ventures Analysis Inc

Renewable Energy Subsidies

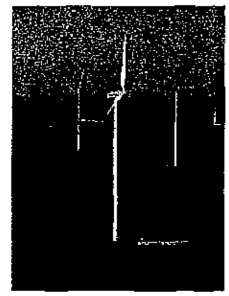


Renewable Portfolio Standard

- Federal Production Tax Credit- $19/MWh for 2005 (10 years-must be online by 12/31/05)
- State renewable portfolio standards-21 states
- Public Benefit Funding subsidies-16 states
- Net metering- 40 States
- State rebate programs
- Property tax breaks
- Green power purchasing programs

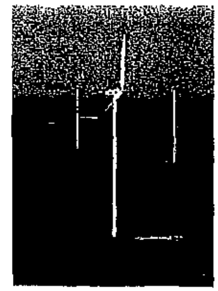
State Public Benefit Funding For Renewable Energy

Baileyville Wind Farm



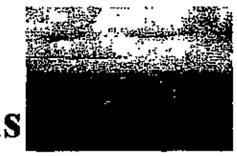
- **Highly Visible**
  - 400 feet high (255 ft high Supporting tower plus 159 ft long blade)
  - Night lights on structures for safety reasons
  - Likely highly visible from large portion of County

Baileyville Wind Farm



- **Small contribution to county property taxes**
  - Energy producing equipment exempt from property taxes, taxable items may be limited to foundation and tower structure
- **Impact on local property values**
  - 7 Studies: Wind farms may have adverse property value impacts
  - 3 Studies: No adverse property value impacts

Effects on Local Property Values– Few studies exist, some methodology problems



Several factors drive local property values– interest rates, local economic activity, supply/demand for area properties, recreational activities, etc. It is difficult to isolate market impact from wind turbines without conducting a large, long term assessment. Does it affect property demand ?

<u>Studies Concluding Wind Turbines Devalue Local Property Values</u>

- 2001-02 Lincoln Township WI study comparing property sales prices to assessed values before and after wind farm construction. Assessor reported that property sales (vs. 2001 assessed values) declined by 26% within 1 mile and by 18 % > 1 mile of its wind farm project. <u>However, study includes related party transactions</u>. Moratorium Committee survey of County residents reported 74% of respondents would not build/buy within ¼ mile, 61% within ½ mile and 59% within 2 miles of wind farm.
- May 2000 County Guardian article <u>*Case Against Windfarms*</u>– Observations of English surveyors concluding wind turbines significantly decrease property values by as much as 30%. Simple survey, no transaction data provided.
- 1996 Danish report <u>*Social Assessment of Wind Power-Visual Effect and Noise from Windmills-Quantifying and Valuation*</u> contained survey of 342 people living close to wind mills. Survey found 13% of people surveyed considered wind mills a nuisance and would be willing to pay 982 DKK per year to have them leave. Survey of house sale prices showed 16,200 DKK lower price near single windmills and 94,000 DKK lower price near wind farms versus similar houses located in other areas.
- Assessed values declined significantly for property adjoining Mackinaw City WTG after it started operation.

Effects on Local Property Values– Few studies exist, some methodology problems

<u>Studies Concluding Wind Turbines Devalue Local Property Values</u>

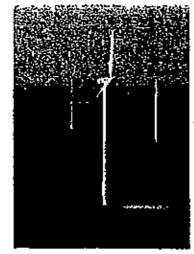
- *<u>Impact of wind farms on the value of residential property and agricultural land: An RICS survey</u>* (November 2004) Khatri, 2004 Survey by Royal Institution of Chartered Surveyors found 60% of respondents thought a windfarm would decrease value of residential properties within its view. Only 28% of the respondents thought a windfarm would decrease the value of surrounding agricultural land while 9% thought there would be a positive agricultural land value impact. Provided no analysis of value change or supporting transaction data.
- *<u>Economic Analysis of a Wind Farm in Nantucket Sound</u>* (May 2004) Haughton, Survey of land owners from 6 towns on Cape Cod. *On average, home owners believe that the windmill project will reduce property values by 4.0%. Households with waterfront property believe that it will lose 10.9% of its value. Applying these survey results, the study estimated the total loss in property values resulting from the construction of an offshore wind farm to be over $1.3 billion, a sum that is substantially larger than the approximately $800 million cost of the wind farm itself.* Provided no supporting transaction data
- *<u>Appraisal Consulting Report- Forward Wind Project- Dodge County WI</u>* (May 2005) Zarem Apprasial report examining paired sales of electric transmission line in Wisconsin concluded that a windfarm would cause an estimated 17-20% lot value loss within viewshed.

Effects on Local Property Values–
Few studies exist, some methodology problems

<u>Studies Concluding Wind Turbines Do Not Devalue Local Property Values</u>

- 2002 Kittitas Valley Washington study by ECONorthwest– Telephone survey of tax assessors views only. Conclude no adverse property impacts. No supporting transaction data provided.
- May 2003 Renewable Energy Policy Report examines property values in areas within 5 miles of surrounding 9 large wind farms. Concludes "presence of commercial scale wind turbines does not appear to harm property values." Did not attempt to look at property values from within 1 mile due to limited data. Could not compare "like" properties. Roughly 70% of data was related party transactions and 72% of the data did not have actual views of the turbines.
- *<u>A Real Estate Study of the Proposed Forward Wind Energy Center Dodge & Fond du Lac Counties WI</u>* (May 2005) Poletti & Associates, Examined property sales records in Kewanee County Wisconsin and Lee County Illinois, had discussions with two town assessors, reviewed the two prior wind property studies above and reviewed property value impact studies of sanitary landfills. Concludes that the "*Forward Wind Energy Center is so located as to minimize the effect on the value of the surrounding property*."

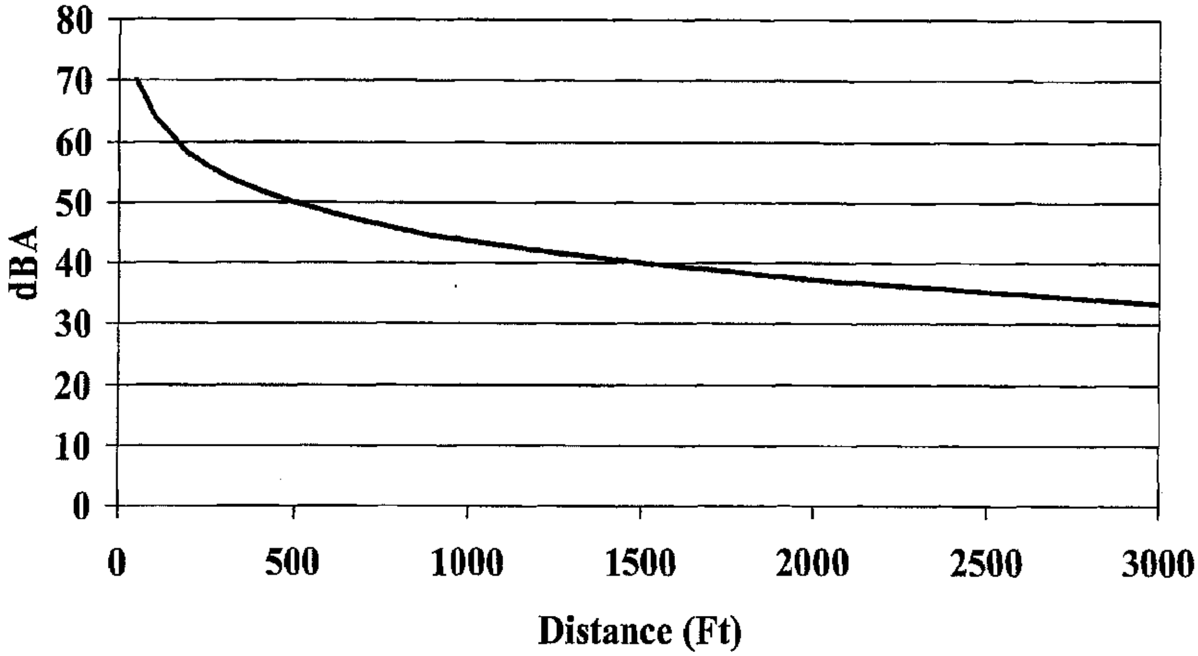
Baileyville Wind Farm



- **No air emissions but may pose other environmental health & safety challenges**
  - Noise: Noticeable noise up to ½ mile depending upon background levels. Projects subject to Illinois Illinois 35.901.102 sets max noise levels at residences. Applicant studies suggest that these levels may be exceeded at 24 non-participating owner residences at modeled wind speed of 18 mph.
  - Source must be at least 750ft away from residential property lines to comply with limits set for each frequency range (assuming no attenuation from trees/terrain,etc..) to meet state limit at 8m/s wind speed. (EVA model of single NM-82 turbine)
  - Must be at least 1,200ft (if located in Class C area) away from residential property lines to comply with limits set for each frequency range (assuming no attenuation from trees/terrain,etc..) to meet state limit at 4m/s wind speed. (EVA model assumptions)

Single Wind Turbine Noise Level

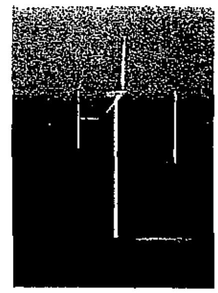
Model: NM-82 WTG



Wind Speed- 8m/s, relative humidity 80%, 50 degrees F, no attenuation from trees, terrain or barriers

Energy Ventures Analysis Inc

Baileyville Wind Farm



- **No air emissions but may pose other environmental health & safety challenges**
  - Shadow Flicker: Strobe like effect caused by shadows of moving blades
  - Wildlife: Has caused bird and bat deaths if poorly located. Concerns raised when endangered species are in area
  - Aviation hazard: May cause radar interference. FAA can deny permits if turbine heights pose airport safety risk. Illinois Agricultural Aviation Association has adopted a resolution not to serve areas inside or immediately adjacent to wind turbine groupings
  - Ice Throw: Turbines can throw ice accumulating on blades. Risk increases with decreasing distance.

Wind Siting Issues- Environmental Health & Safety

- Local ordinances for wind power development needed to protect public health & safety, minimize adverse environmental impacts and achieve land use plan
  - **Setback provisions**
    - **Noise**
    - **Visibility**– Address through limiting allowable sites and setting minimum project setbacks and height restrictions.
    - **Shadow Flicker**– Address though minimum setbacks and/or WTG location
    - **Safety** (blade throw, ice throw, structural failure, ground clearance)– Use Setback & minimum clearance requirements.

Setbacks can reach up to 2500 ft
Boone County– 2,000 feet setback provision
Bureau County– 750 minimum setback from any residence
Lee County– 1,400 feet from residences, 500 feet from roads
Pike County– minimum 3 times turbine+tower height from home
9-10 Rotors recommended

- **Height restrictions**
- **Exclude areas from development**

Wind Siting Issues- Environmental Health & Safety

- Local ordinances for wind power development needed to protect public health & safety, minimize adverse environmental impacts and achieve land use plan
  - **<u>Unsafe & inoperable wind energy facilities</u>**– Require bond to cover cost of removal & site restoration.
  - **<u>Interference with navigational systems</u>**– Location away from airport flight paths & locking mechanisms to limit airport radar interference
  - **<u>Non-compliance penalties</u>**– Must remove facility if out-of-compliance

Claimed Project Benefits

- **No air emissions**
  - SO2/NOx emissions maybe displaced **but are not avoided**. Displaced generation can sell/transfer their emission credit to other stations/units.
  - Since wind projects will be competing against other renewable projects for the "set-aside" market, the **wind project may not avoid any CO2 emissions**.

- **Reduced dependence on fossil fuel**
  - Wind projects displace no fossil fuels in the renewable set-aside market
  - Since wind power has no capacity value, power companies must still build new fossil fuel capacity to meet increase power demand

- **Lease payments to local property owners ($1,000-5,000/turbine/year)**

  Property owners often lose ability to develop their property during lease period (up to 30 years). In some cases, WTGs have devalued local surrounding property values.

- **Jobs**
  - Some temporary construction jobs created to erect wind turbines (0.7-2.6 jobs per turbine depending upon construction period). Estimated to be 50 construction jobs.
  - Few maintenance jobs (usually <10 for large wind farms). Estimated to create 6 jobs.

  Some economic activity and jobs may be lost if higher power costs imposed onto local ratepayers through renewable portfolio standards.

The Telegraph

Homeowners living near windfarms see property values plummet

Estate agents have said no one is likely to buy the Jones's house, which was worth £170,000 before the wind farm was built

By Nigel Bunyan and Martin Beckford
12:01AM BST 26 Jul 2008

Thousands of homeowners may see the value of their properties plummet after a court ruled that living near a wind farm decreases house prices.

When the wind stops - the other side of the wind turbine argument (http://www.telegraph.co.uk/earth/main.jhtml?xml=/earth/2008/07/23/nosplit/eawind123.xml)

Refusal for wind turbine on iconic landscape (http://www.telegraph.co.uk/earth/main.jhtml?xml=/earth/2008/05/26/eawind126.xml)

Wind turbines 'are ruining our quality of life' (http://www.telegraph.co.uk/news/uknews/1548746/Wind-turbines-%27are-ruining-our-quality-of-life%27.html)

In a landmark case, Jane Davis was told she will get a discount on her council tax because her £170,000 home had been rendered worthless by a turbine 1,000 yards away.

The ruling is effectively an official admission that wind farms, which are accused of spoiling countryside views and producing a deafening roar, have a negative effect on house prices.

It means many other families living in the shadow of the giant turbines could see thousands wiped off the value of their homes, as the Government pushes ahead with plans to build 7,000 more wind farms over the next decade to meet ambitious green targets.

Campaigners also fear ministers want to remove the legal right to complain about noise nuisance, condemning those who live near wind farms to years of blight and reducing the opportunity for them to resist expansion plans.

Wind farm battle to go to High Court (http://www.telegraph.co.uk/earth/earthnews/6195145/Wind-farm-battle-to-go-to-High-Court.html)

Mrs Davis, who launched a nationwide campaign after her own home was rendered worthless by the deafening roar of a wind farm, claims ministers are tabling an amended to the Planning Act which will remove eight crucial words that previously offered at least some protection to householders.

"For people living near wind farms, both now and in the future, it will be a disaster," she said.

"There are many, many people living in Middle England who have worked hard all their lives and yet will see the values of their homes suddenly diminish.

"This isn't about Nimbyism, but the rights of ordinary people to live a normal life."

Mrs Davis, 52, a retired nurse, lives 1,017 (930m) from a wind farm at Deeping St Nicholas, Lincolnshire. Her husband, Julian, 43, originally bought the property from the county council and the couple had planned to extend it.

But the noise generated by the turbines is so severe, particularly when certain winds make all the blades rotate in unison, that it left the Davises unable to sleep. They currently live in a rented house a few miles away.

"It's just like the effect you get in a car when the sun roof is open or a window at the back is open. In a car you can do something about it. But if it's in your house and is coming from a giant turbine a few yards away, you can do nothing," said Mrs Davis.

Local estate agents have acknowledged that the house, worth £170,000 before the wind farm was built in 2006, is now so severely blighted that no one is likely buy it.

Earlier this week the Davises won a landmark victory that reduced their council tax banding.

Although financially the difference is minimal, the reduction was granted on the basis that their home had been blighted by noise "on the balance of probability".

Furthermore, the couple secured the ruling in the absence of a statutory noise nuisance - a fact that brought dismay to wind farm operators.

But Mrs Davis now fears the imminent change in legislation will turn the advantage back to the wind farm lobby, which is planning to build 4,000 turbines across the countryside - double the current number - and increase the number of those offshore from 150 to 3,000 by 2020.

LOCAL

1 comment(s) | E-mail | Print | Text Size | Bookmark

Saturday, December 4, 2010 8:10 AM EST

Canaan denies local permit for BNE Energy wind turbine

CANAAN -- The Planning and Zoning Commission recently denied two applications from BNE Energy Inc. of West Hartford to erect a wind turbine on the property of Lone Oak Campsites in East Canaan. Chairman Steve Allyn said the decision was made because there is nothing in the regulations dealing with turbines. He said two applications, one a regular one and the other for a special permit, were submitted. The commission took the action after consultations with the zoning enforcement officer, its attorney and a land-use consultant, said Allyn.

BNE Energy has proposed two larger projects in the area, wind turbines in Colebrook and in Prospect, which because of their size will require Connecticut Siting Council approval.

More Stories About: Canaan, BNE Energy, Wind turbines, Wind power, Alternative Energy, Green power

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karen reich wrote on Dec 4, 2010 4:47 PM:

" fyi "

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Please be civil and respectful.
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Registered users comments will be posted automatically.
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- State to repave sections of Route 6, Route 64 (9)
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- Synthetic marijuana taken off store shelves (8)
- Waterbury mayor presents gloomy financial future for city (8)
- Survivor of Brutal Cheshire Home Invasion to Appear on Oprah (8)

Conn. residents see Falmouth wind power up close

Associated Press | Monday, December 6, 2010 | http://www.bostonherald.com | Northeast

HARTFORD, Conn. — Residents of Prospect concerned about a proposal to build wind power turbines in their small Connecticut town have gotten a close-up look at a wind project in neighboring Massachusetts to see what they might be up against.

Mayor Robert Chatfield hired a bus and took nearly three dozen residents to Cape Cod on a recent weekend to look at a wind turbine on Falmouth property and to talk to neighbors.

"When I first heard of it, I thought it was the best thing since sliced bread," the mayor said. "Now I've kind of backed off a little bit."

Chatfield said most of those who took the bus trip were opposed to the proposal. He said the project has been the most contentious issue in town since the late 1990s when plans to build a regional high school drew opposition.

BNE Energy Inc. of West Hartford wants to build two 1.6-megawatt wind turbines. The company did not immediately return a call Monday.

On its application to the Connecticut Siting Council, BNE Energy said its "Wind Prospect" project will not result in air emissions, will have minimal impacts on state water quality standards and will advance Connecticut's energy policy by developing renewable energy resources.

Chatfield said the project would bring the town $150,000 a year in taxes, a small contribution to Prospect's budget of $7 million and millions more in school spending.

Jerry Potamis, wastewater superintendent at Falmouth, greeted the Prospect visitors on his day off.

said one turbine has been operating since March at the town's wastewater plant and another is planned. The turbine far has generated revenue of $164,000 and is expected to bring in additional $99,000 in less than a year, he said.

"It's definitely a cash cow," Potamis said.

During the planning stages, no one opposed the project, he said. But that has changed because of noise produced by the turbine.

"There's a growing number of people that don't like it visually or say they don't like the whooshing noise," Potamis said.

Prospect neighbors of the proposed project cite, among other complaints, noise and flickering sunlight produced by the turbines.

Resident Tim Reilly, who visited Falmouth, said the proposed turbines would be 1,800 feet from his house. Speaking to Falmouth residents unhappy with the wind turbine gave him new insight, he said.

"It was eye-opening to hear the personal accounts," he said.

Reilly, a high school marketing teacher, and other residents say the project is potentially dangerous to public safety, health, quality of life, wildlife and real estate values.

"These things should not be in anyone's back yards," he said. "These things should be on a mountain range, on a bay somewhere."

Other pressures working against the project include Connecticut's energy goals. The state set goals 10 years ago to increase renewable energy in its portfolio of power sources, but an annual plan submitted to state regulators earlier this year sought significant increases in megawatts generated by sources other than wind — landfill gas, hydro power, biomass, fuel cells and solar energy.

addition, Falmouth may have better prospects generating wind power than Connecticut. The Cape has a superior location near the Atlantic Ocean, while Connecticut does not have access to the stiff winds generated by the ocean and has no mountains to produce so-called wind corridors.

Linda Roberts, executive director of the Connecticut Siting Council, said the agency has 60 days from the Nov. 17 filing of the proposal to take action on it.

Article URL: http://www.bostonherald.com/news/national/northeast/view.bg?articleid=1301254

USA TODAY

ne of the nation's first nuisance lawsuits against a .ind farm ended with rulings in 2006 in favor of the company that developed it after landowners near the Abilene, Texas, project objected to turbine noise.

Objections to wind farms continue to be raised:

• Pierpont's website, www.windturbinesyndrome.com, includes reports of illness from Union, Ore.; Mars Hill, Maine; Saginaw, Texas; King City, Mo.; and elsewhere.

Wendy Todd, who lives 2,500 feet from a turbine in Mars Hill, says she suffers sleep deprivation, and her neighbors have headaches and dizziness. "You just can't get used to it," she says of the noise.

• British physician Amanda Harry said in a 2007 study that people living near turbines can experience anxiety, depression, vertigo and tinnitus.

• Mariana Alves-Pereira, a Portuguese acoustical engineer, said in a 2007 study that turbines can cause vibroacoustic disease, which can lead to strokes and epilepsy.

A 2008 study funded by the European Union, however, found that the sound annoys many people, it it doesn't affect health "except for the .terruption of sleep."

Some of Meyer's neighbors don't understand the fuss. People who say the noise makes them ill are exaggerating, says Rudy Jaeger, 67, who has a turbine on his farm. "It's no worse than traffic driving by." Francis Ferguson, chairman of the Byron Town Board, which voted to approve the project here, has heard talk that the sound makes people sick, but says, "I haven't seen any documentation."

The American Wind Energy Association would like to see "a credible, third-party" scientific study, Jodziewicz says. Setbacks are settled between developers and communities, and there's no industry standard, she says.

Susan Dennison, spokeswoman for Invenergy, the Chicago company that built the 86-turbine wind farm here, says it hasn't received any complaints about health problems in the area.

The turbines here, which are 389 feet tall including blades, must be 440 feet from property lines and at least 1,000 feet from homes, she says.

Concerns over home values

Eric Rosenbloom of National Wind Watch, an information clearinghouse, says noise and health concerns are the top issues in communities considering them. The group recommends 1-mile setbacks from homes.

Rick James, an acoustical engineer from Okemos, Mich., suggests keeping turbines 1¼ miles from homes.

That makes sense to Larry Wunch, a firefighter who lives a few miles from the Meyers. Turbines encircle his property, and when the wind tops 15 mph, he says, they "just scream." The closest is 1,100 feet from his house.

Wunch says he and his wife, Sharon, "have lost sleep and are irritated." He worries his home's value has declined and says the wind farm has created tension between opponents and those who have them on their property in exchange for annual payments that Dennison says are about $5,000 a year. "It's really turned our township upside down," Wunch says.

"If it's affecting your health," Meyer says, "it's hard to ignore."

WICKED LOCAL NEWBURYPORT
WITH NEWS FROM THE NEWBURYPORT CURRENT

A 292-foot mistake

By Staff reports
GateHouse News Service
Posted Feb 27, 2009 @ 07:39 AM

Newburyport -- There's no doubt that Mark Richey had nothing but good and green intentions when he erected an industrial wind turbine to generate electricity for his wood-working factory in the city's industrial park. And there's no question that city leaders who ushered in that project - first with a wind turbine ordinance and then with a Zoning Board of Appeals special permit - believed they were putting Newburyport in the lead of local communities that support alternative and renewable forms of energy.

But now that it's up and running, it seems clear that both Richey and the city failed to fully investigate the potential impact of the 292-foot-high turbine on the Back Bay neighborhood. And it's the residents of that neighborhood who are going to pay for that mistake.

This week, more than a dozen homeowners turned out for the City Council meeting to explain what it's like to live next door to the huge, high-tech windmill that is so dramatically out of scale with everything surrounding it. Some described an incessant hum from the generator; others talked about a continual whooshing sound created as the blades cut through the air. In the afternoons, residents say their homes are hit with a shadow and light flicker; in the evenings, some catch a red strobe-light effect in their windows. Some say they have trouble sleeping and one resident reported that the turbine interrupts his television reception.

Residents raised those exact concerns months ago before the turbine was built, but their worries were dismissed by a stack of reports and experts who said those problems, if they existed at all, would be so insignificant, that no one would notice.

And what's troubling about all the experts and turbine proponents being so far off the mark on these issues is the fact that most were equally dismissive about concerns the neighbors have raised about safety. Over the past several years, as more and more industrial wind turbines have been erected, there have been an increasing number of failures that include blade throws, oil leaks, fires and, in some cases, a complete collapse of the towers.

In light of all of that, the City Council unanimously agreed this week to send the city's wind turbine ordinance back to its Planning and Development Subcommittee for review. It is the very least the city can do. The next step may be to answer the concerns of homeowners who have an eye-level view of the head of the turbine from their windows and back porches. Most would probably agree that those homes have lost some of their market value, and the city should re-assess those properties and adjust their taxes accordingly.

And one other thing about those homeowners - throughout the wind turbine debate, residents of the Back Bay neighborhood have been accused of being a NIMBY crowd that supports green initiatives except when it comes to their backyard. Although the residents who spoke at the council meeting were upset with what's happened to their neighborhood and angry with the city for failing to listen to them and protect their homes, they were not there this week for their backyards. Just about everyone who spoke this week was resigned to the fact that the wind turbine is a reality that isn't going to go away. Back Bay residents are speaking out now to make sure that no other neighborhood in the city is forced to live with the problems and worries of a wind turbine in their back yard.

They understand and agree that wind power is part of the solution to the country's challenge to find alternative sources of energy. What they want in Newburyport is an ordinance that protects the entire community with adequate setback and site requirements that take into consideration the health and safety of residents, no matter what part of the city they live in.

And there's nothing NIMBY about that.

Department of Veterans Affairs
Medical Center
830 Chalkstone Avenue
Providence, Rhode Island 02908-4799

July 2, 2010

To Whom It May Concern,

This letter is in support of Mr. Barry Funfar's complaint regarding noise generated from the windmill installed near his home. Mr. Funfar is currently receiving treatment for posttraumatic stress disorder (PTSD) at the VA Medical Center in Providence, RI related to his military service. PTSD is an anxiety disorder characterized by symptoms including sensitivity to loud or unexpected noises, watchfulness, irritability, sleep disturbance, and nightmares. These symptoms cause significant distress to the individual and impair functioning in a number of domains. Mr. Funfar has been making great progress in treatment in recent years. However, his symptoms have worsened significantly since the installation of the windmill. He is experiencing great difficulty with anxiety, irritability, concentration, and sleep disturbance. These symptoms are causing him significant distress and impairment in his daily functioning. His backyard, previously his "sanctuary" where he spent many peaceful hours gardening, is now a place of stress and conflict. Please consider the mental and physical health of the individuals who are affected by this windmill, particularly those, like Mr. Funfar, who have already sacrificed so much for our country. Should you require further information you may contact me at (401) 273-7100 x 6169.

Sincerely.

Christy Capone

Christy Capone, PhD
Clinical Psychologist

BFLNUSA@yahoo.com

508 294-2375

Wed, November 17, 2010 11:18:48 AM
SUICIDE PREVENTION
From:
barry funfar <bfunusa@yahoo.com>
Add to Contacts
To:Selectman <selectmen@falmouthmass.us>

Nov 17, 2010
DEAR BOARD OF SELECTMEN,
I am someone who has been on both sides of the mental health fence. I lived 35 years with undiagnosed chronic ptsd
(post traumatic stress disorder from 19 months combat in VN), followed by seven years of intensive twice/week
therapy. By 2008 I was doing very very well to where I felt I possessed a new life with grandkids, a secure retirement,
a great place to live, my garden, I volunteered for Habitat for Humanity, and my wife and I were in travel mode. Then along
came Falmouth's wind turbine #1. Within one month I was in a deep depression, I started drinking once again, my
primary doctor at the VA, Dr. Carol Ryan told me that I "must move away from the wind turbine, that with my ptsd I
cannot stand the added stress". My main counselor wrote a letter for me. It is enclosed. It all comes down to me not being
able to stand the sounds from the turbine. It absolutely drives me crazy. When it is not running there is the fear of when it
will start up again. I left my home for the month of August to come out of that depression. Now I totally avoid going outside
on my own property.
Every article I see in the Enterprise about suicide makes me think, wonder, if any of you really know how at the same time
you are trying to prevent something, you are also contributing to it. I am not the only one who has had suicidal thoughts
over Falmouth's turbine. It is best here if I do not mention the other person that I know of, but if you really wanted to know
I am sure her husband would give you a call.
There actually are studies that show the suicidal inclinations of a percentage of persons living too near industrial wind turbines.
Just my three cents worth, because to some of us it really is that bad.
Sincerely,
Barry Funfar
BARRY FUNFAR
27 Ridgeview Drive
508 294-2375

Dec 7, 2010

Dear Kay and Richard Turgeon,

My name is Barry Funfar. I live 1662 feet from Falmouth's wind turbine # I, a 1.65MWatt Vestas 397 foot tall model V-82 which went into operation in April of this year. Never did I expect I would be spending my retirement time and savings fighting my own town for my God given rights as a citizen of this country and this town. Falmouth's irresponsible siting of this wind turbine has caused me a great loss of quality of life, loss of my rights to use and enjoy my own property, a significant decline in the value of my property, and certain detriments to my health and well being. My primary doctor has told me that I must move away from my home of 30 years, that I cannot endure the stress and anxiety heaped upon me by noise from the wind turbine. A letter from one of my medical providers is enclosed.

I notice that your setback distance is ~1250 feet from your house. So what, even if you could insulate your house to keep out the noise. I can no longer stand to garden in my yard where I had found sanctuary for thirty years. The noise from the turbine drives me crazy. It is not so much the loudness as the character and quality of the noise. It gets in my head and becomes ingrained. The sound can go on for days, be intermittent, or be absent for periods of time. When it is not there one's concentration is still broken because there is the fear of when the noise will start again. Seeing the machine stick up to the sky is a constant reminder that it rules. Believe me when I say that life near a wind turbine results in TURBINE TORTURE. I am also enclosing a recent letter I sent to my Selectmen (Falmouth's) regarding suicide--YES IT IS THAT BAD. Do not let anyone tell you that I know not what I am talking about. Attempting to live at 1662 feet from this thing has had me learning everything I possibly can about them. I have attended every public seminar having to do with wind turbines offered on or near Cape Cod. I attended the "First International Symposium on the Effects of Industrial Wind Turbines" recently held in Ont., Canada. I read all I can find on the subject, books and Internet.
These industrial power plants do not belong within 1.25 miles of anyone's home. That makes it so simple. Last night I picked up some friends at Logan who were returning from two weeks in Germany where they had in fact moved from about 35 years ago. They said that yes, there are wind turbines all over the place, but they are NOT located near peoples homes. Why are we trying to squeeze them in where they do not belong in this country.

My neighbors: John Ford at over 3200 feet testified at the Cape Cod Commission hearing that he is highly bothered by the noise even at that distance. Neil and Betsy Andersen at 1320 feet have their house windows and garage door shaking. They have had to move their master bedroom into the basement. Brian Elder, Colin Murphy, Anne Hart Cool, Jill Worthington, and others. These are real people who have legitimate complaints about health and sleep deprivation issues caused by Falmouth's wind turbine. YES IT REALLY IS THAT BAD. DO NOT MAKE THE MISTAKE THAT FALMOUTH MADE. There is only one solution and that is to properly site wind turbines with sufficient setback. At 1.25 miles there may still be some noise under some certain conditions, but it will be minimal and tolerable for all except that very rare extremely sensitive person.

Sincerely,

Barry Funfar

BARRY FUNFAR
27 RIDGEVIEW DRIVE
FALMOUTH, MA 02540
BFUNUSA@yahoo.com
508 294-2375

Photo: Polizeiinspektion Stade

An Ill Wind Blowing?

Utility company executives supposedly stall wind-farm development because they're in cahoots with Big Coal and uranium suppliers, but are the accusations accurate?

by Ed Hiserodt

According to the 2009 Energy Information Agency Report on Electricity Generation, wind power provided 70.8 billion kilowatt hours (KWh) out of the U.S. total of 3,953 billion KWh. Why, it must be asked, does wind power equal only 1.79 percent of the generated power when over the past 30 years seemingly every political speech has contained the phrase "wind, solar, or other renewables" as the solution to our energy problems? Then, too, while wind power has been pushed by politicians and environmentalists, new construction of coal-fired plants has been opposed to the extent that net energy production from coal in 2009 was below that of 1996, and no new nuclear plants have been allowed to proceed from the drawing board since the 1979 accident at Three Mile

Island, indicating that an energy void was waiting to be filled by some power source. Cleaner burning but more expensive natural gas has made up the difference, not wind and solar energy.

As we all know, fuel for wind turbine generators is free, so why don't the tight-fisted executives at electrical generating companies insist that the percentage of wind power be brought up to at least 10 percent, if not 20 or 30 percent? One contention is that utility executives are in bed with fuel suppliers and reject wind energy out-of-hand. However, before saddling the operators of generating companies with that condemnation, let us take a look at wind energy from their perspective.

Wind Energy in the Business Plan

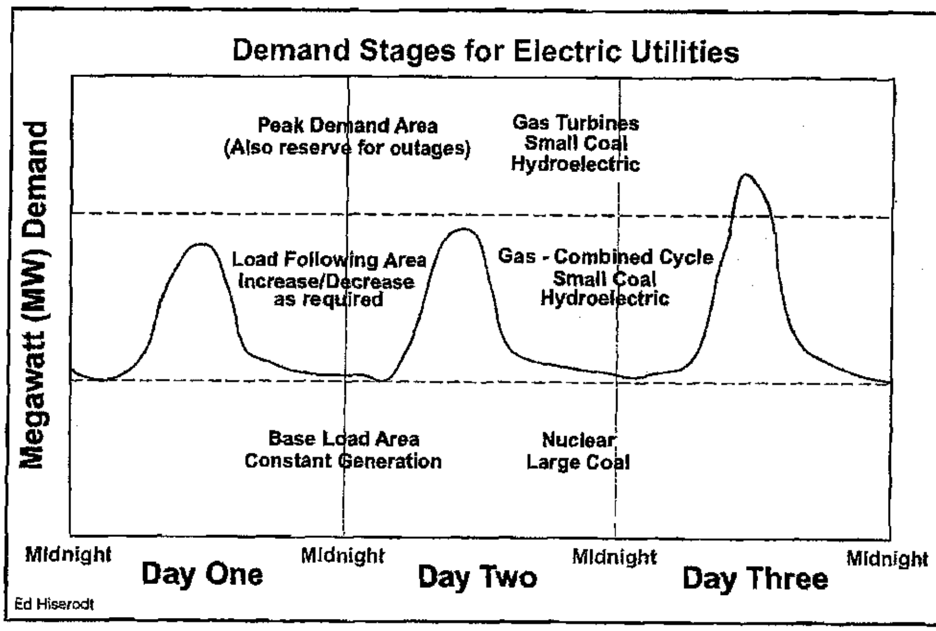
To see wind energy through the eyes of electricity producers, it is important to know one basic fact about electricity generation, whether it be the generator in your car or the output of Palo Verde nuclear complex: Electricity must be used at the instant of generation. When you turn on a light switch, somewhere on the electrical network a generator is loaded and slows down. At generating plants, an automatic device senses the added load and increases the temperature of the steam in the boiler to bring the frequency back to its set point. When you turn off a light, the temperature is automatically reduced, and the frequency returns to the desired value. This is known as negative feedback and is like "cruise control" on your car.

Electric utilities have a variety of generators on a network. The workhorses are large coal-fired and nuclear plants that are designed to run at peak load constantly. Some nuclear plants have run at full power for over a year — the record for continuous power production is 512 days, held by Watts Bar 1 in Tennessee. These plants are used for *base load*, i.e., the load on the system that is there day and night, caused by homes' hot water heaters, heating and cooling systems, street lights, hospitals, 24-hour industries, water and sewage systems, airports, etc. It would make no sense to use wind power for these loads for a number of reasons, but primarily because wind power is not *dispatchable* upon demand.

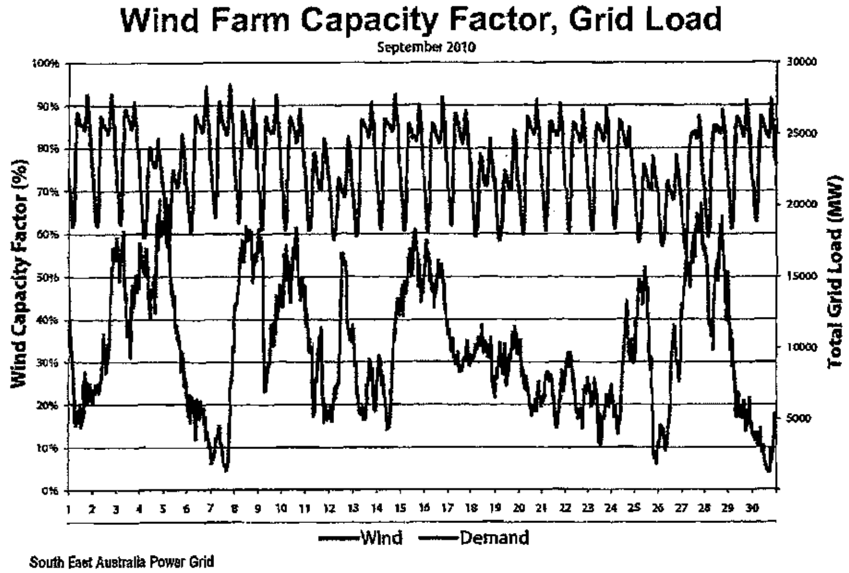
Power suppliers must contend with fluctuating power demands, both daily and seasonal changes. At 5:30 a.m. alarm clocks start ringing, coffee pots start up, along with hot water heaters for showers. Restaurants fire up toasters, and factories come up to speed for a day of production. Grid operators expect this to happen and, based on hour of day, time of year, and day of week, bring on additional generating assets, such as small coal plants, combined-cycle gas, and — if lucky enough to have them — hydroelectric or pumped-storage generation. This is known as the *diurnal cycle*, and the generators called on to meet the varying demand are known as *demand followers*. Can wind power be scheduled by operators to follow the daily variations in demand? Hardly. Not only must operators respond to a variable demand from customers but, in the case of wind power, must do so with a variable supply, thus bringing a new unknown into the equation.

Can wind power be scheduled by operators to follow the daily variations in demand? Hardly. Not only must operators respond to a variable demand from customers but, in the case of wind power, must do so with a variable supply, thus bringing a new unknown into the equation.

Fortunately for grid operators (and those of us that expect power when we turn on the light switch), power supplied to the grid can usually be closely modulated by the various dependable sources, but not always. For the grid operator, terror strikes when one of his generating plants suddenly goes offline or when, on a particularly hot July afternoon, the system demand is obviously headed past maximum generation capacity. In these cases of *peak loads*, when demand exceeds the available supply of electricity, a whole lot of unhappy things happen. Frequency and voltage drop, while currents in power lines increase, requiring automatic or manual interruption of loads — blackouts — to protect the grid. To deal with this, "spinning reserves," power plants that have spinning generators but are not loaded, are brought instantly online. Gas turbines — essentially jet plane engines connected to a generator — are also able to add generating capacity in a very short time.



Ed Hiserodt



Old unreliable: The red graph line represents the megawatts of load (demand) on the South East Australia Power Grid, read on the right-hand scale only. The blue line represents the percent of total capacity of several hundred wind turbines over an area of 40,000 square miles, read on the left-hand scale only. (Note: this is two separate graphs commingled.) The total capacity of the wind farms is only 1,918 megawatts, a small fraction of demand.

Where's wind power? Is it even available? Maybe, maybe not. Because the operator cannot reliably call it up when needed, it is certainly not useful for peak loads.

If wind power does not meet requirements for base loads, is not *dispatchable* for load following, and cannot be called up to answer spikes in peak loading, where does wind power fit into the business plan? Assuming the preceding analysis is correct (and it is), wind has no place in energy production from an operational standpoint. As Jon Boone (www.stopillwind.org) so tersely puts it: "In terms of reliable, secure, affordable electricity, *wind performs best when it produces nothing*."

It's Always Blowing Somewhere

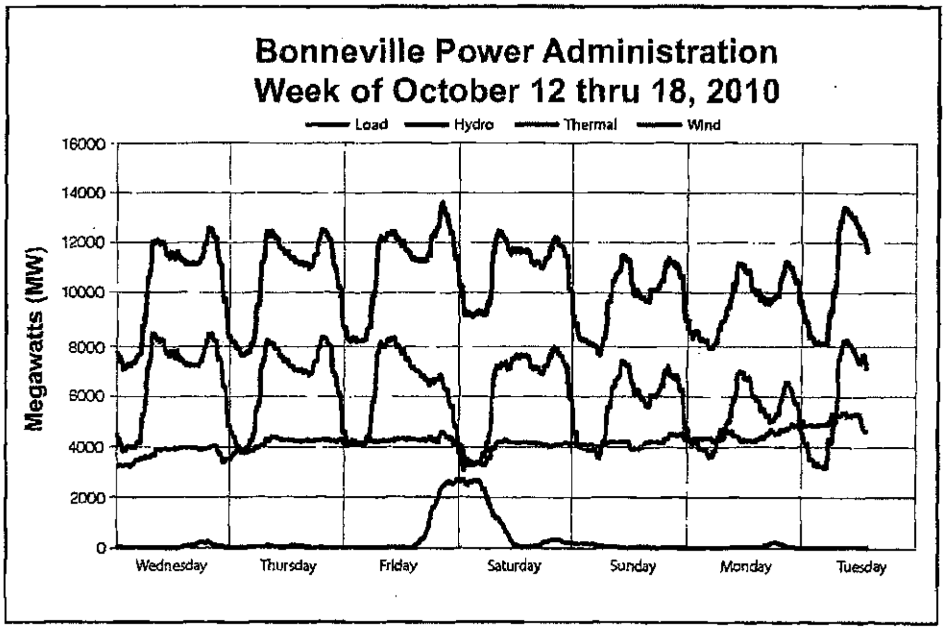
Utility executives would no doubt be concerned with wind power's variability and lack of reliability, and wind industry lobbyists would assuredly attempt to allay executives' fears with the standard answer: "Yes, you may find times when local conditions are such that sufficient wind is not available, but as the network of wind farms and projects is tied together in a 'smart grid,' you will be able to draw on wind resources from other areas thus 'smoothing out' your wind power supply."

As they say, "It sounds good in theory." Perhaps we could look around the world and see if this holds true.

Fortunately, there is such a place to provide us an example. In Southeast Australia, there are 18 wind "projects" or "farms" interconnected within an area covering 40,000 square miles. Roughly, this would equate to an area in the United States bounded by Des Moines, east to Philadelphia, south to Charleston, South Carolina, and west to a location just south of Tulsa. Certainly most of us would consider 40,000 square miles sufficient for wind power to "average out." The Australian projects have the added benefit that they are all built near the coast where the winds are stronger and more constant than in the outlined area in the United States. But the graph above, which provides actual output data from hundreds of wind turbines, shows this to be another wind fiction.

Fuel and Emissions Savings

Unable to find a place for wind in electricity generation, proponents change to their pseudo-environmental hats: "You can't deny that when wind energy is producing



This set of curves shows (from the top) the total load on the Bonneville Power Administration, hydroelectricity generation, thermal (coal, nuclear, natural gas), and sporadic wind power input. Note that the maximum wind input comes at a low point in system load.

power, we are saving fossil fuels that otherwise would be being used." It is a persuasive argument and correct if considering an isolated system. But it is a wrong one when speaking of industrial electricity generation.

Let us assume that a standalone windmill turning a pump runs for an hour and delivers 1 kW of power for 15 minutes, 2 kW for 15 minutes, zero for 15 minutes, and 1 kW for the last 15 minutes. One kWh of energy was used by the pump, and was delivered via wind power. If the pump were instead connected to an electrical outlet, we would have used enough fuel to provide 1 kW of power for one hour, or 1 kWh. Obviously, the windmill here would save on whatever fuel was fueling the generation.

Weak power: Because of its volatility and diluteness, wind power has long been abandoned for industrial uses.

But the wind turbines that are foisted upon our utilities by lobbyists, environmentalists, and politicians do not operate in what might be considered a generating vacuum. They operate in a network of other generating equipment where a change in the output of one device has an effect on the operation of another.

Let us take an imaginary power grid that has 100 megawatts (MW) of coal-fired generating power and 10 MW of wind power. Let us further suppose that there is a constant demand on the system of 50 MW — of which 45 MW is provided by coal, and 5 MW from wind turbines. If the wind component increases to 10 MW, requiring the temperature in the fossil-fired boiler to drop by say 10°F in order to maintain the equality of demand and supply, energy must be shed as waste heat in cooling the boiler. Thus when wind power to the system increases, the energy in the boiler must be wasted, else the balance of generation and usage would be disrupted causing the network frequency to rise.

But then when the wind component decreases, the boiler must increase its temperature to the point where it is now handling the demand. On the way to this point, energy is added to the system without doing any work: The boiler is merely "heating up" to the point that generation occurs. Thus any time the wind component varies (and it is constantly varying), there is wasted energy in the operation of the primary generating source.

In practice, the base load is rarely affected by wind, but the boilers in the power plants functioning as spinning reserves ("spinning standbys" in the U.K.) don't stop consuming fuel while the wind generation is occurring. To be responsive to wind speed increases or decreases, the boilers must maintain a temperature very near that required for production should they be called upon to respond instantaneously to changes in the wind component.

Those generators paired with wind generation experience inefficiencies that are related to wind volatility (the bigger the swings, the worse the effect) and the percentage of wind on the grid (the higher the wind percentage, the greater the inefficiencies). When the wind-power component equals one percent or so of a grid's power, studies show there are little or no savings of fossil fuel, but when wind power is over two or three percent, there may be an *increase* in fuel usage and CO_2 emissions — the raison d'être for wind power in the first place.*

Looking at the Long Term

Utilities executives, whose job it is to make sure that customers have a reliable, economical source of electric power, would likely want to deeply explore the benefits versus drawbacks of wind generation, and so far it doesn't look good. Wind power certainly does not fit into normal generation plans, and the savings of fossil fuels is largely a myth. Moreover, even if a plethora of wind farms are tied together, the vagaries of the weather insure times of insufficient wind; therefore, all current generating assets must be kept available. In fact, the assets need to be consuming thermal energy, ready, rotating, and costing the utility and/or its customers money without doing any useful work, i.e., generating electricity.

There is another factor that should be considered: maintainability. How will the flood of turbines currently being installed hold up over time? For comparison, remember that many of our 104 nuclear plants are nearing their 40-year expected lifetimes, but thanks to careful engineering and maintenance are being extended for another 20 years of operation, often at a higher than originally designed MW output level.

A modern wind-turbine generator is a highly complex device that is much more than three blades connected to a genera-

* Interested readers should download "The Ultimate Irony" by Kent Hawkins, available from http://scienceandpublicpolicy.org/reprint/subsidizing_co2.html

When the wind-power component equals one percent or so of a grid's power, studies show there are little or no savings of fossil fuel, but when wind power is over two or three percent, there may be an *increase* in fuel usage and CO_2 emissions.

If the wind component increases to 10 MW, requiring the temperature in the fossil-fired boiler to drop by say 10°F in order to maintain the equality of demand and supply, energy must be shed as waste in cooling the boiler.

tor. There are motors to adjust the pitch of the blades to maximize the wind-to-shaft efficiency — and to stop rotation in high winds to avoid damaging the turbines. There is an anemometer on top that directs a motor to turn the blades into the wind, a large bearing to hold the weight of the blades and resist the many other forces on it (such as the gyroscopic force encountered when turning the nacelle), and a transmission to increase the speed of the drive shaft from a few rpm to 1,800 rpm. It also has a variety of electrical controls to synchronize the output frequency to within microseconds of the grid frequency, monitor subsystems, and communicate this information to wind-farm operations.

Knowing that mechanical systems do experience wear, and must be maintained and eventually replaced, what does this bode for wind turbines?

A report sponsored by the National Renewable Energy Laboratory† — not exactly a regular skeptic of wind power — contained the following statement:

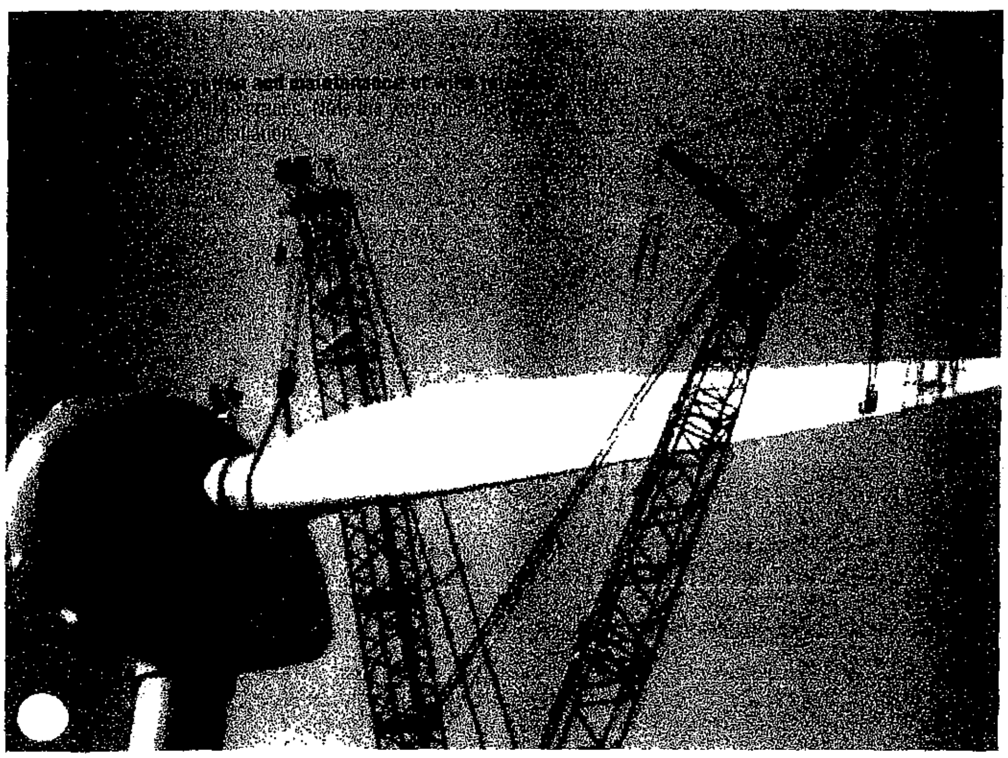
> Despite reasonable adherence to these accepted design practices, wind turbine gearboxes have yet to achieve their design life goals of twenty years, with most systems requiring significant repair or overhaul well before the intended life is reached.

Ouch! Since the cost of wind energy is largely due to the high cost of wind turbines, wouldn't that increase the already-high price paid for wind power? From the same report:

> Since gearboxes are one of the most expensive components of the wind turbine system, the higher-than-expected failure rates are adding to the cost of wind energy. In addition, the future uncertainty of gearbox life expectancy is contributing to wind turbine price escalation. Turbine manufacturers add large contingencies to the sales price to cover the warranty risk due to the possibility of premature gearbox failures.

But that's only one source. Perhaps the wind promoters in government are being uncharacteristically negative. How about a Durham University School of Engineering report‡ looking to promote off-shore wind generation. These were the concluding points regarding the state of wind-turbine reliability:

> 1. Unreliability: Greater than one failure per turbine per year is common.
> 2. Unreliability is higher for larger turbines.
> 3. Such unreliability will be unacceptable offshore, we need reliability of less than 0.5 failures per year per turbine.



Fixing a broken wind-turbine gear box isn't as simple as strapping on a tool belt and turning wrenches for a couple of hours. Perhaps you have seen the scary sight of your car's engine being pulled out of the engine compartment by an overhead crane in a repair shop. There are hoses and wires and belts and tubing poking everywhere. It is maneuvered over to a bench where the mechanics perform mysterious operations, and then the overhead crane plucks it up and returns it back into the car. In a few hours you're on your way with a considerably lighter wallet.

Now imagine that it is not your car sitting on terra firma, but a nacelle with blades together

† Contract No. DE-AC36-99GO10337 to Midwest Research Institute

‡ Durham University School of Engineering, "The Reliability of Different Wind Turbine Concepts, with Relevance to Offshore Applications."

weighing 92 tons, perched 25 stories in the air so that a crane longer than a football field must be brought in, in many cases over mountain roads, to pick up the gearbox or generator and bring it to earth. The mechanic in this case isn't leaning over your fender, but has had to climb 25 stories on a ladder — not a staircase, elevator, or man-lift — straight up hand-over-hand with precious few places to rest on the way up (or down).

It gets even worse when doing maintenance or replacement of rotors, clinging to the nacelle while directing the crane operator as to where to put the hook.

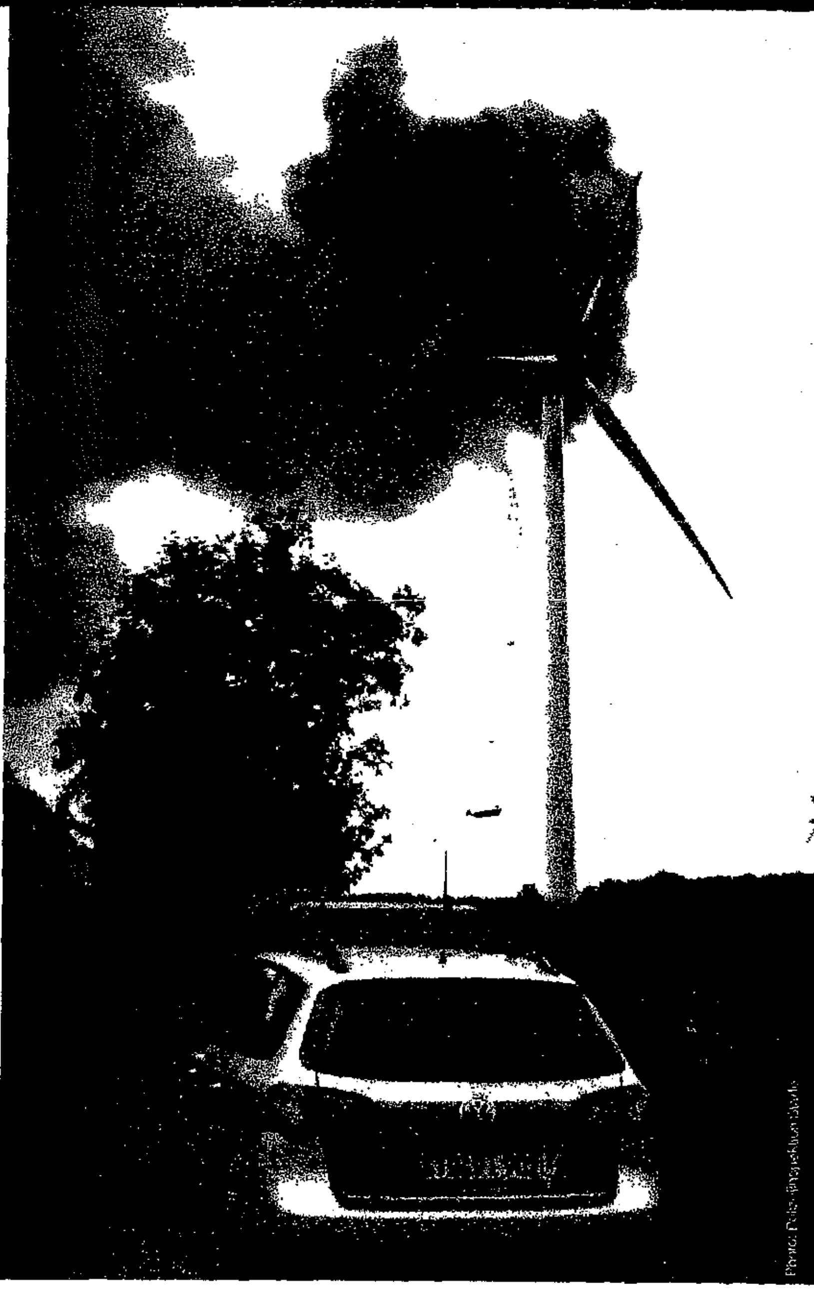
Oh, did we mention the transformers and miles of underground 25,000- to 30,000-volt electric cables connecting the wind turbines to the collection transformer?

Rephrasing the Question

Given the ample drawbacks to wind generation for utility companies and the paucity of benefits, maybe we should change the question to: "Why would any utility executive be in favor of wind energy being anywhere on his or her radar?"

Two reasons are evident. First, there are some left-wing, environmentalist activists in charge of large utility companies. "Cap and Tax" supporter Peter Darbee, president of Pacific Gas and Electric, comes immediately to mind. (But he is likely an exception to the rule.)

Second, most executives want to keep their companies profitable and stay out of jail, though not necessarily in that order. Enter the Renewable Portfolio Standard (RPS), which requires utility companies to produce a certain percentage of "renewable" energy output. Lawmakers, many of whom don't know a volt from a pineapple, have taken it upon themselves to require those who have provided energy to their customers for many decades to change their wicked ways and embrace wind energy — to please the wind lobby and the radicals in our government. Unfortunately, it is within their power to do so, temporarily. The manipulations can only continue for so long before the energy chickens come home to roost.



Wind turbine fires are usually started by lightning [illegible] malfunctions. With fires being fueled by several hundred gallons of [illegible] fluid, firefighters [illegible] only look on and work to put out secondary [illegible] in Buxtehude-Hedendorf (Lower Saxony), Germany.

Politicians, their scientific lackeys, and environmental activists can lie, and people can be taken in by smooth-sounding propaganda about "free energy" and "green jobs." But eventually the laws of physics will show that charlatans have hoodwinked a country into wasting its capital on structures that one day will be toppled like the statue of Saddam Hussein: torn down in protest of government manipulation and deceit. ■

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OPINION | AUGUST 23, 2010

Wind Power Won't Cool Down the Planet

Often enough it leads to higher carbon emissions.

By ROBERT BRYCE

The wind industry has achieved remarkable growth largely due to the claim that it will provide major reductions in carbon dioxide emissions. There's just one problem: It's not true. A slew of recent studies show that wind-generated electricity likely won't result in any reduction in carbon emissions—or that they'll be so small as to be almost meaningless.

This issue is especially important now that states are mandating that utilities produce arbitrary amounts of their electricity from renewable sources. By 2020, for example, California will require utilities to obtain 33% of their electricity from renewables. About 30 states, including Connecticut, Minnesota and Hawaii, are requiring major increases in the production of renewable electricity over the coming years.

Wind—not solar or geothermal sources—must provide most of this electricity. It's the only renewable source that can rapidly scale up to meet the requirements of the mandates. This means billions more in taxpayer subsidies for the wind industry and higher electricity costs for consumers.

None of it will lead to major cuts in carbon emissions, for two reasons. First, wind blows only intermittently and variably. Second, wind-generated electricity largely displaces power produced by natural gas-fired generators, rather than that from plants burning more carbon-intensive coal.

Because wind blows intermittently, electric utilities must either keep their conventional power plants running all the time to make sure the lights don't go dark, or continually ramp up and down the output from conventional coal- or gas-fired generators (called "cycling"). But coal-fired and gas-fired generators are designed to run continuously, and if they don't, fuel consumption and emissions generally increase. A car analogy helps explain: An automobile that operates at a constant speed—say, 55 miles per hour—will have better fuel efficiency, and emit less pollution per mile traveled, than one that is stuck in stop-and-go traffic.

Recent research strongly suggests how this problem defeats the alleged carbon-reducing virtues of wind power. In April, Bentek Energy, a Colorado-based energy analytics firm, looked at power plant records in Colorado and Texas. (It was commissioned by the Independent Petroleum Association of the Mountain States.) Bentek concluded that despite huge investments, wind-generated electricity "has had minimal, if any, impact on carbon dioxide" emissions.

Bentek found that thanks to the cycling of Colorado's coal-fired plants in 2009, at least 94,000 more pounds of carbon dioxide were generated because of the repeated cycling. In Texas, Bentek estimated that the cycling of power plants due to increased use of wind energy resulted in a slight savings of carbon dioxide (about 600 tons) in 2008 and a slight increase (of about 1,000 tons) in 2009.

The U.S. Energy Information Administration (EIA) has estimated the potential savings from a nationwide 25% renewable electricity standard, a goal included in the Waxman-Markey energy bill that narrowly passed the House last year. Best-case scenario: about 306 million tons less CO_2 by 2030. Given that the agency expects annual U.S. carbon emissions to be about 6.2 billion tons in 2030, that expected reduction will only equal about 4.9% of emissions nationwide. That's not much when you consider that the Obama administration wants to cut CO_2 emissions 80% by 2050.

Earlier this year, another arm of the Department of Energy, the National Renewable Energy Laboratory, released a report whose conclusions were remarkably similar to those of the EIA. This report focused on integrating wind energy into the electric grid in the Eastern U.S., which has about two-thirds of the country's electric load. If wind energy were to meet 20% of electric needs in this region by 2024, according to the report, the likely reduction in carbon emissions would be less than 200 million tons per year. All the scenarios it considered will cost at least $140 billion to implement. And the issue of cycling conventional power plants is only mentioned in passing.

Coal emits about twice as much CO_2 during combustion as natural gas. But wind generation mostly displaces natural gas, because natural gas-fired generators are often the most costly form of conventional electricity production. Yet if regulators are truly concerned about reducing carbon emissions and air pollution, they should be encouraging gas-fired generation at the expense of coal. And they should be doing so because U.S. natural gas resources are now likely large enough to meet all of America's natural gas needs for a century.

Meanwhile, the wind industry is pocketing subsidies that dwarf those garnered by the oil and gas sector. The federal government provides a production tax credit of $0.022 for each kilowatt-hour of electricity produced by wind. That amounts to $6.44 per million BTU of energy produced. In 2008, however, the EIA reported subsidies to oil and gas totaled $1.9 billion per year, or about $0.03 per million BTU of energy produced. Wind subsidies are more than 200 times as great as those given to oil and gas on the basis of per-unit-of-energy produced.

Perhaps it comes down to what Kevin Forbes, the director of the Center for the Study of Energy and Environmental Stewardship at Catholic University, told me: "Wind energy gives people a nice warm fuzzy feeling that we're taking action on climate change." Yet when it comes to CO_2 emissions, "the reality is that it's not doing much of anything."

Mr. Bryce, a senior fellow at the Manhattan Institute, recently published his fourth book, "Power Hungry: The Myths of 'Green' Energy and the Real Fuels of the Future" (PublicAffairs).

Cost and Quantity of Greenhouse Gas Emissions Avoided by Wind Generation

By

Peter Lang

This paper contains a simple analysis of the amount of greenhouse gas emissions avoided by wind power and the cost per tonne of emissions avoided. It puts these figures in context by comparing them with some other ways of reducing greenhouse gas emissions from electricity generation.

The conclusion: wind farms connected to the National Grid provide low value energy at high cost, and avoid little greenhouse gas emissions.

The paper covers the following:

1. Background
2. Electricity generation cost per MW/h
3. Greenhouse gas emissions per MWh
4. Emissions avoided per MWh
5. Cost of emissions avoided per MWh
6. Comparison with other options to reduce emissions from electricity generation
7. Discussions
8. Conclusions
9. References
10. About the Author

Background

Wind power is intermittent, so either energy storage or constantly, instantly available back-up generation is required to provide constant power.

Wind power is proportional to the cube of the wind speed. So a small drop in wind speed causes a large drop in the power output. For a modern 2.1 MW wind turbine a 2 m/s drop in wind speed from 9 to 7 m/s halves the power output.

The wind speed is very variable. Figures 1 and 2 give examples of how variable it is.

Figure 1 – The variability of wind power

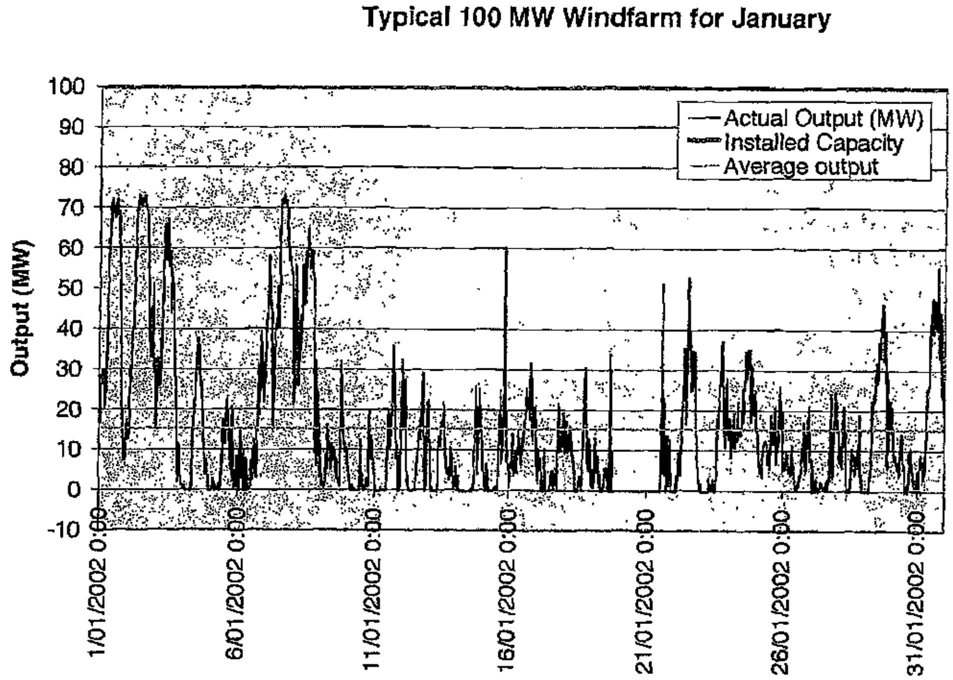
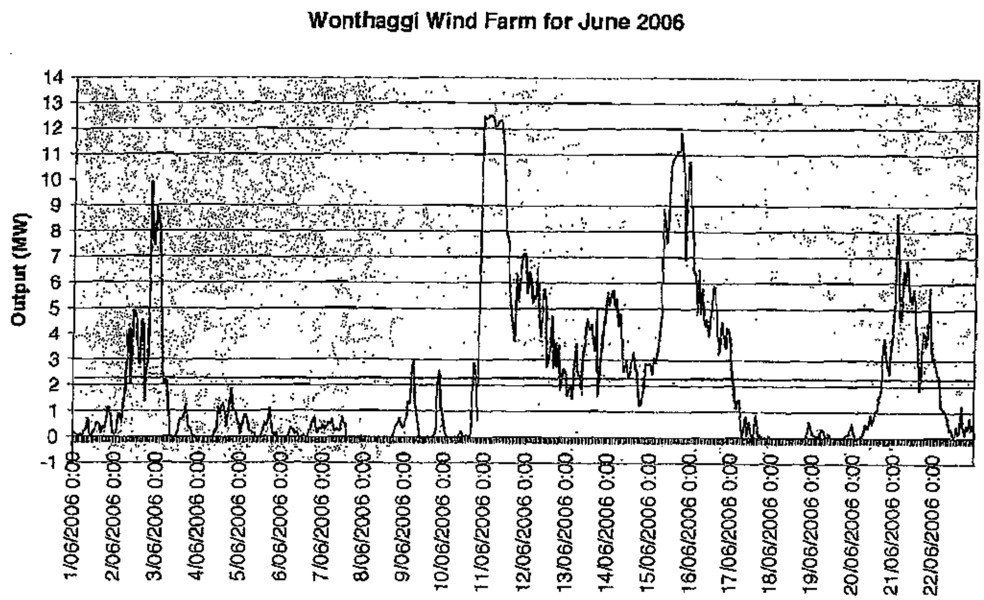


Figure 2 – the variability of wind power



Energy storage[1] is completely uneconomic for the amounts of energy required. So we must use back-up generation.

Constantly, instantly available back-up must be provided by reliable energy sources (to provide power whenever the wind speed drops). Coal, gas, hydro and nuclear power provide reliable power, but not all are suitable as back up generators for wind power.

Back-up generation is mostly provided by gas turbines in Australia. The reasons why gas provides the back-up rather than one of the other energy sources are:

1. We have insufficient hydro resources to provide peak power let alone provide back-up for wind power. Hydro energy has high value for providing peak power and for providing rapid and controllable responses to changes in electricity demand across the network. So our very limited hydro resource is used to generate this high value power.

2. Coal generates the lowest cost electricity and, therefore, coal generation is the last to be displaced when a new source of electricity becomes available (such as when the wind blows). That is, when wind energy is available it displaces the highest cost generator first. Coal is displaced last.

3. Coal generators cannot follow load changes rapidly. Brown coal power stations (as used in Victoria) are designed to run at full power all the time. They can only reduce power by venting steam, but they continue to burn the same amount of coal and hence produce the same amount of emissions whether or not they are generating electricity. Black coal power stations have some limited capability to follow the load but cannot follow the rapid changes in wind power.

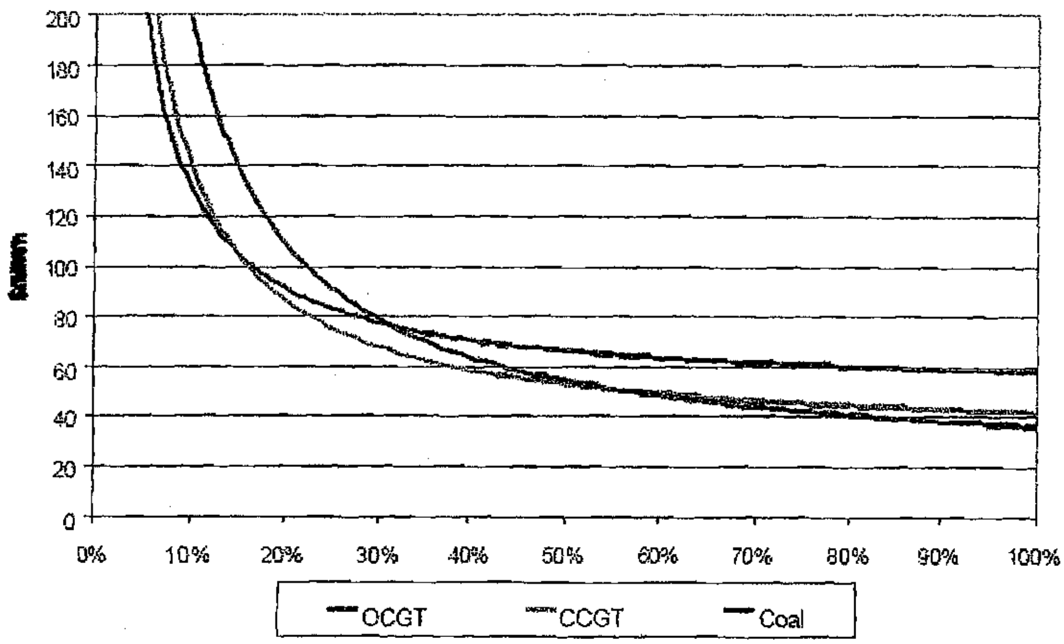
4. Gas turbines can follow load changes fairly well but not as rapidly as the wind power changes. Gas turbines power up and down like a turbo-prop aircraft engine, but with slower response. Next to hydro, gas turbines are best able to follow the load changes created by wind power.

5. There are two classes of gas turbine: Open Cycle Gas Turbine (OCGT) and Combined Cycle Gas Turbine (CCGT). OCGT has lower capital cost, higher operating costs, uses more gas and produces more greenhouse emissions than CCGT per MWh of electricity generated. OCGT follows load changes better than CCGT. OCGT produces electricity at less cost than CCGT at capacity factors less than about 15% (ie 15% of the energy it would produce if running full time at full power). CCGT has higher capital cost and needs to run at higher power and run for longer to be economic. CCGT is more efficient so it uses less gas and produces less greenhouse emissions. CCGT produces electricity at less cost than OCGT for capacity factors above about 15%. (See figure 3).

[1] http://www.greenhouse.gov.au/renewable/aest/pubs/aest-review.pdf , Fig 13, p28

Figure 3
Source: "Long Run Marginal Cost of Electricity Generation in NSW, A report to the Independent Pricing and Regulatory Tribunal, Feb 2004"

Exhibit 1-2 Medium New Entry Cost Scenario as a Function of Capacity Factor (Medium Scenario)



The study noted the cross over points in the cost versus capacity factor characteristic. These cross over points represent the capacity factors where one technology becomes more economic than the next. The optimal capacity factors and the corresponding new entry costs for each technology are shown in Exhibit 1-3 below.

Exhibit 1-3 Optimal Capacity Factors and Associated New Entry Cost (Medium Scenario)

	Thermal Coal	CCGT	OCGT
CF	100%	55%	14%
New Entry Cost	$36.2/MWh	$50.9/MWh	$109.0/MWh

6. The ideal arrangement (grossly simplified) is:

    a. Coal (and/or nuclear) generates base load power (24 hours per day);

    b. CCGT generates shoulder power (approximately 12 hours per day, but variable duration);

c. OCGT generates shoulder and peak power and follows the load changes (average less than 15% capacity factor);

d. Hydro generates peak power and provides stability to the grid.

7. If wind generation is available the power produced is highly variable and unscheduled so it needs to be backed up by OCGT. Although OCGT is called up to back up for wind, the energy produced by wind actually displaces CCGT generation mostly (see next section for explanation).

8. Because wind energy is variable, unreliable and cannot be called up on demand, especially at the time of peak demand, wind power has low value.

9. Because wind cannot be called up on demand, especially at the time of peak demand, installed wind generation capacity does not reduce the amount of installed conventional generating capacity required. So wind cannot contribute to reducing the capital investment in generating plant. Wind is simply an additional capital investment.

The Basis for Comparison

Wind generation displaces CCGT mostly. If we did not have wind power, CCGT would be the most economical and least greenhouse intensive way to generate shoulder power (non-continuous power). To explain, consider the following.

If governments did not mandate and subsidise wind power (by Mandatory Renewable Energy Targets and State based regulations and subsidies) then CCGT and OCGT would be installed in the optimum proportions to provide shoulder and peak generation (in excess of available hydro energy).

If governments mandate wind power then we will need more OCGT and less CCGT than without wind power. The substitution of OCGT for CCGT is (nearly) in proportion to the amount of wind capacity installed, not the amount of wind energy that will be generated. The reason is that the OCGT is required to back up for most of the wind power's maximum capacity, not for its average energy production. For example, if we install 100 MW of wind power, nearly 100 MW of OCGT must be installed instead of 100 MW of CCGT. (For more detailed explanation see "Security Assessment of Future UK Electricity Scenarios"[2]).

To estimate the cost of, and greenhouse emissions avoided by, wind generation we need to compare CCGT versus wind generation plus OCGT back-up.

[2] http://www.tyndall.ac.uk/research/theme2/final_reports/t2_24.pdf

Electricity Generation Cost per MW/h

The cost of electricity generation by gas turbines for various capacity factors[3] is listed below:

	Generation Cost ($/MWh)	
CF	OCGT	CCGT
100%	60	40
45%	70	54
30%	78	67
15%	105	100

The cost of wind generation at 30% capacity factor is about $90/MWh (this figure does not include the cost of back-up). The figure is derived from the proponent's case to the NSW Land and Environment Court for a Wind Farm at Taralga, from ESAA[4], and from actual costs for wind generation in South Australia and New Zealand.

Cost of Back up Generation for Wind

The figure of $90/MWh for wind does not include the cost of back up, nor the cost imposed on the generators, the grid, and distributors caused by the variable and unreliable power. Some of the costs not included in the figure for wind power are:

1. The cost of the investment in generator capacity required to meet peak demand. Nearly the full amount of fossil fuel and hydro generating capacity must be maintained to meet peak demand. The investment in wind displaces almost no capital investment in conventional generating plant.

2. The fossil fuel generators must charge a higher price for their electricity to recoup the fixed costs of their plant over a lesser amount of electricity supplied (ie as they power down when the wind blows)

3. The cost of maintaining 'spinning reserve' - keeping the generators running ready to power up as soon as the wind speed drops. The costs are: fuel, operation and maintenance, and return on capital invested.

4. The cost of fuel for powering up each time the wind changes.

5. Higher gas costs. Most of the gas price is in the pipes, not the price of the gas at the well head. The gas supply pipes need to be sized to run the gas turbines at full power. When the OCGT is operating as back-up for wind it produces less power than optimum. The fixed cost of the gas pipes is spread over less MWh generated by the gas turbine. So the cost of gas and hence the cost of electricity generated must be higher to give an economic return for the generator.

[3] "Long Run Marginal Cost of Electricity Generation in NSW; A report to the Independent Pricing and Regulatory Tribunal, Feb 2004", Exhibit 1.2.
[4] http://www.esaa.com.au/images/stories//energyandemissionsstudystage2.pdf

6. High-value, hydro-energy is wasted. With wind power connected to the grid extra hydro energy (some of it pumped to storage by coal fired plants during off-peak hours) has to be used to stabilise the grid, to provide fast response power when the OCGTs cannot power up fast enough, and to maintain a greater amount of spinning reserve. The rapid changes in wind power causes instability in the network. Some wind changes occur faster than the OCGT's can ramp up. Fast response hydro energy, from our limited reserves, is used to balance these load fluctuations.

7. The grid must be stronger to accommodate the greater variability imposed by the wind generators.

8. There are higher operational costs for the grid operators and distributors. For example, each distributor has a group dedicated to ensure the distributor buys enough renewable energy to meet its government mandated obligations. The full additional cost is millions of dollars per year and this is passed on to consumers in a higher price of electricity.

Assume that the cost of maintaining back up for wind generation is 50% of the cost of generating with the OCGT (i.e., \$39/MWh based on the preceding figures and assumptions). Now we can calculate a cost of having wind power in the generation mix.

Option 1 – No Wind. CCGT generates 45% capacity factor – Cost: \$54/MWh

Option 2 – Wind plus OCGT generates 45% capacity factor - Cost: \$121/MWh (see table below)

	Capacity Factor	Rate \$/MWh	Cost/MWh \$/MWh
OCGT	15%	\$105	\$35
Wind	30%	\$90	\$60
OCGT Back-up for wind	30%	\$39	\$26
Total Wind and OCGT	45%		\$121

The cost of CCGT is \$54/MWh. The cost of wind including back-up is about \$121/MWh. The difference is \$67/MWh. This is the cost per MWh to avoid some CO2 emissions.

Analysis of a report by the UK Royal Academy of Engineering "The Costs of Generating Electricity"[5] gives similar figures.

	UK p/kWh	A\$/MWh
CCGT	2.2	\$51
OCGT	3.2	\$74
Wind	3.7	\$86
back up	1.7	\$40
Wind with back up	5.4	\$126

[5] http://www.raeng.org.uk/news/publications/list/reports/Cost_Generation_Commentary.pdf

Greenhouse Emissions per MWh

The University of Sydney's Integrated Sustainability Analysis report[6] provides the greenhouse gas emission intensity factors for wind in columns 2 and 3 below. The fourth column (for 30% capacity factor and 20 year economic life) is calculated by factoring from columns 2 and 3.

Capacity Factor	31.2%	23.1%	30%
Economic life (yr)	25	20	20
Emissions Factor (t CO2-e/MWh)	0.021	0.040	0.027

Source: http://www.pmc.gov.au/umpner/docs/commissioned/ISA_report.pdf

The greenhouse gas emission factors for gas turbines from the same report are:

Generator technology	**OCGT**	**CCGT**
Greenhouse gas emissions factor (t CO2-e/MWh)	0.751	0.577

Emissions Avoided per MWh

If CCGT generated the power, the emissions would be 0.577 t CO2-e/MWh.

If Wind and OCGT generate the same amount of power, the emissions would be 0.519 t CO2-e/MWh (see table below).

	CF	**Factor t CO2e/MWh**	**Emissions t CO2e/MWh**
OCGT	15%	0.751	0.250
Wind	30%	0.027	0.018
Back-up for wind (assumed 50% of OGCT)	30%	0.376	0.250
Total Wind and OCGT	45%		0.519

Therefore, the emissions avoided by wind are: 0.577 – 0.519 = 0.058 t CO2-e/MWh

We can compare this figure with figures derived from two other sources.

First, the "South Australian Wind Power Study"[7] provides an upper bound figure. This study modelled the effect of introducing wind generation in South Australia on the amount of fossil fuel generation and the long run and short run marginal costs of generation across the whole National Electricity Market. The study also modelled the amount of greenhouse gas emissions saved, but points out that several factors are not included in the analyses. The study determined the amount of CO2 emissions avoided by wind, excluding emissions from providing back up, is about 0.5 t CO2-e/MWh. This can be considered as an upper bound, because the modelling does not consider:

- Emissions from maintaining 'spinning reserve' with back up generators;

[6] http://www.pmc.gov.au/umpner/docs/commissioned/ISA_report.pdf
[7] "South Australia Wind Power Study" by Electricity Supply Industry Planning Council, March 2003.

- Emissions from powering up and running down the generators;
- Emissions from coal power stations when they are required to reduce power by venting steam (while they continue to burn coal and emit CO2 at their full rate);
- Emissions from generating the energy to provide reactive and feed-in power for the wind generators;
- Emissions from building, operating and maintaining the strengthened grid needed to support the distributed wind power generators;
- Emissions from the additional work required by the distributors;
- Emissions from coal power stations pumping water to pumped storage that then has to be used for rapid response back-up, for extra 'spinning reserve' and for stabilising the grid because of the variable power from wind turbines;
- The hydro energy resource on mainland Australia is limited and insufficient to provide for even our peak load energy needs. Any hydro energy used as back up for wind power must be replaced with OCGT generation. In effect, any hydro energy used for back up for wind has the same emissions as OCGT running as back up for wind.

The second source for comparison is the Royal Academy of Engineering report "The Cost of Generating Electricity"[8]. We can calculate the amount of emissions avoided by wind with back up from the information provided in the report.[9]

	Generation cost (UK p/kWh)			Emissions
	Carbon tax £0 / t CO2-e	Carbon tax £30 / t CO2-e	Difference	kg CO2e / kWh
CCGT	2.2	3.4	1.2	0.400[10]
OCGT	3.2	4.8	1.6	0.533
Wind	3.7	3.7	0	0.027
back up	1.7	1.7	0	0.283[11]
Wind with back up	5.4	5.4	0	0.310
Emissions avoided				**0.090**

So, we have three values for the amount of greenhouse gas emissions avoided by wind generation per MWh.

Basis of estimate	**t CO2 avoided /MWh**
Wind with OCGT back up displacing CCGT	0.058
Wind, excluding back up (SA Wind Power Study)[12]	0.5
Wind including back up (Royal Academy of Engineering, UK)	0.09

[8] http://www.raeng.org.uk/news/publications/list/reports/Cost_Generation_Commentary.pdf
[9] Using cost data from the Royal Academy of Engineering report (with and without a carbon tax), we can infer the emissions per kWh factor they used by taking the difference in cost per tonne CO2 and dividing it by the carbon tax cost per tonne CO2 (first two rows). Emissions for wind, back-up and wind with back-up are taken from the previous page. Emissions avoided (last row) are calculated by CCGT emissions minus emissions from wind with back-up.
[10] calculated as: Difference converted from p to £, divided by carbon tax, converted from t to kg
[11] calculated as: emissions from OCGT x cost of back-up / cost of OCGT
[12] "South Australia Wind Power Study" by Electricity Supply Industry Planning Council, March 2003.

Cost of emissions avoided per MWh

The cost of emissions avoided by wind power can be calculated from the figures in the preceding sections. The cost of emission avoided by wind is the cost of substituting wind power plus OCGT back-up for CCGT. We have three figures for the amount of emissions avoided. The higher emissions avoided (lower avoidance cost) is calculated from the results of a modelling analysis which does not include the emissions from back up. The two low figures for emissions avoided (higher avoidance cost) do include an allowance for the emissions from back up. The first is a simple analysis. The other is from a sophisticated study by the UK Royal Academy of Engineering.

Cost per MWh to substitute Wind with back-up for CCGT ($/MWh)	$67	$67	$74
Emissions avoided (t CO2-e/MWh)	0.058	0.5	0.09
Cost of emissions avoided ($t CO2-e avoided)	$1,149	$134	$830

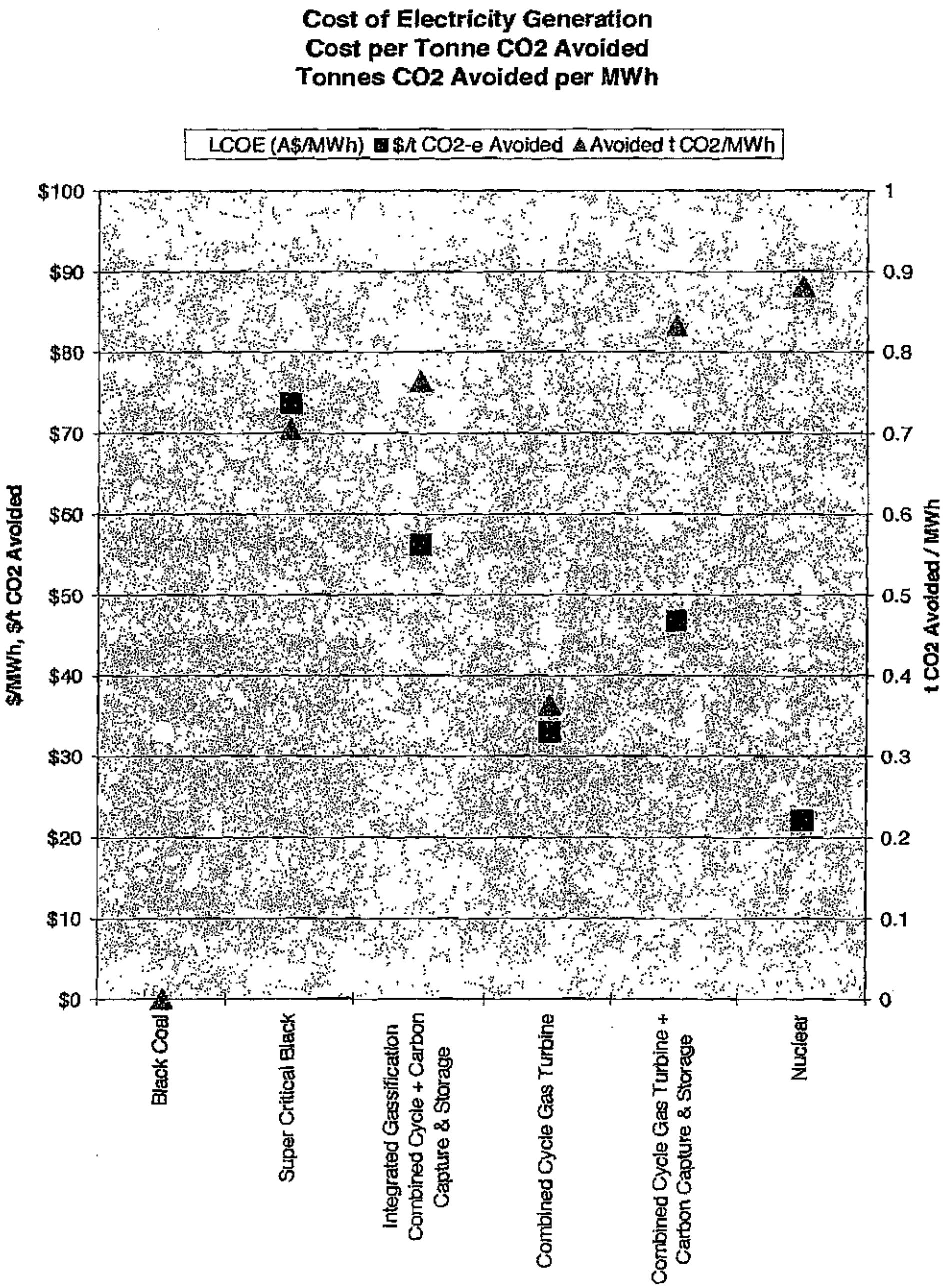
All three figures for the cost of emissions avoided by Wind power are high compared with alternatives.

Comparison with Other Options to Reduce Emissions from Electricity Generation

Figure 4 shows the cost of avoiding emission, and the amount of emissions avoided per MWh, by some new base load electricity generating technologies. Wind contributes to generating for shoulder (or non-continuous) power rather than base load so the figures are not directly comparable. But the figures do indicate that wind power is a costly way to reduce CO2 emissions (i.e., $134 to $1149 per tonne CO2-e avoided), and that the amount of emissions avoided by wind is negligible.

Nuclear power avoids the most emissions per MWh and is the least cost for doing so at about $22 per tonne of CO2 avoided (Figure 4).

Figure 4 - Projected cost of electricity, amount of emissions avoided and avoidance cost per MWh for future base load electricity generation technologies.
Source: calculated from the reports by EPRI[13] and University of Sydney Integrated Sustainability Analysis[14].



[13] http://www.pmc.gov.au/umpner/docs/commissioned/EPRI_report.pdf
[14] http://www.pmc.gov.au/umpner/docs/commissioned/ISA_report.pdf

The table below compares some technology options for reducing emissions. The technologies are ordered from highest to lowest cost of avoiding emissions (column 3).

	Emissions ($t\ CO2\text{-}e$ / MWh	Emissions Avoided ($t\ CO2\text{-}e$ avoided / MWh	Cost of Emissions avoided (\$/t CO2-e avoided)
Wind (including back up generation) (Aus)[15]	0.519	0.058	$1149
Wind (including back up generation) (UK)	0.310	0.090	$830
'Clean Coal' (IGCC + CCS)	0.176	0.765	$56
Combined Cycle Gas Turbine + CCS	0.108	0.833	$47
Combined Cycle Gas Turbine	0.577	0.364	$33
Nuclear	0.060	0.880	$22

The table shows:

1. Wind power is the highest cost and nuclear the lowest cost for avoiding emissions (by a factor of about 50) (Column 3);
2. Wind power does not meet the Clean Energy Targets'[16] 200 kg/MWh test (Column 1);
3. Only nuclear and the fossil fuel technologies with carbon capture and storage meet the '200 kg/MWh test' (Column 1);
4. Only nuclear and the fossil fuel technologies with carbon capture and storage can make substantial reductions in emissions - i.e., can avoid more than 750 kg/CO2-e/MWh (Column 2). To put this in perspective, 750 kg/CO2-e/MWh is about 75% of the emissions from conventional coal fired generation. Coal fired generation produces about 76% of Australia's electricity and 89% of electricity's greenhouse gas emissions.

Discussion

The results are sensitive to the input parameters (capacity factors, emissions per MWh, costs per MWh, and the cost and emissions from back-up).

The capacity factor for wind generation in NSW should be less than the 30% used in this analysis (for example Crookwell 14.7% over 5 years and Blayney 22%).

[15] For wind back up generation the figures are:
Wind (excluding back up generation) (Aus) 0.027 0.500 $134

[16] The Federal Government recently announced national Clean Energy Targets to replace the state based renewable energy and emissions reductions schemes. The new national Clean Energy Target, requires that 30,000 GWh each year must come from low emissions sources by 2020. Low emission sources are those technologies that emit less than 200 kg of greenhouse gases per MWh of electricity generated.

These calculations suggest that wind generation saves little greenhouse gas emissions when the emissions from the back-up are taken into account.

Wind power, with emissions and cost of back-up generation properly attributed, avoids 0.058 to 0.09 t CO2-e/MWh compared with about 0.88 t CO2-e/MWh avoided by nuclear. The cost to avoid 1 tonne of CO2-e per MWh is $830 to $1149 with wind power compared with $22 with nuclear power. If the emissions and cost of back up generation are ignored then win power avoids about 0.5 t CO2-e/MWh at a cost of about $134/t CO2-e avoided. Even if the costs of and emissions from back up generation are ignored, wind is still over six time more costly that nuclear as a way to avoid emissions.

A single 1000 MW nuclear plant (normally we would have four to eight reactors together in a single power station) would avoid 6.9 million tonnes of CO2 equivalent per year. Five hundred 2 MW wind turbines (total 1000 MW) would avoid 0.15 to 1.3 million tonnes per year – just 2 to 20% as much as the same amount of nuclear capacity. When we take into account that we could have up to 80% of our electricity supplied by nuclear (as France has), but only a few percent can be supplied by wind, we can see that nuclear can make a major contribution to cutting greenhouse emissions, but wind a negligible contribution and at much higher cost.

Conclusions:

1. Wind power does not avoid significant amounts of greenhouse gas emissions.
2. Wind power is a very high cost way to avoid greenhouse gas emissions.
3. Wind power, even with high capacity penetration, can not make a significant contribution to reducing greenhouse gas emissions.

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About the Author

Peter Lang is a retired engineer with 40 years experience on a wide range of energy projects throughout the world, including managing energy R&D and providing policy advice for government and opposition. His experience includes: coal, oil, gas, hydro, geothermal, nuclear power plants and nuclear waste disposal (6.5 years managing a component of the Canadian Nuclear Fuel Waste Management Program).

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Speaking Truth to "Wind" Power

By
Michael J. Trebilcock
Professor of Law and Economics, University of Toronto, Faculty of Law

I. Introduction

The Green Energy Act (Bill 150), now before the Legislative Assembly of Ontario, is designed to expedite the process of promoting subsidized industrial wind power in the province by taking planning responsibilities away from local municipalities, while remitting most key decisions to subsequent Ministerial regulations.[1] I have five major objections to the legislation.

II. The Case Against Industrial Wind Turbines

1) Industrial Wind Turbines Have Minimal Impact on Carbon Emissions

There is no evidence that industrial wind power is likely to have a significant impact on carbon emissions. The European experience is instructive. Denmark, the world's most wind-intensive nation with more than 6,000 turbines generating 19 percent of its electricity, has yet to close a single fossil fuel plant. It requires 50 percent more coal-generated electricity to cover wind power's unpredictability, pollution and carbon dioxide emissions have risen (by 36 percent in 2006 alone).[2] The German experience is no different. Germany's carbon dioxide (CO2) emissions have not been reduced and additional coal and gas-fired plants have been constructed to ensure reliable delivery, especially at times of peak demand.[3]

Indeed, recent academic research shows that wind power may actually increase greenhouse gas emissions in some cases, depending on the carbon-intensity of back-up generation required because of its intermittent character.[4] In an Ontario context, wind power cannot be relied on to provide peak-load capacity, and is not

Michael Trebilcock, Professor of Law and Economics, University of Toronto, Faculty of Law, is a Research Fellow at the C.D. Howe Institute. This text draws on his remarks before Ontario's legislative committee on Bill 150, April 8, 2009.

1 I, my wife, and other residents of Grey Highlands, and similar rural municipalities in Ontario, are personally affected by this legislation and acknowledge this conflict. The following comments reflect a professional career studying economic regulation and writing on electricity system design, including a year as Research Director of the Ontario Government's Electricity Market Design Committee (1998).

2 David J. White, "Danish Wind: Too Good to be True?" The Utilities Journal, July 2004. See also article by Angela Kelly, written for the magazine Green Places and available at http://www.countryguardian.net/Green percent20Places.htm

3 Anselm Waldermann, "Wind Turbines in Europe Do Nothing for Emissions-Reductions Goals," Der Spiegel, February 19, 2009. Available (in German) at www.spiegal.de/international/business/0.1518.606763.00.html.

4 Arthur Campbell, "Hot Air? When Government Support for Intermittent Technologies Can Increase Emissions," MIT Department of Economics, November 21, 2008. Available at http://econ-www.mit.edu/files/3563.

needed for base-load where hydro and nuclear generation provide lower cost, low-carbon electricity. On the negative side of the environmental ledger are adverse impacts of industrial wind turbines on birdlife and other forms of wildlife, farm animals, wetlands, and viewsheds.

2) Industrial Wind Turbines Are Uneconomic

Industrial wind power is not a viable economic alternative to other energy conservation options. Again, the Danish experience is instructive. Its electricity generation costs are the highest in Europe (15 cents/kwh compared to Ontario's current rate of about 6 cents).[5] The Chair of Energy Policy in the Danish Parliament calls it "a terribly expensive disaster."[6] The U.S. Energy Information Administration reported in 2008, on a dollar per MWh basis, the U.S. government subsidizes wind at $23.34 – compared to reliable energy sources: natural gas at 25 cents; coal at 44 cents; hydro at 67 cents; and nuclear at $1.59, a significant industrial subsidy.

Wind generation is a good example of what can go wrong when governments pick winners.[7] Each tonne of emissions avoided due to subsidies to renewable energy such as wind power would cost somewhere between $69 and $137, whereas under a cap-and-trade scheme the initial price would be less than $15.[8] Carbon taxes and cap-and-trade systems create incentives for consumers and producers on a myriad of margins to reduce energy use and emissions and, as these numbers show, overwhelm subsidies to renewables in terms of cost effectiveness.

Under its current standing offer program, the Ontario Power Authority will pay wind producers 13.5 cents/kwh (more than twice what consumers currently pay for electricity), even without accounting for the additional costs of interconnection, transmission and back-up generation. As the European experience confirms, this will lead to a dramatic increase in electricity costs with consequent detrimental effects on business and employment (an anti-stimulus policy at a time of serious economic recession in the province).[9] From this perspective, the government's promise of 55,000 new jobs from renewable energy is a delusion. A recent detailed Spanish study finds that for every job created by state-funded support of renewables, particularly wind energy, 2.2 jobs are lost.[10] Each wind industry job created cost almost $2 million in subsidies (to destroy 2.2 other jobs). Why would the Ontario experience be different?

3) Industrial Wind Turbines Cause Insufficiently Researched Health Effects

A growing body of scientific and medical evidence suggests that the health effects on those subjected to long and frequent periods of pulsating, low-frequency noise associated with wind turbines include sleep disturbances leading to depression, chronic stress, migraines, nausea and dizziness, exhaustion and anger, memory loss and cognitive difficulties, cardiac arrhythmias, increased heart rate and blood pressure. A prominent academic study lists no fewer than 13 studies that show noise from wind turbines at night can disturb residents more than 2 km away.[11] Those living close to the source of noise can develop what has been termed "Vibroacoustic Disease (VAD). Noise from wind turbines exhibit the characteristics of noise

5 See John Dyson, "Tilting Against Windmills," Reader's Digest, August 2003; also in the United Kingdom Parliament House of Lords-Science and Technology-Written Evidence, October 2003. Available at http://www.publications.parliament.uk/pa/cm200506/cmselect/cmwelaf/876/876we14.htm; and the Response to the 2006 Energy Review, April 2005. Available at http://www.berr.gov.uk/files/file31065.pdf

6 See The United Kingdom Parliament House of Lords-Science and Technology-Written Evidence, October 2003. Available at http://www.publications.parliament.uk/pa/cm200506/cmselect/cmwelaf/876/876we14.htm; see also the Response to the 2006 Energy Review, April 2005. Available at http://www.berr.gov.uk/files/file31065.pdf

7 William Tucker, Wall Street Journal, December 29, 2008; see also Patrick Sawyer, "Promoters overstated the environmental benefits of wind farms," Telegraph.co.uk., December 21, 2008. Available at http://www.telegraph.co.uk/earth/energy/windpower/3867232/Promoters-overstated-the-environmental-benefit-of-wind-farms.html

8 "Wasting Money on Climate Change (Cap and Binge)," *Economist*, March 14, 2009.

9 Max Schulz, *op. cit.*

10 Study of the Effects on Employment of Public Aid to Renewable Energy Services, Universidad Rey Juan Carlos, March 2009; see also *Seven Myths About Green Jobs*, University of Illinois, March 16, 2009 and available at http://news.prnewswire.com/ViewContent.aspx?ACCT=109&STORY=/www/story/03-16-2009/0004989090&EDATE=.

11 "Simple guidelines for siting wind turbines to prevent health risks," George W. Kamperman and Richard R. JamesDearborn, NOISE-CON 2008, Michigan, July 28-31, 2008.

experienced in various occupations (aircrews, aircraft maintenance workers, ship workers and an islander population exposed to environmental infra and low frequency noise) and has been shown to lead to VAD. Complaints from people living near wind turbines are the same as those from persons who have developed VAD.[12] Also, flicker from turbines at a minimum are disruptive and annoying. Flicker poses a potential risk of photosensitive seizures.[13]

The refusal of the provincial government to order full independent environmental assessments, including assessments of health effects, of any wind turbine project to date, undermines the credibility of claims that there will be no such negative effects.

4) Industrial Wind Turbines Have Adverse Effects on Adjacent Property Values

A three-year study of 600 property sales near the Melancton wind turbine developments north of Shelburne, Ontario found that property values decreased by 20 percent to 25 percent (an average of $48,000), were on the market more than twice as long as properties in adjacent areas, and a large number (four times those that did sell) could not be sold at any price.[14] While wind developers deny that industrial wind turbines have any effect on property values of neighbouring residents, common sense suggests otherwise: how many people familiar with this development would be prepared to buy recreational or retirement homes in this area, even at sharply discounted prices? In recreational areas that promote their scenic attractions these effects on property values are likely to be even more pronounced. Refusal by either wind developers or the provincial government to provide legally enforceable guarantees of compensation for property value losses warrants further skepticism over the claim that there will be no such losses.

5) The Decision-making Process is Undemocratic and Will Undermine Efficient Regulation

When Premier McGuinty first ran for public office in 2003, his platform included a prominent commitment to "democratic renewal" in Ontario. In a June 1, 2004 press release, he and his Minister of Democratic Renewal (Michael Bryant) declared that they were embarked upon "the most ambitious democratic renewal process in Ontario's history."

The *Green Energy Act* will gut locally-elected governments of major planning responsibilities, remit most key decisions to subsequent Ministerial regulations that no one will see until after their promulgation, and will centralize most important powers over the electricity sector in the Minister's office. Furthermore, the politicization of major supply and pricing decisions will seriously compromise the goals of independent, efficient regulation of the electricity sector and hence the effectiveness of the Ontario Energy Board and the Independent Electricity System Operator.[15] For these reasons, the *Green Energy Act* represents a poor example of "democratic renewal."

III. Minimizing the Damage

Even if one thought (contrary to my views), that wind turbines were a good idea environmentally and economically, there would be a simple solution to the impact on rural residents, who face being conscripted to bear most of the burden of solving a problem they mostly did not create. The solution is to ensure that set-backs from residences conform to

12 "Vibroacoustic disease: Biological effects of infrasound and low-frequency noise explained by mechanotransduction cellular signaling." Mariana Alves-Pereira and Nuno A.A. Castelo Branco, Progress in Biophysics and Molecular Biology, (2007) 93: 256-279; see also, "On the Impact of Infrasound and Low Frequency Noise on Public Health - Two Cases of Residential Exposure," Mariana Alves-Pereira and Nuno A.A. Castelo Branco, Rev. Lusofona de Ciencias e Tecnologias da Saude, (2007) 2 (4): 186-200.

13 "Wind turbines, flicker, and photosensitive epilepsy: Characterizing the flashing that may precipitate seizures and optimizing guidelines to prevent them," Graham Harding, Pamela Harding and Arnold Wilkins, Epilepsia (2008) 49 (6): 1095-1098.

14 "Living With the Impact of Windmills," Chris Luxemburger, Director Brampton Real Estate Board, Chairperson of Real Estate By-laws Committee, paper 2008 (available at http://ruralgrubby.files.wordpress.com/2008/chris-luxemburger-presentation1.pdf); see also a recent Texas study that reaches similar findings: http://www.bobvila.com/HowTo_Library/Green_Backlash_The_Wind_Turbine_Controversy-Green_Building-A3923-4.html.

15 See George Vegh, "Green Energy Unbounded," February 24, 2009. http://utorontolaw.typepad.com/files/green-energy-unbounded.doc.

international standards as endorsed by renowned medical and scientific bodies that have closely examined the health and environmental risks. The French Academy of Medicine in a 2006 study recommends 1.5 km, pending further research on health effects of persistent exposure to low-intensity noise.

Alternatively, the government could concentrate wind farms in more remote or sparsely populated areas, as has been done in Quebec and much of Europe. These measures would also minimize negative impacts on property values. But these are modest palliatives to the fundamental policy flaws in Bill 150 and do not address industrial wind power's two key "inconvenient truths": failure to reduce significantly carbon emissions, and exorbitant cost to taxpayers and consumers.

IV. Good Politics, Bad Policy

In debates over climate change, and in particular subsidies to renewable energy, there are two kinds of green. First there are some environmental greens who view the problem as so urgent that all measures that may have some impact on greenhouse gas emissions should be undertaken immediately, whatever their cost or their impact on the economy and employment.[16] Then there are the fiscal greens, who being cool to carbon taxes and cap-and-trade systems that make polluters pay, favour massive public subsidies to themselves for renewable energy projects, whatever their relative impact on greenhouse gas emissions. These two groups are motivated by different kinds of green. The only point of convergence between them is their support for massive subsidies to renewable energy (such as wind turbines).

This unholy alliance of these two kinds of greens (doomsdayers and rent seekers) – a classic Baptist-Bootlegger coalition, harking back to the Prohibition era – makes for very effective, if opportunistic, politics (as reflected in the Ontario government's *Green Energy Act*), just as it makes for lousy public policy: politicians attempt to pick winners at our expense in a rapidly-moving technological landscape, instead of creating a socially efficient set of incentives to which we can all respond.

16 See Bill McKibben, "The Fierce Urgency of Now," Toronto Star, 25th March, 2009: "We have to do everything we can imagine, all at once." For a critique of this view, see Robert MacIntosh, "The Approaching Global Energy Crunch: And How Canada Should Meet It," C.D.Howe Institute Commentary 283.

Old Cap & Jacket property has chilling clean-up cost

By Alan Blagg
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PROSPECT — The Town Council received good and bad news Tuesday night about the 2001 cleanup of the former U.S. Cap & Jacket property on New Haven Road.

The good news is that the 5.1-acre property has been largely cleared of sources of contamination suspected of tainting local wells. The $900,000 cleanup project removed seven underground storage tanks and about 1,500 tons of contaminated soil in September 2001.

The bad news is that finishing the job — by removing residual contamination deep in the soil — could cost up to $2 million, which is at least four times more than the value of the property.

Officials from the Environmental Protection Agency and state Department of Environmental Protection debriefed the council Tuesday night and gave a bleak picture of what needs to be done.

"The source is pretty much gone, but there's a lot of residual contamination left," explained John Meyer of the engineering firm Tetra Tech NUS of Massachusetts. "Depending on what you have in the bedrock, it could be quite a while before the groundwater meets state drinking water standards."

Meyer said it may take up to 50 years for the site to cleanse itself naturally.

Given that a private developer would be unlikely to take on the expense, James Chow of the EPA's Brownfields Program recommended that the town take steps to eliminate "any ongoing public health threat" in order to abandon the site.

He suggested sealing several on-site drinking water wells, filling two empty septic tanks with sand to prevent anyone from falling into them and demolishing the 21,000-square-foot warehouse on the site.

The cost for these projects could total nearly $280,000, which could expand if the building contains other contaminant materials, like asbestos, lead paint or PCBs.

As the final phase of the cleanup project, the EPA will examine the building for such materials and provide bid specifications for private contractors to give more accurate cost estimates. "The costs to clean up and close out this site are prohibitive," Chow said. "The town is facing a classic orphan site — ownerless and abandoned." Chow also recommended a long-term groundwater monitoring program, which is already being handled by the DEP.

Mayor Bob Chatfield applied for an environmental assessment of the property and warehouse in 2000.

The EPA found high concentrations of chlorinated solvents, including trichloroethylene, which is used to remove grease from metal parts.

Chatfield emphasized that the property is owned by a defunct corporation and not by the town, which has avoided involvement in the land's chain of ownership.

Council members asked if costs should be the town's responsibility, and Chow explained that it often falls on the municipality "to step up and take responsibility." Federal funds for the project have been depleted, and the site no longer qualifies as an immediate health threat.

Several neighbors to the site attended Tuesday's meeting and listened patiently to the presentation.

Betty Lukeski lives across New Haven Road from the site and once worked in the building. Her tap water is now filtered through equipment provided by the DEP, and she already knew much of what was presented. "It's just a terrible eyesore," she said.

Lukeski and her husband, Joseph, have no plans to move.

Any residents in the neighborhood who are interested in having their well water tested for contamination should call DEP Analyst Stephen Gaura in Hartford, at (860) 424-3786.

STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION

January 6, 2003

Honorable Robert J. Chatfield
Town of Prospect
36 Center Street
Prospect, CT 06712

Dear Mayor Chatfield:

As you know the former U. S. Cap and Jacket site has been found to be grossly contaminated with industrial chemicals from the misuse and mishandling of wastes. You also know that this contamination has impacted ground waters in the area and has impacted at least one private drinking water supply well. The Department will continue to monitor the situation through routine sampling of drinking water wells in the immediate area and will take the appropriate actions necessary when and if drinking water is discovered to be non-potable.

The Department is concerned that any newly developed drinking water wells in at least a one-half mile radius of the site be tested for chemicals that have been discovered at the site, i.e. volatile organic compounds (VOC's), along with any other testing required by law.

I have enclosed excerpts from the State of Connecticut Department of Public Health Code, which is current with materials published in Connecticut Law Journal through 10/01/02, specifically section 19-13-B101,Testing of water quality in private water supply systems to give you an idea of the tests that are required by law.

I hope this information proves useful to you and the City of Prospect. If I can be of any further assistance in this matter please call me at 860-424-3786.

Sincerely,

Stephen J. Gaura

Stephen J. Gaura
Environmental Analyst
Discovery and Assessment
Permitting, Enforcement and Remediation Division
Bureau of Water Management

SJG:sjg
enclosure

cc: Mr. James Chow, United States Environmental Protection Agency, 1 Congress Street (HIO) Boston, MA 02114 w/enclosures

Mr. Thomas Wegrzyn, MPH, RS, Director of Health, Chesprocott Health District, Highland Avenue, Cheshire, CT 06410 w/o enclosures

U. S. Cap and Jacket site
214 New Haven Road, Prospect

1:15764
Dec 30, 2002

1/2 mile radius from site

This map is for illustrative purposes only. Data may not be complete or current.
Environmental Data and Geographic Exchange

Source(s
DEP, DE

BROWNFIELDS
TARGETED SITE ASSESSMENT

U.S. CAP AND JACKET SITE
PROSPECT, CONNECTICUT

RESPONSE ACTION CONTRACT (RAC), REGION I

For
U.S. Environmental Protection Agency

By
Tetra Tech NUS, Inc.

EPA Contract No. 68-W6-0045
EPA Work Assignment No. 114-SIBZ-0100
TtNUS Project No. N4128

April 2003

John L. Meyer, LEP, LSP
Project Manager

George D. Gardner, P.E.
Program Manager

Areas of the Site in which additional subsurface investigations are recommended include the loading dock area, near the main and north building entrances, the area between the one-story building and Route 69, and the area within the building footprint. Although the recent EPA removal action eliminated several sources of VOC and ETPH contamination within the loading dock area, analysis of samples collected during the removal action indicate that residual soil contamination remains on the Site at concentrations that exceed I/C DECs. Analysis of groundwater samples collected during the December 2000 PA/SI, TtNUS's BTSA investigation, and previous site investigations indicate that at least one contaminant plume containing VOCs and metals is present on the Site. Contamination continues to migrate off site and impact adjacent downgradient residential properties.

An additional subsurface investigation of the loading dock area is recommended to determine the extent of residual VOC, ETPH, and metals contamination in soil and groundwater. A minimum of four soil borings should be advanced in this area using a drive-and-wash technique to avoid contaminating subsurface soil samples with VOCs that are likely to be present in shallow groundwater. Continuous soil sampling of each boring should be performed at 2-foot depth intervals at each boring, with each sample field screened for organic vapors using a PID. Soil borings should be advanced to the depth at which organic vapors are no longer detected by field screening. At least one soil sample per each five feet of depth should be collected for laboratory analysis of VOCs, ETPH, and metals. Four of the soil borings should be completed as 2-inch I.D. monitoring wells.

Review of documents pertaining to machining operations that formerly occupied the Site indicates that the disposal of spent acids or other wastes is likely to have occurred in a former leaching pit located somewhere west of the building. No visual evidence of the location of this pit was observed during the BTSA investigation. Recovery of spent solvents and waste oil took place in the southern portion of the building near the loading dock. An additional attempt should be made to find the former leaching pit. Once the pit location is identified a groundwater monitoring well should be placed there. Two to three soil borings and 2-inch I.D. groundwater monitoring wells should be placed in the southern portion of the building's footprint to determine if the disposal and solvent/waste oil recovery operations contaminated soil and groundwater beneath these areas of the building.

The lactic acid acts as a carbon source to promote anaerobic reductive dechlorination of chlorinated hydrocarbons. Anaerobic microbes that are present in the subsurface metabolize the lactic acid, producing consistent low concentrations of dissolved hydrogen which is used by the microbes as an electron receptor to strip chlorine atoms from chlorinated hydrocarbons, thereby enhancing biodegradation. HRC would not be effective in remediating the elevated concentrations of SVOCs and metals that were detected at the Site. Alternative 2 assumes that these contaminants would attenuate through natural processes prior to impacting downgradient water supply wells.

The in-situ enhanced bioremediation proposed in this BTSA would be intended to reduce chlorinated VOC concentrations in groundwater within contaminant "hot spots" located in the loading dock and north building entrance areas, and to reduce VOC concentrations in overburden and bedrock groundwater plumes located downgradient of the contamination "hot spots". In-situ enhanced bioremediation through the addition of HRC is a relatively innovative process, and site conditions could affect its effectiveness and implementability. A pilot test would be necessary to verify that this technique will be effective in reducing contaminant concentrations at this Site.

The HRC injection system recommended for the Site would include a grid of approximately 100 injection points through which HRC would be applied to the overburden aquifer. Approximately 25 injection points would be advanced into the bedrock aquifer to provide enhanced bioremediation of chlorinated VOCs in bedrock. Injection point spacing would be based on analysis of aquifer test results and geological observations, so that the entire groundwater contaminant plume would be contacted by the HRC. Groundwater monitoring would be performed on a quarterly basis to track remedial progress and evaluate the effectiveness of the HRC at decreasing the concentrations of the target contaminants.

7.3 Future Considerations for Site Redevelopment

Reducing VOC concentrations in groundwater to background or to meet RSR criteria can be technically difficult. The presence of DNAPL, which analytical data indicates is likely to be present on the Site, and the contamination of the bedrock aquifer exacerbates this difficulty and may make achievement of background or GA GPC technically impracticable at this site. Therefore, the goal of the recommended remedial measures is to remove soil and groundwater that are acting as sources of VOC contamination to downgradient areas, and then allow natural attenuation to reduce contaminant concentrations to background. The response action conducted in 2001 by EPA removed several sources of contamination to groundwater. If additional sources of contamination are identified during the recommended additional investigations, they should also be removed so that additional treatment and natural attenuation of groundwater contamination can proceed within a reasonable time period.

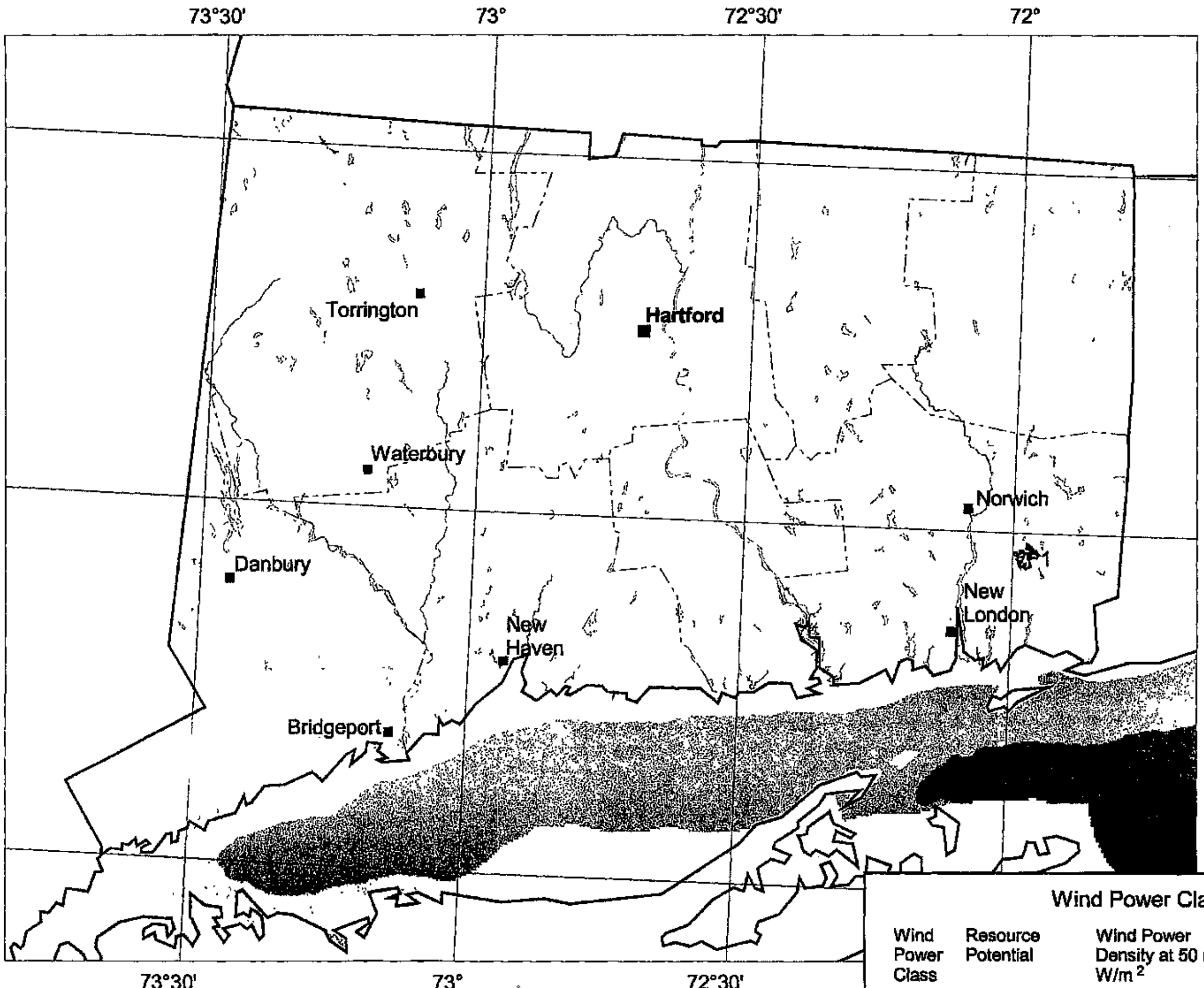
Redevelopment of the Site for a use that involves the presence of on-site workers will require a water supply well to provide (at a minimum) water for waste disposal. Construction of a new water supply well upgradient (southwest) of the source area will be required since the existing wells are heavily contaminated and should be closed since they are located in the contaminant plume and may provide a preferential pathway for migration of overburden contamination to the bedrock aquifer.

Redevelopment of the Site must consider constraints to construction of new buildings and other site feature that may be imposed by the installation and operation of remedial systems. For example, installation of a groundwater extraction system on the Site will involve installation of extraction wells, piping, electrical wiring, a treatment system, and a groundwater discharge system. The construction of buildings, parking areas and wastewater discharge systems must not damage system components, or otherwise interfere with a system's operation, maintenance or effectiveness.

The elevated levels of VOCs present in the bedrock aquifer on the Site indicate that water from a new supply well is likely to become contaminated due to drawdown-influenced migration of contaminants from the on-site source area(s). This well should be connected to a point-of-use water treatment system to remove VOCs. Both raw and treated water should be monitored monthly for VOCs and metals. The point-of-use water supply treatment system will prevent exposure to VOCs by building occupants in the event that contamination is drawn into the new water supply well. Ion exchange may be required if water from the new water supply well contains elevated metal concentrations. It should be noted that pumping of a new supply well might mobilize contamination from the source area(s) in such a way that it impacts additional downgradient properties.

Connecticut

50 m Wind Power



The annual wind power estimates for this map were produced by TrueWind Solutions using their Mesomap system and historical weather data. This work was commisioned by the Massachusetts Technology Collaborative, in conjunction with the Connecticut Clean Energy Fund and Northeast Utilities, and the results have been validated by NREL.

Wind Power Classification

Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m^2	Wind Speed [a] at 50 m m/s	Wind Speed [a] at 50 m mph
1	Poor	0 - 200	0.0 - 5.6	0.0 - 12.5
2	Marginal	200 - 300	5.6 - 6.4	12.5 - 14.3
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	> 800	> 8.8	> 19.7

[a] Wind speeds are based on a Weibull k value of 2.0

Indian Reservation

1 Mashantucket Pequot

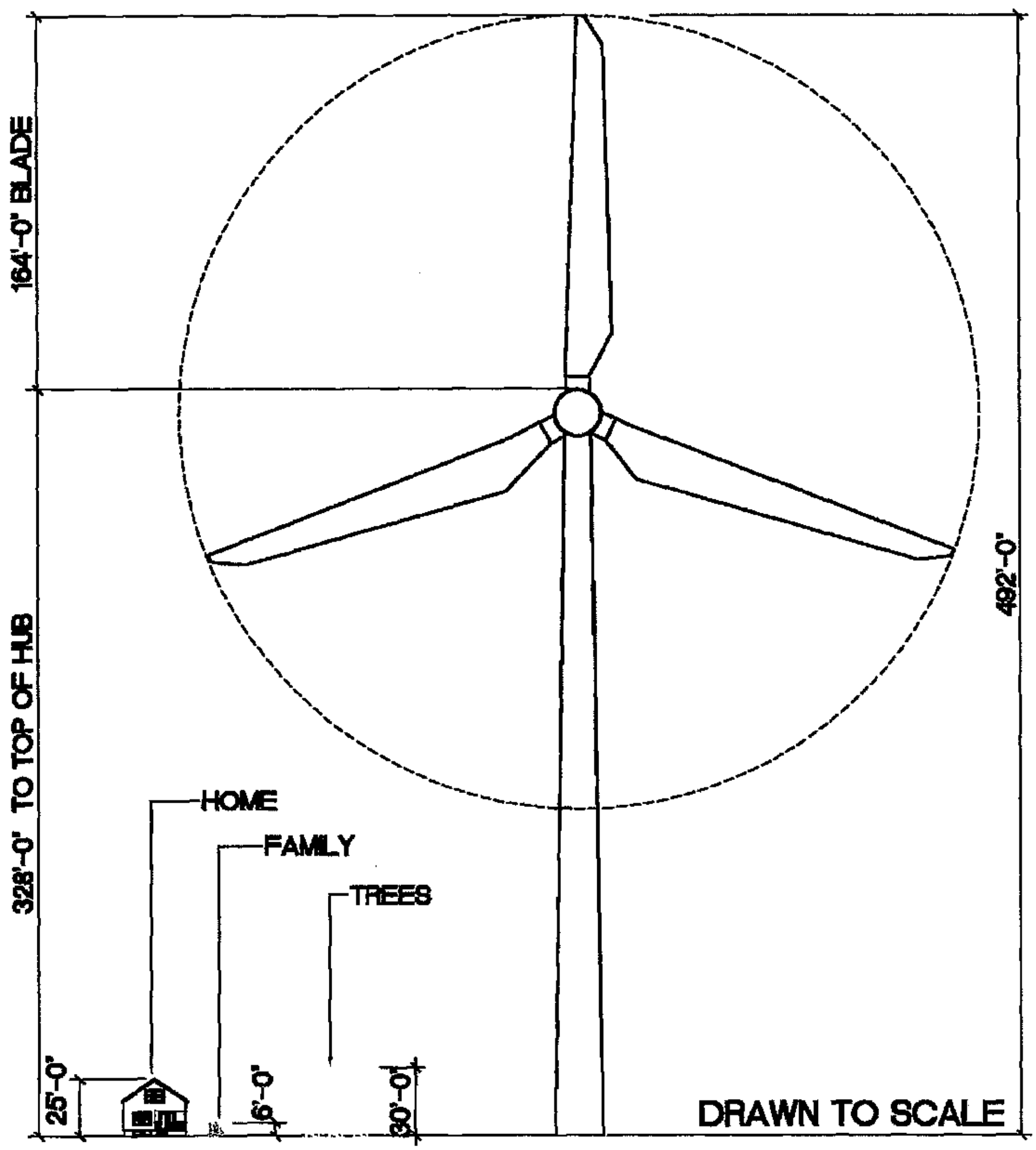
20 0 20 40 60 Kilometers

10 0 10 20 30 40 Miles

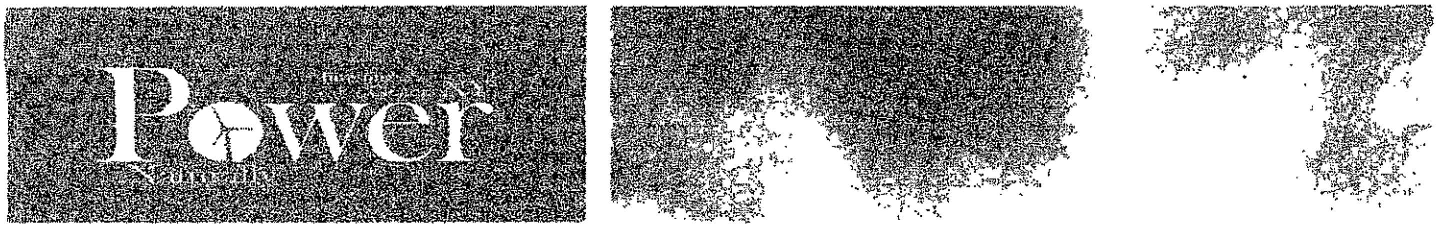
U.S. Department of Energy
National Renewable Energy Laboratory

06-FEB-2007 1.1.3

SOS PROSPECT



RESIDENTIAL + WIND TURBINE = NO



PUBLIC HEALTH AND SAFETY

New York Energy Smart

NYSERDA

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Albany, NY [illegible]

Prepared by
Global Energy Concepts

This document is one of a series of reports and guides that are all part of the NYSERDA Wind Energy Tool Kit. Interested parties can find all the components of the kit at: www.powernaturally.org. All sections are free and downloadable, and we encourage their production in hard copy for distribution to interested parties, for use in public meetings on wind, etc.

Any questions about the tool kit, its use and availability should be directed to: Vicki Colello; vac@nyserda.org; 518-862-1090, ext. 3273.

In addition, other reports and information about Wind Energy can be found at www.powernaturally.org in the on-line library under "Large Wind."

NOTICE

Public health and safety issues associated with wind energy projects are different from other forms of energy generation since a combustible fuel source, fuel storage, and generation of toxic or hazardous materials are not present. However, wind energy projects do share similar electrical infrastructure requirements with conventional power generation facilities such as medium-voltage power lines and substation equipment. Unique concerns for wind turbines relate to the configuration of the equipment: blade throws, ice shedding, fire, and tower collapses. While most of these are extremely unusual events, public agencies generally address these potential occurrences by establishing reasonable setbacks from residences and public corridors based on the size of the turbine and blades.

Blade Throw

A turbine blade can break due to improper design, improper manufacturing, improper installation, wind gusts that exceed the maximum design load of the turbine structure, impact with cranes or towers, or lightning. The distance a blade piece can be thrown from a turbine depends on its mass, shape, speed at the time it breaks from the machine, the orientation of the blade at the time of the throw, and the prevailing wind speed.

Although a few instances of blade throws were reported during the early years of the wind industry, these occurrences are now rare, due in large part to better testing, design, and engineering of commercial wind turbines. Testing and design of blades is discussed in more detail later in this paper.

Fire

Wind turbines have caught fire; however, this is an extremely rare event. Typically, a turbine fire is allowed to burn itself out while staff personnel and fire personnel maintain a safety area around the turbine and protect against the potential for spot ground fires that might start due to sparks or falling material. Power to the section of the project with the turbine fire is also disconnected. An effective method for extinguishing a turbine fire from the ground does not yet exist, and the events do not last long enough to warrant aerial attempts to extinguish the fire. However, since the public typically does not have access to the private land on which the turbines are positioned, the public's well-being should not be at risk.

Tower Collapse

Although turbine tower collapses are rare, there are reported instances of tower collapse due to various circumstances. The reasons for collapses vary depending on conditions and tower type, but have included blade strikes, rotor overspeed, cyclonic winds, and poor or improper maintenance (torque bolts). In cases where information is available, the majority of the major components (rotor, tower, and nacelle) have fallen to within 1 to 2 hub-height distances from the base. As with turbine fires, members of the public do not typically have access to the private lands on which wind farms are located. As of May 2005, no member of the public has been killed or injured by a failure of a wind turbine.

Ice Shedding

Ice can accumulate on the blades, nacelle, and tower during certain extreme cold-weather conditions. Many times turbines will shut down in icing conditions because the wind vane and/or anemometer sensors become frozen, rendering the turbine inoperable. Ice formation can also reduce power production, which is sensed by the control system that subsequently halts turbine operation. As the ice melts it will fall to the ground in the vicinity of the turbine.

During operable wind speeds and when the turbine has not yet been shut down automatically or manually, ice can break off the blades and be thrown from the turbine (instead of dropping straight down). The distance traveled by a piece of ice depends on the position of the blade when the ice breaks off, the location of the ice on the blade when it breaks off, the rotational rate of the blade when the ice breaks from the blade, the mass of the ice, the shape of the ice (e.g., spherical, flat, smooth), and the prevailing wind speed.

No injuries have been reported as a result of ice throws, however, manufacturers and blade designers continue to research materials and methods that could be employed to reduce the possibility of ice accumulation and subsequent throws. Design features such as the use of black blades and the applications of special coatings have been used at some cold-weather sites. The best practices to reduce the possibility of ice throws include establishment of setback safety zones around the turbines and modifications to the turbine operation during periods of icing, as listed below:

Turbine Controls – In addition to accumulating on the blades, icing also affects the wind speed and direction sensors on the nacelle that provide information to the control system of the turbine. If the sensors become iced up, the control computer detects no wind speed and/or no change in the wind direction and then stops turbine operation automatically. When ice melts from the sensor, the control computer automatically returns the turbine to operation. Icing on the blades also results in reduced performance, unusual loads, or vibrations that are detected by the control system and trigger an automatic stop. In these cases, the turbine remains off-line until an operator inspects and manually restarts the turbine. If the turbine is not operating, ice from the blades, nacelle, and tower falls to the ground in the immediate vicinity of the machine.

Operator Intervention – Project operators can halt operation of certain turbines (or the entire project) during icing events to prevent ice throws and equipment damage. Provided some wind is available, site operators can manually 'bump' the rotor for a few slow rotations to make the blades flex and relieve some of the ice build-up. Under these conditions, the slow rotor speed will again result in ice falling to the ground in the immediate vicinity of the machine.

Safety Zones – Establishing adequate setback areas from inhabited buildings, roads, and power lines significantly reduces the risk of injury or damage in the event of ice throws. Research into quantifying ice throws is limited, probably due to the fact that there have been no reported injuries associated with these events. The most complete study to date has been performed in the UK by C. Morgan, et al. The study quantified the risk of possible strikes from ice throws, in terms of distance from the turbine. The study does not propose specific setback distances but provides information to help establish setbacks that are comparable to other levels of risk. For moderate icing conditions (5 icing days per year) setback distances of 750 ft to 1150 ft correspond to potential strike risks of 1 in 10,000 to 1 in 1,000,000 per year, respectively. (The probability of being struck by lightning is 1 in 1,000,000 per year). This study assumes a wind turbine with a 50-m (164-ft) rotor.

Another factor to consider when assessing the risk of ice throws from wind turbines is that the power grid is also impacted by ice formation and power to the project may be interrupted by the utility due to repair work or actual outages. Turbine operations stop immediately when grid power is lost, thereby reducing ice throw risks.

The people most at risk from falling ice are the site personnel, as most ice falls from the blades, nacelle, and rotor near the base of the tower. Most project developers have strict rules established for personnel and operations during icing events to prevent worker injury and to protect the public.

Vandalism

Though not unique to wind turbine installations, the potential for vandalism or trespassing can also cause safety concerns. Wind turbines may attract more attention than other structures. Project developers report incidences of unauthorized access on their sites ranging from curiosity seekers to bullet holes in blades. Permits usually require fencing and postings at project entrances to prevent unauthorized access. Other requirements intended to reduce personal injury and public hazards include locked access to towers and electrical equipment, warning signs with postings of 24-hour emergency numbers, and fenced storage yards for equipment and spare parts. Fencing requirements will depend on existing land uses such as grazing. Some communities have established information kiosks along roadsides to channel curious sightseers out of road traffic and into an area that is a safe distance from the turbines.

Working with Local Emergency Response Teams

Project developers commonly work with local emergency response teams to provide information or training on tower rescues and other wind-specific concerns. Falls, injuries from heavy or rotating equipment, and injuries from electricity represent the types of events that can occur at a wind energy facility. The height of the nacelles provides an additional challenge for medical responders. The national Occupational Safety and Health Administration (OSHA) regulations, in addition to state worker safety regulations, cover all of the worker safety issues associated with electricity, structural climbing, and other hazards present in a wind farm.

Mitigation Through Setbacks

Many concerns associated with safety, noise, and aesthetics can be addressed by placing distance between the wind turbines and people, property lines, roads, and scenic areas. Although no consensus on appropriate distances or types of setbacks exists, there are several common themes that appear in a number of wind energy regulations in place as of May 2005.

Most local government requirements include setback specifications for the distance between the wind turbine and structures (residences and other buildings), property lines, and roads. A few agencies have also defined setbacks from railroads and above-ground transmission lines. The most common way to define a setback distance is in terms of a multiple of the turbine height (for example 1.5 times the wind turbine height). Other options are to specify a fixed distance or a combination of a fixed distance and a multiple of the turbine height. When specifying the structure height, it is important to define whether the height is the top of the nacelle or the highest point reached by the rotor blade (maximum tip height, or MTH).

Examples

Wind turbine setbacks from residences

- Fenner/Stockbridge, NY – 1.5 x MTH
- Martinsburg, NY – 1500 ft
- Contra Costa County, CA – 2 x MTH
- Palm Springs, CA – 1200 ft

With regard to setbacks from structures and residences, some permitting agencies differentiate between houses and buildings on the property leased for the project, and houses and buildings on *adjacent* parcels. The implication is that a greater distance is appropriate from structures on adjacent parcels since those properties have less control over the development than the landowner. A waiver of such requirements is typically granted if written permission is provided from the neighboring landowner.

Setbacks from property lines may vary for side and rear lot lines but are generally specified in the same way as setbacks from residences. Setbacks from property lines can pose a challenge for small wind turbines since these installations tend to occur on smaller landparcels. To address this issue, some agencies define setbacks for *commercial* wind turbines only. Small turbines are either exempt or evaluated on a case-by-case basis. Turbines should be exempt from property line setbacks if the adjacent property contains a wind turbine from the same plant, or the adjacent property is a participant in the project through a land lease and/or wind access agreement. This is an important consideration particularly in New York, since turbine layouts and plant infrastructure can result in many parcels of land being utilized for one project.

> **Examples**
>
> Wind turbine setbacks from property lines
>
> Fenner/Stockbridge, NY – 1.5 x MTH
>
> Martinsburg, NY – 300 ft (rear and side lot lines)
>
> Contra Costa County, CA – 3 x MTH or 500 ft, whichever is greater (from all boundaries)
>
> Cook County, MN – tower height
>
> Wasco County, OR – at least 5 rotor diameters

Setbacks from roads are typically greater for major highways than for local roads. In some cases, scenic setbacks have been required from particular state highways in close proximity to designated wind development areas.

When establishing setbacks, the intended effect must be balanced with economic considerations for the project and overall permitting objectives. For example, a setback decision made by a Town Board in Addison, Wisconsin, had the effect of reducing the number of proposed turbines by more than two-thirds for a wind project in their jurisdiction. The project developer proposed a setback of 650 ft around each turbine (approximately 2.5 x MTH) to address concerns raised about noise, safety and visual impacts. The Town Board decided to expand the setback to a minimum of 1000 ft from any residences, road right-of-ways, or property boundaries. The developer had a limited ability to re-position the turbines on the remaining leased property while still maintaining an acceptable energy output from the project. As a result, the number of proposed turbine sites was reduced from 28 to approximately 8 and the developer dropped the project because it was uneconomical.

Safety in Design, Construction, and Operation

Wind turbines and wind power projects are inspected by the utilities (for grid and system safety) prior to being energized and during operation. In the design phase, state and local laws require that licensed professional engineers review and stamp the structural elements (tower, foundation, roads, building, etc.) and the electrical collection system.

Depending on the local requirements and permits, building inspectors can inspect the project. Finally OSHA has the authority to inspect working conditions.

Wind turbines and wind energy project installations are designed to meet numerous applicable standards. Many of these standards are common to a wide range of industrial equipment and electrical and structural installations. All engineered structures and power generating equipment in the United States must meet a number of codes and standards as dictated typically by the local municipalities and the interconnecting utilities. At the top level of these are the National Building Code and the National Electrical Code. All, or part, of these codes are typically included in municipal permitting regulations. These codes include standards for earthquakes, structural integrity, electrical specifications, and power quality. Local municipalities may have noise, environmental, and safety codes as well. The interconnecting utility may also have its own set of design requirements that pertain to power factor, voltage, frequency and the like. These are often based on applicable Institute of Electrical and Electronic Engineers (IEEE) standards.

Others pertain to wind-turbine-specific design standards, including the International Electrotechnical Commission (IEC) standards for design and safety. The IEC standards are contained in Sections 61400 and can be found at http://www.awea.org/standards/iec_stds.html. Some of the areas addressed in the wind-turbine-specific design standards include, but are not limited to, wind regime definitions, load cases, and safety factors. The overall certification requirements are codified in an individual standard, as are the detailed methodologies for testing power performance, acoustic noise emissions, power quality, and blade structure.

For example, the IEC 61400 group of wind turbine standards includes a section on blade testing. Testing to these standards is conducted by both independent agents and by the blade and turbine vendors themselves. The test standards include procedures for both fatigue and maximum-strength tests. The fatigue testing typically includes long-duration testing (one to three months) by continuously cycling the load on the blade. The maximum strength test is designed to mimic an extreme load event. In each case the blade is either proof tested to a predetermined load or tested to failure, depending on the goals of the test. Blade tests are carried out at the NREL/NWTC facility in Boulder, Colorado, in the U.S., at the Risø National Laboratory in Denmark, the Technical University at Delft in the Netherlands, and CRES in Greece. In addition, LM in Denmark, a blade manufacturer, maintains its own blade test facilities as does turbine manufacturer Vestas (NEG Micon has its own facility, which is now also Vestas).

Three certifying bodies have established procedures for reviewing manufacturer's designs and confirming compliance with these standards: Underwriters Laboratory, Germanischer Lloyd, and Det Norske Veritas. All wind turbines must meet the design and safety requirements in order to be certified by one of these bodies. Certification to these standards is a nearly universal requirement for a wind power project to be built or financed.

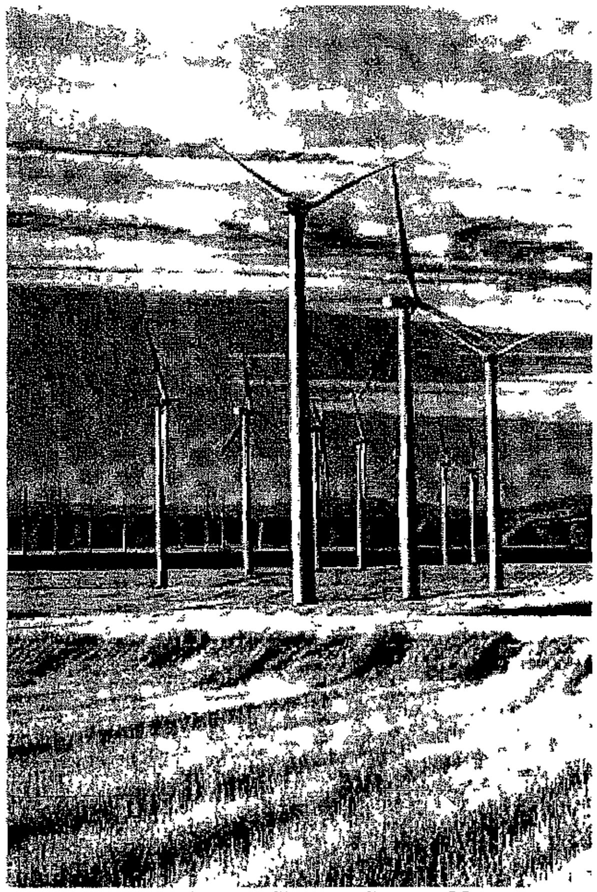
Additional Resources

NWCC Siting Subcommittee (1998) Permitting of Wind Energy Facilities: A Handbook. Washington, National Wind Coordinating Committee

Morgan, C., E. Bossanyi, et. al. (1998) Assessment of Safety Risks Arising From Wind Turbine Icing. BOREAS IV Conference Paper, Finland.

The Germanischer Lloyd, Det Norske Veritas, and Underwriter's Laboratory standards are available from these entities. For information about these certifying bodies, see the following web sites: http://www.gl-group.com/start.htm and http://www.dnv.com/ and http://www.ul.com/.

WIND POWER SITING, INCENTIVES, AND WILDLIFE GUIDELINES IN THE UNITED STATES



Wind Farm Sherman County, OR

ASSOCIATION *of* FISH & WILDLIFE AGENCIES

U.S. FISH & WILDLIFE SERVICE

October 2007

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EXECUTIVE SUMMARY

Wind energy is an increasingly important renewable energy source and offers promise for contributing to renewable energy portfolios to reduce greenhouse gas emissions from carbon-based sources. While many believe that wind energy is environmentally benign, there can be costs to wildlife and essential habitats.

This report details the current status of wind siting regulations, incentives for wind energy development, and wind siting guidelines for wildlife issues in the United States. In addition, a review was conducted on which states had "little NEPA's" (state environmental policy acts with similar environmental assessment provisions to the National Environmental Policy Act) to determine if there was any additional environmental review requirements that wind development would be subject to. The report is intended to provide baseline information about these issues as state and federal natural resource managers assess ways to proactively address concerns about the impacts to wildlife from wind development.

Because of the growing interest in renewable energy, wind power siting processes are developing rapidly with legislative or regulatory changes occurring regularly across the country. Every effort was made to make this report as accurate as possible. The contents of this report are the results of a survey of state fish and wildlife agencies as well as independent research. The results were made available for review by the state fish and wildlife agencies to verify the results and the contents are believed to be accurate as of October 26, 2007.

Notes:
State Data on Installed Utility-Scale Wind Power Capacity from the **American Wind Energy Association** as of June 30, 2007 (http://www.awea.org/projects/).

State Data on Renewable Portfolio Standards and Renewable Energy Incentives from **Database of State Incentives for Renewable Energy** (www.dsireusa.org).

OVERVIEW OF STATE WIND POWER SITING PROCESSES

States vary widely in their approach to the wind power siting process. The two most common approaches are through the state's public utilities commission (or similar name) or the local communities that may or may not have zoning requirements. However, since wind development is a new issue in many cases or if there is limited wind potential in the state, there is often no specific process for wind development. Only six states – Colorado, Minnesota, North Dakota, Oregon, South Dakota and Vermont – had wind specific siting authority at the time of this review.

Typically, if a development will exceed a certain size it will fall under the jurisdiction of the utilities commission; however the threshold for consideration varies widely. In states that have a longer history of wind development, the threshold might be lower. For instance, the Public Utilities Commission in Colorado has jurisdiction over wind facilities that are greater than 2 megawatts (MW) or has a structure greater than 50 feet tall. In Minnesota, the Public Utilities Commission regulates large wind energy conversion systems which are defined as greater than 5 MW. Connecticut's Siting Council is responsible for renewable energy facilities greater than 1 MW. In contrast, New Mexico's Public Regulation Commission does not have wind-specific regulatory authority and the threshold for PRC review of energy generating facilities is 300 MW. Arizona, Massachusetts and Wisconsin also do not have wind-specific authority and the threshold for review of energy facilities in these states is 100 MW. If a facility does not fall within the threshold of consideration by the utility commission, it often will fall to local jurisdiction for review or there may be no specific siting regulation.

In nearly a quarter of states, wind siting is managed by local jurisdictions. In many cases, local zoning or planning regulations impact wind siting and often there is state-based environmental permitting as well. However, in rural counties there may be no zoning or planning authority.

OVERVIEW OF STATE ENVIRONMENTAL POLICY ACT APPLICABILITY TO WIND POWER SITING

Currently, there are sixteen states that have a state environmental policy law that requires some form of environmental assessment. The laws vary as to what types of projects trigger environmental impact analysis - some only require review for state agency or state funded projects, others also require review for any project that requires a state permit, license or certificate and some laws also impact local government projects as well. The latter two categories are the primary way that wind development would require environmental assessment, or if the development receives some state funding through one of the incentives available. A short list of these states, the name of the law, the code and the year enacted is below. A more detailed review of each of these laws and its applicability to wind is included in the wind summaries by state.

States with Environmental Policy Acts

California Environmental Quality Act - California Public Resources Code Division 13 §§21000 to 21177, CA Code of Regulations Chapter 13 §§15000 to 15387, 1970

Connecticut Environmental Policy Act - Connecticut General Statutes, Title 22a, Ch. 439, §§ 22a-1 to 22a-1i , §§ 22a-1a-1 to 22a-1a-12, 1972

Georgia Environmental Policy Act - Official Code of Georgia Annotated, Ch. 12-16 (12-16-1 to 12-16 23), Ch. 391-3-16, 1991

Hawaii Environmental Impact Statement law - Hawaii Revised Statutes, Ch. 343, Hawaii Administrative Rules (HAR), Title 11, Ch. 200, 1974

Indiana Environmental Policy Act - Indiana Code Title 13, Art. 12 Ch. 4 (13-12-4-1 through -10), 329 Indiana Administrative Code (IAC) Art. 5, Rules 1

Maryland Environmental Policy Act - Annotated Code of Maryland, Natural Resources Title, Subtitle 3, §§ 1-301 to 1-305, State departments have developed their own regulations (e.g. Dept. of Transportation is COMAR 11.01.08.01 to .08), no specific guidelines in DNR title., 1974

Massachusetts Environmental Policy Act - Mass. General Laws, Title III, Ch. 30, §§61, 62-62H, 301 CMR 11.00, 1977

Minnesota Environmental Policy Act - Minnesota Statutes, Ch. 116D, Minnesota Rules, Ch. 4410, 1973

Montana Environmental Policy Act - MCA Title 75, C. 1, Pts. 1-3, Administrative Rules of Montana (ARM) Ti. 17, Ch. 4, Subch. 6: 17-4-601 through 17-4-636, 1971

New Jersey, Executive Order 215 (Kean, 1989) - §§ 7:22-10.1 to 7:22-10.12 of the NJ Administrative Code provides the guidelines on environmental assessment for projects receiving state funding, 1989

New York State Environmental Quality Review Act - Environmental Conservation Law Sections 3-0301(1)(B), 3-0301(2)(M) and 8-0113, 6 NYCRR Part 617, 1978

North Carolina Environmental Policy Act (SEPA) - North Carolina General Statutes, Ch. 113A, §§ 113A-1 to 113A-13, North Carolina Administrative Code, Title 15a, Ch. 01, Subch. 01C.0101-0411 (1 NCAC 25, 1971

South Dakota Environmental Policy Act - South Dakota Codified Laws, 34A9-1 through 34A9-13, 1974

Virginia - Code of Virginia §10.11188 through 1192, 1973

Washington State Environmental Policy Act - Revised Code of Washington 43.21C, Washington Administrative Code 197-11, 1971

Wisconsin Environmental Policy Act - Wisconsin Statutes, Ch. 1, 1.11(1) through 1.11(5), Wisconsin Administrative Code, NR 150.01 through NR 150.40, 1972

In researching state environmental review law, eight additional states had a similarly named law (e.g. [State] Environmental Quality Act, [State] Environmental Improvement Act, etc.) that did not include any provisions requiring environmental assessment. Typically these laws were created to establish the state's environmental agency and/or to establish its permitting authority. A list of these states and the code is below.

States with similarly named Acts with no assessment provisions

Arizona Environmental Quality Act - Arizona Administrative Code Title 18

Idaho Environmental Protection and Health Act - Idaho Code §39-101 et seq, 1972

Illinois Environmental Protection Act - 415 ILCS 5/, 1970

Maine Site Location of Development Law - MRSA Title 38 Chapter 3 Subchapter 1 Article 6 §§481 to 490

Michigan Natural Resources and Environmental Protection Act - Act 451 of 1994 Articles I-IV, 1994

New Mexico Environmental Improvement Act - 74-1-1 to 74-1-10 New Mexico Statutes Annotated, 1978

Oklahoma Environmental Quality Act - Oklahoma Statutes Title 27A 1-3-101, 1993

Wyoming Environmental Quality Act - Wyoming Statutes, Title 35 Chapter 11

OVERVIEW OF STATES WITH WIND/WILDLIFE GUIDELINES

In review of state fish and wildlife agency response to wind power siting, it is apparent that this is a relatively new issue for most agencies and that the majority can provide suggestions to developers but most existing guidelines are voluntary. Some states' guidelines were developed primarily by the fish and wildlife agency and focused entirely on wildlife issues, while others included wildlife recommendations among guidelines ranging from public safety and recreational considerations to sound and visual impacts.

Only three states currently have mandatory siting requirements through provisions within their power siting authority's regulations. Maryland was poised to be the fourth state with mandatory guidance, however a law passed in early 2007 exempted most wind development (projects 70 MW or less) from review by the Public Service Commission; whether Maryland's proposed guidelines will be approved by the PSC is now in question.

There are twelve States that have final or near-final voluntary guidelines that were available for review and analysis for this report. These ranged from Ohio's that outlined the Department of Natural Resources permitting authorities, to California's draft guidelines that take a comprehensive look at all stages of wind development with detailed recommendations. Four states are in the process of developing guidelines but have not made them available publicly prior to the writing of this report. And four states use the U.S. Fish & Wildlife Service's interim guidelines when addressing wind development.

Finally, five states approached siting that is largely handled by local jurisdictions by developing model zoning requirements. These documents provided recommendations or existing examples of how local governments are already approaching the issue.

Only one state, Kansas, has a position statement on wind power siting (Kansas also has existing guidelines and a model zoning publication).

States with Mandatory siting requirements through siting rules

Colorado
Oregon
West Virginia

States with Final or Near-Final Voluntary Guidelines

Arizona - *Wind Energy Development Guidelines*, Final - July 2006.

California - *California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development* (pub # CEC-700-2006-013-SD), Final – September 14, 2007.

Iowa - *Wind Energy and Wildlife Resource Management in Iowa - Avoiding Potential Conflicts*, Final – October 2007

Kansas - *Siting Guidelines for Windpower Projects in Kansas,* Kansas Renewable Energy Working Group, Final - April 2005.

New Hampshire - *Proposed guidance for wind siting permitting process*. Preliminary draft submitted by Wind Energy Facility Siting Guidelines Working Group on May 29 2007 to NH Energy Policy Committee Wind Siting Subcommittee for review. Focuses only on guidelines for permitting process and does not include post-construction mitigation or operational surveys.

New Mexico - *Impacts of Wind Energy Development on Wildlife*, January, 2004

Pennsylvania - *Standardized Site Assessment and Monitoring Procedures Regarding Bats/Birds and Wind Power Development; Mortality Studies Guidance*, Final

South Dakota - *Siting Guidelines for Wind Power Projects in South Dakota*, Final

Vermont - *Guidelines for the Review and Evaluation of Potential Natural Resources Impacts from Utility-Scale Wind Energy Facilities in Vermont*, Draft - April 2006

Washington - *Washington State Wind Power Guidelines*, Final - August 2003

Wisconsin - *Considering Natural Resource Issues in Wind Farm Siting in Wisconsin*, Final – August 2005.

Guidelines in place but do not include prescriptive siting recommendations

Ohio - The Ohio Department of Natural Resources' (DNR) guidance is a comprehensive list of DNR authorities that may be related to the location and operation of wind power generating facilities. For larger projects, a report containing detailed location maps, construction activities, an environmental/biological assessment is usually sent to the DNR by Ohio's Power Siting Coordinator in the Public Utilities Commission of Ohio.
Final - August 29, 2005

States with Model Zoning

Hawaii
Kansas
Massachusetts
Michigan - *Michigan Siting Guidelines for Wind Energy Systems*, Final - December 2005
Oregon

States that use the US Fish and Wildlife Service interim guidelines or other state's guidelines

Nevada
Montana
North Dakota
Oklahoma

States with Draft Guidelines not available for review

Indiana
Maine
New York
Texas

States with Wind Position Statements

Kansas

ALABAMA

BACKGROUND

Contact: Gary Moody, Gary.Moody@dcnr.alabama.gov

Installed Utility Scale Wind Power: None

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: No

Incentives for Industrial or "Big Wind" Production:
None

Incentives for Residential and "Small Wind" Production:
TVA Green Power Switch Partners Program - \$500 plus \$.15/kWh (residential/small-commercial) or \$0.20/kWh (large commercial) to purchase entire production of renewable power including wind; systems must be 50 kW or less.

Interconnection and Net Metering Standards:
No net-metering/interconnection standards

ENERGY SITING PROCESS

Power Siting Authority: No state agency regulates wind power in the state. Wind potential is limited and not a focus of the state renewable energy program. Utilities seeking to build a generation plant have to file with the Alabama Public Service Commission for a Certificate of Public Convenience and Necessity. The jurisdiction of the Commission is limited to investor-owned utilities providing retail service to the public. However, air permits are required from the Department of Environmental Management.

Wind Specific Siting Authority? No

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No Guidance

ALASKA

BACKGROUND

Installed Utility Scale Wind Power: 2 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: No

Incentives for Industrial or "Big Wind" Production:
Power Project Loan Fund - Loans from state to local governments, local utilities and independent power producers for development or upgrade of small scale power production facilities that use renewables including wind.

Incentives for Residential and "Small Wind" Production:
Golden Valley Electric - Sustainable Natural Alternative Program (SNAP) - up to $1.50/kWh to purchase all power from small (max 25 kW) systems including wind.

Interconnection and Net Metering Standards:
No net-metering/interconnection standards.

ENERGY SITING PROCESS

Power Siting Authority: Regulatory Commission of Alaska provides a Certificate of Public Convenience and Necessity to any utility that provides electricity (and other utility service) to ten or more people. This is not a siting review, but if a facility was to be used commercially without choosing to be unregulated it would need to go through this process. Smaller facilities or city utilities would be regulated at the municipal level. Most siting decisions would also be made at the local level.

Wind Specific Siting Authority? No

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No Guidance

ARIZONA

BACKGROUND

Contact: Ginger Ritter, Arizona Game and Fish Dept.-WMHB, 602-789-3606, GRitter@azgfd.gov

Installed Utility Scale Wind Power: None

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes -15% by 2025

Incentives for Industrial or "Big Wind" Production:
Corporate (commercial, industrial, schools, etc.) tax credit of 10% of installation cost up to $25,000 per building and $50,000 in total credits in one year.

Incentives for Residential and "Small Wind" Production:

- Sales tax exemption for the retail sale and installation by contractors of "solar energy devices" which is defined to include wind electric generators and water pumps.
- Arizona's Solar Energy Credit provides an individual taxpayer with a credit for installing a solar or wind energy device at the taxpayer's Arizona residence, a credit of 25% of the cost of a solar or wind energy device, with a maximum limit of $1,000 is allowed against the taxpayer's personal income tax.

Interconnection and Net Metering Standards:
The state's utilities individually developed distributed generation interconnection agreements prior to the Arizona Corporate Commission's current proceeding to establish statewide standards. The utilities' net-metering varies by utility, but generally relates to systems of 10 kW or less.

ENERGY SITING PROCESS

Power Siting Authority: Arizona Power Plant and Transmission Line Siting Committee provides a Certificate of Environmental Compatibility (CEC) to build power plants of 100 MW or more. Smaller facilities are handled at the county level.

Wind Specific Siting Authority? No

Code or Regulations: APPLSC Authority: Arizona Revised Statute - 40-360.01. Criteria for Certificate for Environmental Compatibility - ARS § 40-360.06

Role of State Fish & Wildlife Agency: The Arizona Game & Fish Department reviews all CECs. However most proposed wind facilities are less than 100 MW, which does not require a CEC.

Therefore, the Department is working with counties and the AZ State Land Department to get wildlife concerns incorporated into decisions.

How are wildlife laws applied: Same as any other development project; plans are analyzed for consistency with Commission and Department policies, management plans, and programs regarding the protection and conservation of fish and wildlife resources. The state provides project specific recommendations but does not have the authority to require mitigation.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Wind Energy Development Guidelines

Lead Agency on Guidelines: Arizona Game & Fish Department

Status of Wildlife Guidelines: Final - July 2006

Summary of Guidelines: Voluntary guidelines provide recommendations for minimizing the potential impacts of wind development on wildlife and their habitats. The guidance recommends a three year baseline survey, at various times of the year, prior to construction to assess the level of impact to wildlife and their habitats as well as an invasive species management plan. Outlines considerations for site placement, habitat fragmentation, power transmission, tower configuration, and tower design that should be addressed in the pre-construction phase. Describes steps to undertake during construction to reduce disturbance to habitats and wildlife including siting on previously disturbed areas, avoiding building during breeding periods, etc. Post-construction recommendations include conducting a three-year monitoring plan to assess movement, mortality, behavior changes, and abundance of local species for potential future facility design modifications to reduce impacts.

Web site for Guidelines: http://www.azgfd.gov/hgis/pdfs/WindEnergyGuidelines.pdf

	Detailed Summary of Arizona's Voluntary Guidelines
Pre-construction survey	Requires a three-year baseline survey to assess the level of impact to wildlife (local and migrating populations) and their habitats. Conduct surveys at various times of the year to assess breeding, wintering, and migrating wildlife use (raptors, bats, songbirds, etc.). Avoid developing in areas of high-density breeding birds or wintering raptors, in high wildlife use areas, or in migration corridors. Create an Invasive Species Management Plan during planning and development of project to address potential impacts from the introduction or spread of invasive species.

Design/Operation Recommendations	Recommends using underground power lines and raptor protective devices on above ground wires. Suggests development in cluster and/or string designs with non-bladed pylons at the ends of large cluster strings. Use tubular towers with lower blade reaches higher than 100 feet and upper blade reaches less than 400 feet tall, unless site-specific observations indicate more optimal tower and blade dimensions. Utilize the minimum blade rpm. Consider reducing the blade rpm during spring and fall bird migration, and nights. Minimize lattice towers with guy wires and use bird flight diverters when guy wires are necessary. Utilize white strobe lights with no more than 24 pulses/minute and a longer "off" phase between the flash phases of the light pulses. Paint the ends of the blades to minimize motion smear. Avoid riprap around towers to reduce prey species that attract raptors.
Site Development Recommendations	Recommends maximizing the use of flat land and gentle slopes; when ridges, canyons, cliffs, and fissures are within the project vicinity, offset the turbines at least 50 meters from the geologic features. Avoid placing strings or clusters of towers close to prairie dog colonies. Minimize the number of new roads constructed and maximize use of existing corridors and roads. Close and rehabilitate any unnecessary roads after completion of the project. Roads and rights-of-way that provide access to critical wildlife habitat should be designed for easy and effective closure. Gates should be installed at onset of construction and closed immediately after completion of the project. Temporary roads should be obliterated and re-vegetated immediately after construction. If possible, use agriculture lands or other disturbed areas.
Consultation with wildlife agency, USFWS	Recommends that developers of wind towers on private property should consider entering into a Habitat Conservation Plan with the U.S. Fish and Wildlife Service (USFWS) for the possibility of violating the Endangered Species Act, Migratory Bird Treaty Act, and the Bald and Golden Eagle Protection Act. Also recommends consulting with AZ Department of Agriculture to minimize impacts to native plants.
Mitigation requirements	None
Post-Construction/ Operational Surveys	A three-year monitoring plan should be developed to assess movement, mortality, behavior changes, and abundance of local species. Developers should control noxious weeds using approved herbicides and eliminate use of rodenticides to reduce concentrations of rodent populations on the perimeter of the facility. Current research recommends development of a Fire Management Plan.
Decommissioning	

ARKANSAS

BACKGROUND

Installed Utility Scale Wind Power: 0.1 MW

Renewable Portfolio Standard: No

INCENTIVES FOR WIND DEVELOPMENT

Incentives for Industrial or "Big Wind" Production:
None

Incentives for Residential and "Small Wind" Production:
None

Interconnection and Net Metering Standards:
Net-metering program that allows interconnection of residential renewable systems up to 25 kW and nonresidential systems up to 300 kW.

ENERGY SITING PROCESS

Power Siting Authority: Small wind power is regulated by local jurisdictions through zoning and land use regulations. Major utility facility construction is authorized by a Certificate of Public Convenience and Necessity issued by the Arkansas Public Service Commission.

Wind Specific Siting Authority? No

Code or Regulations: Arkansas Public Service Commission siting authority: (Ark, Code Ann. §23-3-201 et seq.)

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No Guidance

CALIFORNIA

BACKGROUND

Contact: Scott Flint, California Department of Fish & Game, sflint@dfg.ca.gov

Installed Utility Scale Wind Power: 2376 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - 1% increase per year to achieve 20% by 2010 - Governor has set goal of 33% by 2020.

Incentives for Industrial or "Big Wind" Production:
The California Energy Commission awards production-based incentives, referred to as Supplemental Energy Payments (SEPs), to eligible renewable energy generators for the above-market costs of renewable resources selected by investor-owned utilities – PG&E, SDG&E, and SCE – to fulfill their Renewables Portfolio Standard (RPS) obligations. Funded at approximately $70 million per year.

Incentives for Residential and "Small Wind" Production:

- Emerging Renewable Program - The California Energy Commission provides cash incentives for the installation of grid-connected small wind turbines (up to 50 kW): $2.50/W for first 7.5 kW and $1.50/W for increments > 7.5 kW and < 30 kW.
- Self-Generation Incentive Program provides incentives to customers who produce their own power, includes wind turbines (minimum of 30 kW) @ $1.50/W.

Interconnection and Net Metering Standards:
California specifies standard interconnection, operating and metering requirements for distributed generation (DG) systems up to 10 megawatts (MW) in capacity, including renewables, with separate simplified rules for small renewables under 10 kilowatts (kW). Net metering in California applies to renewable-energy systems up to 1 MW in capacity and includes provisions for time-of-use (TOU) net metering.

ENERGY SITING PROCESS

Power Siting Authority: Local agencies issue land use permits for wind energy

Wind Specific Siting Authority? No

Code or Regulations: California Environmental Quality Act (CEQA) requires state and local agencies to assess environmental impacts of proposed actions they undertake or permit.

Role of State Fish & Wildlife Agency: For wind energy projects subject to CEQA, lead agencies are required to consult with the California Department of Fish and Game (CDFG). In addition to CDFG's responsible and trustee roles in the CEQA process, direct consultation with CDFG is required to ensure that a proposed project will meet the intent of Fish and Game Code statutes for protection of wildlife species, including the California's Fully Protected Species Act and the California Endangered Species Act. CDFG cannot approve or disapprove a project but lead agencies are required to consult with the Department.

How are wildlife laws applied: Plans are analyzed for consistency with Commission and Department policies, management plans, and programs regarding the protection and conservation of fish and wildlife resources.

STATE ENVIRONMENTAL POLICY ACT

California Environmental Quality Act - California Public Resources Code Division 13 §§21000 to 21177, CA Code of Regulations Chapter 13 §§15000 to 15387, 1970

Overview:
An Environmental Impact Report (EIR) is required if there is a fair argument based on substantial evidence that the project may have a significant effect on the environment. An EIR is a detailed statement that describes and analyzes the significant environmental effects of a project and discusses ways to mitigate or avoid the effects. CEQA requires that an EIR consider a range of feasible alternatives that meet most of the objectives of the project and that the significant effects on the environment be mitigated to the extent feasible.

Projects Affected by Law:
Applies to public works (on state land or using state money, etc.) as well as private projects that require a permit from the state.

Public Participation Provisions:
CEQA requires that the public have notice and an opportunity to comment on any negative declaration, mitigated negative declaration, or EIR prepared under CEQA. If an EIR is prepared, the lead agency must prepare written responses to the comments.

Applicability to Wind Development?
Local Governments have wind siting jurisdiction and are subject to CEQA

Implementing Agency:
CEQA is a self-executing statute. The Resources Agency is charged with the adoption of CEQA Guidelines and may assist public agencies in the interpretation of CEQA, but does not enforce CEQA, nor does it review the many state and local agency actions which are subject to CEQA for compliance with the law.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development (pub # CEC-700-2006-013-SD)

Lead Agency on Guidelines: California Energy Commission in collaboration with CA Dept. of Fish & Game

Status of Wildlife Guidelines: Final – September 14, 2007

Summary of Guidelines: Voluntary guidelines provide information to help reduce impacts to birds and bats from new development or repowering of wind energy projects in California. Provides science-based reference for CA counties, cities and public utilities that permit wind energy projects. Include recommendations on preliminary screening of proposed wind energy project sites; assessing direct, indirect, and cumulative impacts to birds and bats in accordance with state and federal laws; developing avoidance and minimization measures; establishing appropriate compensatory mitigation; facilitating completion of the permitting process; and operations monitoring, analysis and reporting methods.

Web site for Guidelines: http://www.energy.ca.gov/2007publications/CEC-700-2007-008/CEC-700-2007-008-CTF.PDF

	Detailed Summary of California's Voluntary Guidelines
Pre-construction survey	Recommends a site-screening and a pre-permitting study plan to assess the site's sensitivity and species-specific data to evaluate a wind energy project's potential impacts to birds and bats. From site screening, sites will fall into one of four categories 1) project sites with available wind-wildlife data, where pre-siting evaluations could be completed in less than one year 2) project sites with little existing information and no indicators of high wildlife impacts, where pre-permitting surveys should last a minimum of one year 3) project sites with high or uncertain potential for wildlife impacts, where surveys in excess of one year are likely to be needed and 4) project sites inappropriate for wind development. Outlines detailed standards for acceptable surveys including bird use counts and raptor nest searches for diurnal birds, radar, acoustic monitoring, and visual monitoring for nocturnal migratory birds, and one year of acoustic monitoring for resident or migratory bats.
Design/Operation Recommendations	Provides recommendations for developing infrastructure at facilities to reduce or avoid impacts including appropriate turbine design and layout, reducing artificial habitat for prey at turbine base area, avoiding lighting that attracts birds and bats, minimizing power line impacts by placing lines under ground whenever possible, avoiding using structures with guy wires, and decommissioning non-operational turbines.

Site Development Recommendations	Recommends minimizing fragmentation and habitat disturbance. Suggests establishing buffer zones to minimize collision hazards (for example, avoiding placement of turbines within 100 meters of a riparian area).
Consultation with wildlife agency, USFWS	Recommends consultation with the U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Game (CDFG), CEQA lead agency, and other appropriate stakeholders during the site-screening, pre-permitting assessment phase in order to gather information and establish contacts with key individuals and organizations. For development of effective compensation measures, the guidelines recommend involving the CEQA lead agency, project proponent, wildlife agencies, and the affected public stakeholders through the CEQA process.
Mitigation requirements	Where planning and construction measures are insufficient to avoid or minimize estimated impacts to birds and bats, compensation can be used to mitigate or offset the impacts, including cumulative impacts. Recommends consultation with CDFG, USFWS, and species experts to develop site-specific ratios and fees to use for compensation formulae. Compensation typically involves purchase of land through fee title or conservation easements and the permanent protection of the biological resources on these lands. Recommends establishing a range of compensatory mitigation options to offset high levels of unexpected fatalities that consider operational and facility changes such as habitat modification, seasonal changes to cut-in speed, limited and periodic feathering of wind turbines during low wind nights, seasonal shutdowns, or removal of problem turbines.
Post-Construction/ Operational Surveys	In most situations, two years of operations monitoring is needed so that carcass counts and bird and bat use data can be collected in spring, summer, fall, and winter and capture variability between years. Category 1 projects need a minimum of one year of operations monitoring to assess whether pre-permitting impact estimates were as low as expected, and to evaluate the effectiveness of mitigation measures. Category 2 and 3 projects need the full two years of operations monitoring. Results of the first year of data should be assessed to determine whether modifications to the second year of study are warranted. Outlines specific survey needs for number of carcass search plots (at least 30% or turbines), search plot size (search width is equal to the maximum rotor tip height), search protocol, frequency of carcass searches (generally every 2 weeks for 2 years), searcher efficiency trials, seasonal carcass removal (scavenging) trials, bird and bat metrics, monitoring reports, bird use counts and bat acoustic monitoring.

Decommissioning	As part of permitting applications, developers should submit a decommissioning and reclamation plan that describes the expected actions when some or all of the wind turbines at a wind energy project site are non-operational. Decommissioning a project typically involves removal of turbine foundations to three feet (one meter) below ground level and removal of access roads, unnecessary fencing, and ancillary structures. The decommissioning plan should also include documentation showing financial capability to carry out the decommissioning and restoration requirements, usually an escrow account, surety bond, or insurance policy in an amount (approved by the lead agency) sufficient to remove the wind turbines and restore the site.

COLORADO

BACKGROUND

Contact: Tom Blickensderfer, CO Department of Natural Resources, (303)866-3157, t.blick@state.co.us

Installed Utility Scale Wind Power: 366 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - 3% for 2007; 5% for the years 2008 to 2010; 10% for the years 2011 to 2014; 15% for the years 2015 to 2019 and 20% for 2020 and beyond.

Incentives for Industrial or "Big Wind" Production:
Renewable-energy facilities installed are assessed property taxes as though their installed costs were comparable to those of nonrenewable-energy facilities. The incremental value of the renewable facilities above the nonrenewable facilities is disregarded. 2007 Assessment Cost Threshold is $627/kW up to 100 MW and $533/kW between 100 and 250 MW.

Incentives for Residential and "Small Wind" Production:

- Counties and municipalities are authorized to offer property or sales tax rebates or credits to residential and commercial property owners who install renewable energy systems on their property (enacted in April 2007).
- Gunnison County Electric Association provides a loan of up to $25,000 over 10 years for installation of renewable energy including wind.
- Holy Cross Energy's WE CARE (With Efficiency, Conservation And Renewable Energy) Program offers a $2.00-per-watt DC incentive for renewable energy generation including wind. Payments are not to exceed 50% of actual installed costs, and the maximum rebate per installation is $50,000.
- LaPlata Electric Renewable Generating Program provides one-time cash rebate to residential customers installing grid-connected renewable energy including wind - $2 per watt up to $2000.
- Qualified schools (criteria are statutory) may apply to the Wind for Schools grant program if authorized by their local board of education, through the Office of Energy Management and Conservation (adopted in 2007), for up to $5000 total to offset the costs of generating electricity for schools using wind turbines.

Interconnection and Net Metering Standards:
The Colorado Public Utilities Commission (PUC) net metering and interconnection standards apply to all qualifying retail utilities (QRUs) that serve 40,000 or more customers. Systems up to two megawatts (MW) in capacity that generate electricity using qualifying renewable-energy resources are eligible for net metering.

ENERGY SITING PROCESS

Power Siting Authority: Public Utilities Commission regulates 1) "Eligible Renewable Energy Resources" (as defined CCR Sub Document 3650(f)); 2) Larger than 2 MW; 3) Structure exceeding over 50 feet in height. Counties have addressed siting through County Master Plans. Included in this are master planning statutes for "location and extent" of public utilities, access to alternate energy facilities and location of "areas containing.....endangered or threatened species"

Wind Specific Siting Authority? Yes

Code or Regulations: Code of Colorado Regulations for Public Utilities Commission; 4 CCR 723-3656(b)(c),Colorado State Statutes re: County Master Plans: 30-28-106(3)(a)(III) C.R. S.; 30-28-106(3)(a)(VI) C.R.S.; 30-28-106(3)(a)(XI)(B) C.R.S

Role of State Fish & Wildlife Agency: PUC is required to consult with Colorado Division of Wildlife and U.S. Fish & Wildlife Service.

How are wildlife laws applied: Broad statutory authority to the Colorado Wildlife Commission and the Colorado Division of Wildlife to investigate populations and habitat needs of species and to promulgate rules and regulations to implement management programs in order to insure perpetuation of wildlife species. State can require mitigation for wildlife (game, non-game and threatened, endangered, and species of concern).

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Siting Authority serves as specific requirements for wildlife impact studies.

Lead Agency on Guidelines: CO Division of Wildlife

Status of Wildlife Guidelines: Current

Summary of Guidelines: Mandatory guidelines contained within PUC Rule require consultation with Colorado Division of Wildlife and U.S. Fish and Wildlife Service. Developers must provide certification of site-specific avian surveys conducted on facility site and verification that surveys are used in design, placement and management of facilities for state or federal listed species, sites shown to be local bird migration pathways and critical habitat and areas where birds or other wildlife are highly concentrated and are considered at risk.

Web site for Guidelines: www.sos.state.co.us/CCR

	Detailed Summary of Colorado's Siting Rule
Pre-construction survey	Before achieving commercial operation, the Qualified Retail Utility's Renewable Energy Supply Contract requires project developers to certify that the developer has performed and made publicly available site specific avian and other wildlife surveys conducted on the facility's site prior to construction. Developers are required to certify that they used the survey results in the design, placement, and management of the facilities to ensure that the environmental impacts of facility development are minimized to state and federally listed species and species of special concern, sites shown to be local bird migration pathways, critical habitat and areas where birds or other wildlife are highly concentrated and are considered at risk. These rules only apply to energy resources larger than 2 MW with any wind turbine structures extending over 50' in height.
Design/Operation Recommendations	None
Site Development Recommendations	None
Consultation with wildlife agency, USFWS	Qualified Retail Utilities must require project developers to include written documentation that consultation occurred with appropriate governmental agencies (for example, the Colorado Division of Wildlife or the U.S. Fish and Wildlife Service) responsible for reviewing potential project development impacts to state and federally listed wildlife species, as well as species and habitats of concern.
Mitigation requirements	None
Post-Construction/ Operational Surveys	None
Decommissioning	None

CONNECTICUT

BACKGROUND

Contact: Greg Chasko, Assistant Director, CT DEP - Wildlife Division, 860-424-3494, Greg.Chasko@po.state.ct.us, 79 Elm Street, Hartford, CT 06106

Installed Utility Scale Wind Power: None

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - 27% by 2020: 20% Class I resources (including wind); 3% Class I or Class II resources; 4% Class III resources by 2010

Incentives for Industrial or "Big Wind" Production:

- Connecticut Clean Energy Fund (CCEF) Project 100 Initiative requires the state's two electric distribution companies to obtain a total of at least 100 megawatts (MW) of "Class I" renewable energy (projects of at least 1 MW). Pricing under these contracts includes a premium of up to 5.5¢ per kilowatt-hour (kWh).
- The Connecticut Clean Energy Fund (CCEF) Operational Demonstration Program enables early-stage companies to demonstrate the effectiveness of their own near-commercial, clean-energy technologies (capacity of at least 1 kW) that have a high likelihood of developing into a commercial product within a reasonable period of time, projects must have a front-loaded 25% cash cost-share for any funding provided and the maximum amount of funding for each individual award is $750,000.

Incentives for Residential and "Small Wind" Production:

- Connecticut provides a property tax exemption for Class I renewable energy sources installed for the generation of electricity for private residential use provided such installation occurs on or after October 1, 2007 (was not mandatory exemption prior to 10/1).
- CCEF - On-Site Renewable Distributed Generation (DG) Program provides grants to support the installation of systems (including wind - $3.60 per watt; 15-year evaluation timeframe) that generate electricity at commercial, industrial and institutional buildings - maximum individual project award is $4 million.
- Connecticut offers grants and loans to retail end-use customers of electric distribution companies for the installation of customer-side distributed resources (no more than 65 MW, includes small wind turbines) - $450/kW for baseload projects ($500/kW if sited in southwest CT); $200/kW for emergency generators ($250/kW if sited in southwest CT).
- Single-family and Multi-Family Energy Conservation Loans are available through the Connecticut Housing Investment Fund (CHIF), loans range from $400 - $25,000 (1-4 family units) and $2,000 - $60,000 (multi-family of 5+ units); interest rates vary in accordance with the borrower's family size and income and the loan may be repaid over ten years.

Interconnection and Net Metering Standards:
Connecticut has interconnection rules and procedures for all distributed generation (DG) technologies up to 25 megawatts (MW) in capacity. Connecticut requires investor-owned utilities to provide net metering to customers that generate electricity using Class I renewable energy sources up to two megawatts (MW) in capacity, there is no stated limit on the aggregate capacity of net-metered systems in a utility's service territory.

ENERGY SITING PROCESS

Power Siting Authority: Connecticut Siting Council provides a Certificate of Environmental Compatibility and Public Need for electricity generating facilities and regulates facilities 1 MW or larger that are fueled by renewable energy sources. Town planning and zoning will also impact development. State environmental permitting affects development; requirements will vary by location, for example, offshore sites would be governed by Coastal Zone Management authorities.

Wind Specific Siting Authority? No

Code or Regulations: CT Siting Council - General Statutes § 16-50i, Environmental statutes: various sections of Connecticut General Statutes - Titles 22a26 would apply.

Role of State Fish & Wildlife Agency: Towns can consult with CT Dept. of Environmental Protection

How are wildlife laws applied: Energy facility applications must include "a description of the effect that the proposed facility would have" on ecological integrity, wetlands and watercourses, and wildlife and vegetation, including rare and endangered species, critical habitats, and species of special concern, with documentation by the Department of Environmental Protection Natural Diversity Data Base. State can require mitigation if a state permit is required, state listed endangered or threatened species can overrule other factors

STATE ENVIRONMENTAL POLICY ACT

Connecticut Environmental Policy Act (CEPA) - Connecticut General Statutes, Title 22a, Ch. 439, §§ 22a-1 to 22a-1i, §§ 22a-1a-1 to 22a-1a-12, 1972

Overview:
For each State action covered by CEPA, the sponsoring agency must make a detailed written evaluation of its environmental impact before deciding to undertake or approve the action. Environmental Impact Evaluations (EIEs) must examine the direct, indirect, and cumulative environmental consequences of the proposed action, and any reasonable alternatives to it. The regulations list a number of factors the sponsoring agency must consider, including impacts on public water supply systems, effects on natural land resources and formations, use of pesticides or toxic or hazardous materials, a substantial increase in traffic, and substantial esthetic or visual effects.

Projects Affected by Law:
Applies to activities (1) proposed by a state department, institution, or agency or (2) funded in whole or in part by the state, that could have a major impact on the state's land, water, air, historic structures and landmarks, existing housing or other environmental resources, or could serve short term to the disadvantage of long-term environmental goals.

Public Participation Provisions:
The legislature added a public "scoping" process to CEPA in 2002 that allows the public to comment on a proposed action before an agency begins the formal EIE process. After completion of an EIE, it is made available for public review; the public has 45 days to comment on an EIE. A public hearing may be held during the public scoping process but it is required if requested by 25 people or a group representing 25 people.

Applicability to Wind Development?
Only if wind project is receives state funding (the state does have incentives for wind power development) or it is on state land.

Implementing Agency:
Department of Environmental Protection, Office of Environmental Review

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No Guidance

DELAWARE

Background

Installed Utility Scale Wind Power: None

Incentives for Wind Development

Renewable Portfolio Standard: Yes - 20% by 2019

Incentives for Industrial or "Big Wind" Production:
The Technology and Demonstration Program, through Delaware's Green Energy Fund, provides grants to projects that demonstrate the market potential for renewable technologies and accelerate the commercialization of these technologies in Delaware; individual grants cannot exceed 25% of the cost of the eligible equipment for a renewable energy technology project and will not exceed $200,000 per project

Incentives for Residential and "Small Wind" Production:
Delaware Green Energy Program Incentives - provides rebate of 50% of installation cost for renewable energy up to $22,500 for residential small wind turbines or $100,000 for non-residential.

Interconnection and Net Metering Standards:
Delmarva and Delaware Electric Cooperative (DEC) offer net metering to residential and small commercial customers with renewable-energy systems up to 25 kilowatts (kW) in capacity, there is no statewide limit on the aggregate capacity of net-metered systems.

Energy Siting Process

Power Siting Authority: Delaware's utility grade wind power potential is primarily offshore, this would likely fall under the jurisdiction of the Delaware Department of Natural Resources and Environmental Control (DNREC) through the Coastal Zone Act. Small wind power generation is governed by local zoning ordinances.

Wind Specific Siting Authority? No

Role of State Fish & Wildlife Agency: Permits from Department of Natural Resources and Environmental Control required for components of wind siting.

Wildlife Guidelines for Wind

Wildlife Guidelines for Wind Power Siting: No Guidance but DNREC has included a recommendation in their State Wildlife Action Plan to work with industry to develop standards for the siting of wind towers.

FLORIDA

BACKGROUND

Contact: Julie Rowland, Legislative Affairs Office, Florida Fish & Wildlife Conservation Commission, 850-487-3795, julie.rowland@MyFWC.com, 620 South Meridian Street, Tallahassee, FL 32399-1600

Installed Utility Scale Wind Power: None

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Florida does not have an RPS standard in place, but in July, 2007 Florida Governor Charlie Crist signed Executive Order 07-127, entitled "Immediate Actions to Reduce Greenhouse Gas Emissions within Florida". The executive order establishes reduction targets for Greenhouse Gas emissions and requests that the Florida Public Service Commission initiate rulemaking by September 1, 2007 to require that utilities produce at least 20% of their electricity from renewable sources with a strong focus on solar and wind energy.

Incentives for Industrial or "Big Wind" Production:
Florida Renewable Energy Production Tax Credit is a corporate tax credit of $.01/kWh for production of renewable energy (including wind) that is sold to an unrelated buyer.

Incentives for Residential and "Small Wind" Production:
The Renewable Energy Technologies Grants Program provides renewable energy matching grants for demonstration, commercialization, research, and development projects relating to renewable energy technologies. Eligible recipients (must be in-state) include municipalities and county governments; businesses; universities and colleges; utilities; not-for-profit organizations; and other qualified entities; ranking criteria for grant awards includes availability of matching funds, economic development potential, technical feasibility, innovation, long-term production potential, and public visibility, among others.

Interconnection and Net Metering Standards:
Current interconnection and net-metering only applies to photovoltaic systems.

ENERGY SITING PROCESS

Power Siting Authority: There is not significant wind power potential at this time, so no current regulations and local governments would most likely have jurisdiction for small scale projects. Florida DEP, Siting Coordination Office has broad authorities for certification of power plants - these are currently defined as traditional as well as solar power plants 75 MW or greater. Should utility scale wind power opportunities increase, this would be the most likely authority.

Wind Specific Siting Authority? No

Code or Regulations: The Power Plant Siting Act (PPSA), §§ 403.501-.518, F.S.

Role of State Fish & Wildlife Agency: Florida Fish & Wildlife Conservation Commission has joint environmental review with Department of Environmental Protection for utility projects.

How are wildlife laws applied: Same as any other development project. The agency is authorized to collect development-of-regional-impact wildlife mitigation contributions pursuant to § 372.074(2), Florida Statutes, which are directed to the purchase and management of lands important to the conservation of fish and wildlife.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No Guidance

GEORGIA

Background

Contact: Jim Ozier, Georgia DNR, (478) 994-1438, jim_ozier@dnr.state.ga.us, 116 Rum Creek Drive, Forsyth, GA 21029

Installed Utility Scale Wind Power: None

Incentives for Wind Development

Renewable Portfolio Standard: No

Incentives for Industrial or "Big Wind" Production:
None

Incentives for Residential and "Small Wind" Production:
TVA Green Power Switch Partners Program - $500 plus $.15/kWh (residential/small-commercial) or $0.20/kWh (large commercial) to purchase entire production of renewable power including wind; systems must be 50 kW or less.

Interconnection and Net Metering Standards:
Georgia allows residential electricity customers with photovoltaic systems, wind-energy systems or fuel cells with a maximum capacity of 10 kilowatts (kW), and commercial facilities up to 100 kW, to connect to the grid. A utility is not required to enroll customers beyond 0.2% of its peak load for the previous year.

Energy Siting Process

Power Siting Authority: Voluntary review of projects, local governments (through zoning authority or county planning boards) have primary authority. Environmental regulations apply to construction.

Wind Specific Siting Authority? No

Role of State Fish & Wildlife Agency: Department of Natural Resources has a memorandum of understanding with environmental regulator for project review and will provide joint environmental review. May be asked for integrated resource planning.

How are wildlife laws applied: Same as any other development project, State cannot require mitigation.

STATE ENVIRONMENTAL POLICY ACT

Georgia Environmental Policy Act - Official Code of Georgia Annotated, Ch. 12-16 (12-16-1 to 12-16 23), Ch. 391-3-16, 1991

Overview:
The Georgia Environmental Policy Act (GEPA) requires that any proposed governmental action which may "significantly adversely affect the quality of the environment", including the state's air, water, land, plants, and animals, requires an Environmental Effects Report (EER). As outlined in the Act, an Environmental Effects Report describes the environmental impact and any adverse environmental effects of the action, alternative actions, mitigation measures proposed to avoid or minimize impact, and other effects of the action.

Projects Affected by Law:
GEPA applies to state government agency actions, defined in the law to include any state agency action or activity of a city or county whose cost is covered by more than 50 percent with funds from a state government agency or is provided a grant of more than $250,000 by a state agency.

Public Participation Provisions:
At least 45 days before making the decision on the EER, the responsible official must publish in the county where an action is to occur that an EER has been prepared; they must make the report available to the public on request. GEPA allows the responsible official to hold a public hearing at their discretion, however a public hearing is mandatory if at least 100 residents send a written request for a meeting within 30 days of the publication of the EER.

Applicability to Wind Development?
Unlikely since Georgia does not currently have any state funding programs for wind energy incentives.

Implementing Agency:
Department of Natural Resources

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No Guidance

HAWAII

BACKGROUND

Contact: Paul Conry, Administrator, Division of Forestry and Wildlife, (808) 587-0166, Paul.J.Conry@hawaii.gov

Installed Utility Scale Wind Power: 63 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - 20% by 2020

Incentives for Industrial or "Big Wind" Production:
Hawaii Energy Tax Credit - Commercial tax credit of 20% for installation costs of wind systems (up to $500,000 for commercial property).

Incentives for Residential and "Small Wind" Production:
Hawaii Energy Tax Credit - Residential tax credit of 20% for installation costs of wind systems (up to $1500 for single-family units or $200 each for multi-family units).

Interconnection and Net Metering Standards:
Hawaii has simplified interconnection net metering rules for residential and "small commercial" customers (including government entities) with solar, wind, biomass and hydroelectric systems up to 50 kW in capacity. Net metering is available on a first-come, first-served basis to eligible customers until total net-metered capacity equals 0.5% of each utility's peak demand.

ENERGY SITING PROCESS

Power Siting Authority: Most wind facilities are currently small in scale and addressed by local government through zoning. Facilities subject to standard environmental regulating.

Wind Specific Siting Authority? No

Role of State Fish & Wildlife Agency: Permits are required from Hawaii Department of Land and Natural Resources. The State Department of Forestry and Wildlife (DOFAW) will provide general comments to potential site data that can be used to plan renewable energy projects. Historically, DOFAW reviews projects based on its environmental impacts to endangered flora and fauna since most requests occur outside of its primary forestry and wildlife management responsibilities.

STATE ENVIRONMENTAL POLICY ACT

Environmental Impact Statement law - Hawaii Revised Statutes, Ch. 343, Hawaii Administrative Rules (HAR), Title 11, Ch. 200, 1974

Overview:
An environmental review document must be prepared for any proposed project or activity, if one or more of nine specific conditions (called "triggers") is present, and circulated to the public for review. The environmental assessment (EA) is a written evaluation to determine whether the action may have a significant effect on the environment. If the EA finds that the proposed action may have a significant effect on the environment, then an environmental impact statement (EIS) must be prepared. An EIS must, at a minimum, identify environmental concerns, obtain various relevant data, conduct necessary studies, receive public input, evaluate alternatives, and propose measures for minimizing adverse impacts.

Projects Affected by Law:
The Environmental Impact Statement Law has 9 specific "triggers". These include, projects that propose the use of: state or county lands or funds; land in the conservation district; land in the shoreline setback area; any historic site or district; or land in Waikiki must be subject to an environmental review prior to its implementation. Also, any proposed reclassification of conservation land; amendment to a county general plan, any new or expanded helicopter facility; any new or expanded fossil-fueled power generating facility; certain types of facilities (waste-to-energy facilities; landfills, etc.; power generating facilities are included in this list of actions) may trigger an environmental review.

Public Participation Provisions:
The public has 30 days to review and comment on a draft environmental assessment; if there is a finding of no significant impact, the public may challenge an agency's determination within 30 days of the notice of this finding by filing suit in circuit court. A draft EIS is subject to a 45 day review by the public and government agencies after publication in The Environmental Notice of an acceptance or non-acceptance determination of a final EIS by either the accepting authority or the approving agency initiates a 60-day legal challenge period.

Applicability to Wind Development?
Yes, through the actions that list "power-generating facilities" as a trigger for the Enviromental Impact Statement Law.

Implementing Agency:
Office of Environmental Quality Control

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Guidelines for siting in Conservation District. Hawaii Revised Statutes, Chapter 183C, Hawaii Administrative Rules (HAR), Title 13, Subtitle 1, Chapter 5, Conservation District. These are model zoning guidelines.

	Detailed Summary of Hawaii's Model Zoning Guidelines
Pre-construction survey	The model zoning language includes specific requirements for permits for conservation district land use including construction of any structures including wind energy facilities. The administrative rules require that the applicant demonstrate that the proposed land use will not cause substantial adverse impact to existing natural resources within the surrounding area, community or region and this typically requires preparation of a draft environmental assessment or environmental impact statement. The environmental assessment would identify and assess any potential impacts on the natural environment including, but not limited to threatened and endangered species, wetlands and other fragile ecosystems, historical and cultural sites, and antiquities. Where appropriate, surveys for endangered plants, bats, seabirds, and general avian use should be conducted.
Design/Operation Recommendations	Typically recommends that guide wires and lighting be minimized to avoid light attraction and collision impacts to endangered bats, endangered birds, and seabirds.
Site Development Recommendations	Recommends that clearing of natural vegetation shall be limited to what is necessary for the construction, operation and maintenance of the wind facility and all efforts should be taken to avoid impacts to endangered plant species.
Consultation with wildlife agency, USFWS	Where there are endangered and protected species, requires consultation with State Division of Forestry and Wildlife, and if applicable, receipt of a Habitat Conservation Plan or other take permits from State and U.S. Fish and Wildlife Service (USFWS).
Mitigation requirements	Requires the applicant take appropriate measures to minimize, eliminate or mitigate adverse impacts to the environment, wildlife, threatened and endangered species that are identified in the permit process.
Post-Construction/ Operational Surveys	Can require applicant to conduct post construction and operational surveys for take of any T&E listed species, and report on mitigation efforts.
Decommissioning	The applicant is typically required to restore the site at the end of project life.

IDAHO

BACKGROUND

Contact: Gregg Servheen, Wildlife Program Coordinator, Idaho Department of Fish and Game, 208-287-2713, gservheen@idfg.idaho.gov, 600 South Walnut, PO Box 25, Boise, ID 83707

Installed Utility Scale Wind Power: 75 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: No

Incentives for Industrial or "Big Wind" Production:

- Bonneville Environmental Foundation provides grants up to 33% of the capital costs for installation of renewable energy, including wind to local governments, non-profits and tribal governments; emphasis is on large grid-connected projects.
- Renewable Energy Project Bond Program allows independent renewable energy producers to apply for financing from the Idaho Energy Resources Authority, the state bonding authority created to finance the construction of electric generation and transmission projects by electric.

Incentives for Residential and "Small Wind" Production:

- Residential Alternative Energy Tax Deduction - income tax deduction for installation of alternative energy (including wind) - 40% deduction for the cost of the system in the year it is installed, 20% each year for three years thereafter; maximum deduction in any one year is $5,000 and a total maximum deduction of $20,000.
- Renewable Energy Equipment Sales Tax Refund - Purchasers of equipment used to develop a renewable facility or a project capable of generating at least 25 kW of electricity can apply for a refund of the sales tax from the Idaho Sales Tax Commission.
- Idaho Department of Water Resources provides low-interest energy loans (4% over 5 years), can include the installation of wind for residential or commercial purposes (up to $100,000); energy produced can not be sold, renewable must be least-cost alternative.
- The Northwest Solar Cooperative (NWSC) offers to purchase the rights to the environmental attributes or "Green Tags" derived from grid-connected solar PV- or wind-generated electricity at a rate of $0.05/kWh through December 31, 2009; systems up to 25 kW are automatically approved; > 25 kW approved on case-by-case basis.

Interconnection and Net Metering Standards:

Idaho has not established uniform interconnection rules and procedures either for net-metered systems or for larger distributed-generation (DG) systems that are not net-metered; net metering is generally available to customers who generate electricity using a renewable-energy system up to 25 kilowatts (kW) in capacity. However, through their respective tariffs, each of the state's three investor-owned utilities – Avista Utilities, Idaho Power and Rocky Mountain Power – has established guidelines for the interconnection of small renewable-energy systems and larger DG.

Energy Siting Process

Power Siting Authority: Wind power is currently unregulated at any level of government - local zoning may impact siting but this is variable. State energy siting legislation has been proposed this year but it may not pertain to wind project but rather only very large energy projects such as coal fired and nuclear power plants.

Wind Specific Siting Authority? No

Role of State Fish & Wildlife Agency: Idaho Department of Fish & Game has no formal role in the siting process.

How are wildlife laws applied: Same as any other development project, State cannot require mitigation.

Wildlife Guidelines for Wind

Wildlife Guidelines for Wind Power Siting: No Guidance

ILLINOIS

BACKGROUND

Contact: Todd Rettig, Manager, Division of Ecosystems and Environment, Illinois Department of Natural Resources, 217-557-0877, todd.rettig@illinois.gov, One Natural Resources Way, Springfield, IL 62702

Installed Utility Scale Wind Power: 305 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - 25% by 2025, 75% of renewable energy must be from wind

Incentives for Industrial or "Big Wind" Production:

- Illinois provides a property tax exemption for renewable energy systems for residential, industrial or commercial use.
- The Illinois Department of Commerce and Economic Opportunity provides Wind Energy Production Development grants of up to $25,000 for systems greater than .5 MW; non-profit, schools, commercial, government, agricultural and institutional applicants are eligible.

Incentives for Residential and "Small Wind" Production:

- The Illinois Clean Energy Community Foundation (ICECF) provides private, competitive grants for developing renewable energy in schools, non-profits or local governments.
- Illinois provides a property tax exemption for renewable energy systems for residential, industrial or commercial use.
- Illinois Department of Commerce and Economic Opportunity provides grants for small wind (1 to 50 kW) development up to 50% of cost up to $25,000; all sectors are eligible.

Interconnection and Net Metering Standards:
Commonwealth Edison (ComEd), an investor-owned utility serving Chicago and surrounding areas, established interconnection and net-metering for photovoltaic (PV) and wind-energy systems up to 40 kW. The program is available to all customer classes. The total installed capacity of all net-metered systems is limited to 0.1% of the utility's annual peak demand.

ENERGY SITING PROCESS

Power Siting Authority: There are no specific authorities for regulating siting at the State level. Most projects would currently fall under the jurisdiction of local governments through county-level zoning or building permits.

Wind Specific Siting Authority? No

Role of State Fish & Wildlife Agency: Decisions to grant zoning changes and building permits is subject to the Illinois Endangered Species Act (520 ILCS 10/1 – 11) and the Illinois Natural Areas Preservation Act (525 ILCS 30/1-26). These two statutes set up a consultation process that involves the Illinois Department of Natural Resources (IDNR) evaluating impacts to protected natural resources and making recommendations (if necessary) to avoid or mitigate any adverse impacts. Units of local government are not required to adopt any IDNR recommendations during their zoning or permitting process. The consultation process is detailed in regulations at 17 Ill. Adm. Code Part 1075.

How are wildlife laws applied: Same as any other development or utility project; State cannot require mitigation unless threatened or endangered species are adversely affected.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No Guidance

INDIANA

BACKGROUND

Contact: Jon Eggen, Environmental Supervisor, DNR Division of Fish and Wildlife, (317) 233-4666, jeggen@dnr.IN.gov

Installed Utility Scale Wind Power: None

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: No

Incentives for Industrial and Residential Wind Production:
Renewable Energy Property Tax Exemption - all renewable energy systems, including wind, are exempt from property taxes for years that the system is functioning; the entire renewable energy system and affiliated equipment, including equipment for storage and distribution, are exempt. Applies to commercial, industrial and residential sectors.

Interconnection and Net Metering Standards:
The Indiana Utility Regulatory Commission (IURC) has net-metering rules requiring the state's investor-owned utilities (IOUs) to offer net metering to residential customers and K-12 schools. The rules, apply to solar, wind and hydroelectric projects with a maximum capacity of 10 kilowatts (kW) with a limit on the aggregate amount of net-metering (nameplate) capacity to 0.1% of its most recent summer peak load. Net-metered systems must comply with interconnection standards.

ENERGY SITING PROCESS

Power Siting Authority: Wind power facilities are regulated but only at the local level and siting requirements vary by location.

Wind Specific Siting Authority? No

Role of State Fish & Wildlife Agency: Department of Natural Resources (DNR) provides comments and recommendations if requested, but counties are under no obligation to seek input.

How are wildlife laws applied: Same as any other development project. DNR can require mitigation under certain circumstances through regulations that apply to all construction projects but are not specific to wind power. The Flood Control Act regulates construction in a floodway and allows for mitigation.

STATE ENVIRONMENTAL POLICY ACT

Indiana Environmental Policy Act - Indiana Code Title 13, Art. 12 Ch. 4 (13-12-4-1 through -10), 329 Indiana Administrative Code (IAC) Art. 5, Rules 1

Overview:
All state agencies are required to do an environmental assesment (EA) to determine if an action will have a significant impact on the environment. The EA must assess both primary and secondary consequences of short term and long term duration as well as impacts of a complex of projects that might have considerable cumulative impacts or projects that may be highly controversial. If the impacts are found to "significantly affect the quality of the human environment," a detailed report on the environmental impact of a proposed action, listing adverse environmental effects which cannot be avoided should the action be implemented, alternatives to the proposed action, any irreversible and irretrievable commitments of resources which would be involved, the growth-inducing aspects of the proposed action, effects of the proposed action on the use and conservation of energy resources, the rationale for selecting the final proposed action, and other information will be required.

Projects Affected by Law:
Relates to state agency action or projects that are funded all or in part by the state - law specifically states that projects requiring licenses or permits from state agencies are not required to do an EIS.

Public Participation Provisions:
Local, state, and federal agencies and the general public (deemed by the agency to have an interest in the proposed action) have 30 days after the draft environmental impact statement is made publie submit comments on the proposed action. After receipt of comments, the agency shall determine by vote of the governing body whether or not to conduct a public hearing on the environmental impact of the proposed action.

Applicability to Wind Development?
Unlikely since Indiana does not have any state funding programs for wind energy incentives.

Implementing Agency:
Indiana Department of Environmental Management

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Draft guidelines

Lead Agency on Guidelines: Department of Natural Resources, Environmental Section

Status of Wildlife Guidelines: Internal draft, not available to public yet, they will be voluntary.

IOWA

BACKGROUND

Contact: Douglas C. Harr, Wildlife Diversity Program Coordinator Iowa Dept. of Natural Resources, Doug.Harr@dnr.iowa.gov

Installed Utility Scale Wind Power: 967 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - 105 MW

Incentives for Industrial or "Big Wind" Production:

- Iowa has two Renewable Energy Production Tax Credits that can be applied to wind energy facilities that have been approved by the Iowa Utilities Board. First under Iowa Code § 476C is a production tax credit of 1.5¢ per kilowatt-hour available for energy generated and sold by eligible wind energy generators and other renewable energy facilities for 10 years after they enter into production - there are specific ownership eligibility requirements for this credit, and the maximum total amount of wind generating capacity eligible for this credit is 180 megawatts (MW). Second, under Iowa Code § 476B, a production tax credit of 1.0¢ per kilowatt-hour is available for electricity generated and sold by eligible wind energy facilities for 10 years after they enter into production, there are no specific ownership or capacity criteria for individual projects; however, facility owners may not own more than two eligible facilities, and must have an executed power purchase agreement or interconnection agreement, and this credit is not available to facility owners who have received the state's property tax exemption for renewable energy systems, the local option special assessment of wind energy devices, or the sales tax exemption for wind energy equipment. The maximum total amount of generating capacity eligible for the credit is 450 MW.
- Iowa's Energy Replacement Generation Tax Exemption allows wind energy conversion properties to be exempt from the state's replacement generation tax of 0.06 cents ($0.0006) per kWh (the tax imposed in lieu of property tax).
- Iowa's Local Option Special Assessment of Wind Energy Devices allows any city or county to pass an ordinance assessing wind energy conversion equipment at a special valuation for property tax purposes, beginning at 0% of the net acquisition cost in the first assessment year and increasing annually by five percentage points to a maximum of 30% of the net acquisition cost in the 7th and succeeding years.
- In Iowa, the market value added to a property by a solar or wind energy system is exempt from the state's property tax; there is no maximum limit on the size of the system. Iowa also exempts from the state sales tax the total cost of wind energy equipment and all materials used to manufacture, install or construct wind energy systems.
- The Alternate Energy Revolving Loan Program (AERLP) provides low-interest loan funds, 50% of the total loan at 0% interest, with a maximum of $250,000, to individuals and organizations that seek to build renewable energy production facilities in Iowa.

Incentives for Residential and "Small Wind" Production:

- Residential and small wind producers in Iowa are also eligible for the Renewable Energy Production Tax Credits, the Local Option Special Assessment of Wind Energy Devices, the Alternate Energy Revolving Loan Program described above.
- In Iowa, the market value added to a property by a solar or wind energy system is exempt from the state's property tax; there is no maximum limit on the size of the system. Iowa also exempts from the state sales tax the total cost of wind energy equipment and all materials used to manufacture, install or construct wind energy systems.
- Iowa's Energy Bank Program provides financing for public and some non-profit organizations for energy analysis and energy improvements that will pay for themselves within their useful lives; financing is available via a pre-arranged, low-interest capital loan note or lease purchase-agreement with a local or regional investment bank.
- Independence Light & Power provides a Renewable Energy Rebate, customers with qualifying wind-energy systems rated 20 kW or less will receive a rebate equal to 25% of the system's cost, with a maximum incentive of $10,000; customers may also receive a rebate for 75% (up to $375) for a renewable energy site assessment and 50% rebate (up to $2,500) for both routine maintenance, as well as major system repairs.

Interconnection and Net Metering Standards:
Iowa allows net metering (generally up to 500 kW) for renewable-energy systems, but no uniform interconnection standards are currently in place either for small renewables or for larger distributed generation.

ENERGY SITING PROCESS

Power Siting Authority: In Iowa, zoning and permitting is handled on a county and/or city level. Each county or city may have different guidelines and application procedures to follow. The Iowa Department of Natural Resources (DNR) has developed a *Wind Energy Checklist* for small-scale wind turbine project in Iowa. (http://www.iowadnr.com/energy/renewable/files/windchecklist.pdf). The Iowa Utilities Board provides a certificate of public convenience, use, and necessity for electric power generating plant or a combination of plants at a single site, owned by any person, with a total capacity of 25 MW of electricity or more. However it has been argued successfully that wind does not always have to go through the Board since it is typically individual generating units connecting to several different lines. Exemptions have been authorized in part because wind is a renewable energy source that the Board has been required to promote.

Wind Specific Siting Authority? No

Code or Regulations: Iowa Code §§ 476A.1 to 19

Role of State Fish & Wildlife Agency: All projects are reviewed and subject to environmental regulation by the Department of Natural Resources (DNR). The Utilities Board often defers to the DNR on environmental and land use factors. Counties are not required to consult with DNR. DNR is monitoring wind farms for avian mortality.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Wind Energy and Wildlife Resource Management in Iowa - Avoiding Potential Conflicts, Final. The DNR has also developed a map of "Areas of Concern for Wind Farm Sitings" that highlights protected natural resource and wildlife areas where developers may want to take extra precautions when developing wind farms.

Lead Agency on Guidelines: Iowa Department of Natural Resources

Status of Wildlife Guidelines: Final – October 2007

Summary of Guidelines: The guidelines were developed from a variety of sources including the U.S. Fish & Wildlife Service Interim Guidelines for siting and construction of wind energy facilities, and recommendations from the National Wind Coordinating Committee. Guidelines recommend that a site study plan and description of turbine structural and lighting design be submitted to Iowa DNR well in advance of final siting decisions, for review by staff wildlife experts and advisements on acceptability or suggestions for modifications and/or monitoring. A baseline inventory of wildlife and evaluation of habitat should be considered for every site under serious consideration for windfarm development. Special attention should be paid to Spring and Fall migration seasons, reviewing migrational use of the proposed site by raptors, waterfowl, shorebirds, gulls, songbirds and bats. Upon completion and startup of wind energy generation, monitoring wildlife populations and migrations should be conducted for at least 2-3 years.

Web site for Guidelines: http://www.iowadnr.com/energy/wind/windwildlife.html

	Detailed Summary of Iowa's Voluntary Guidelines
Pre-construction survey	A baseline inventory of wildlife and evaluation of habitat should be considered for every site under serious consideration for windfarm development. Special attention should be paid to Spring and Fall migration seasons, reviewing migrational use of the proposed site by raptors, waterfowl, shorebirds, gulls, songbirds and bats.
Design/Operation Recommendations	Guidelines recommend using tubular support towers with pointed tops, rather than lattice supports, and avoiding placement of permanent external ladders or platforms on tubular towers to reduce opportunities for birds to perch or nest upon the structures. Avoid use of guy wires for turbine or meteorological tower supports. Any existing guy wires should be marked with recommended bird deterrent devices. The minimum amount of pilot warning and avoidance lighting necessary should be used, and unless otherwise required by the Federal Aviation Administration, only white strobe lights should be used at night. Electric power lines should be placed underground wherever possible, or should utilize insulated, shielded wire when placed above ground, in order to reduce bird perching and electrocution. Where the height of rotor-sweep area produces high wildlife collision risks, tower heights should be adjusted to lower risks.

Site Development Recommendations	Recommends using map of Iowa, denoting areas of particular concern for possible adverse effects by wind turbines upon wildlife and habitat developed by DNR. Avoid placing turbines in areas known to have federally protected threatened or endangered species. Avoid placing turbines in or near recognized bird concentration areas or migration pathways. Avoid placement of turbines in or near areas where highly "area-sensitive" wildlife species, such as prairie-chickens (recommends at least 5 miles from known leks) are known. Avoid placing turbines near documented bat hibernation, breeding or nursery colonies and in migration corridors or between known colonies and feeding areas. Avoid placement of multiple turbines in close proximity to one another or perpendicular to known migration pathways (typically north-south); consider possible cumulative regional effects of multiple wind energy projects. Reduce or eliminate availability of carrion within wind farms, to reduce chances of attracting eagles, vultures and other raptors colliding with turbine blades. Place wind turbines in areas already fully developed for agriculture, especially row-crop farming, where there is minimal extant wildlife habitat.
Consultation with wildlife agency, USFWS	Recommends submitting a site study plan and description of turbine structural and lighting design to Iowa DNR well in advance of final siting decisions, for review by staff wildlife experts and advisements on acceptability or suggestions for modifications and/or monitoring. Recommends contacting the Iowa Department of Natural Resources Endangered Species Coordinator or Wildlife Bureau staff for areas known to have federally protected endangered species
Mitigation requirements	If wildlife habitat losses or fragmentation must be mitigated, develop a plan to create or restore habitat away from the wind farm site. This will serve to attract birds, bats and other wildlife away from the development and reduce collisions. Wherever possible, coordinate habitat mitigation sites with other public or private wildlife lands, to connect, enlarge or enhance those areas.
Post-Construction/ Operational Surveys	Upon completion and startup of wind energy generation, monitoring wildlife populations and migrations should be conducted for at least 2-3 years. If wind turbine facilities absolutely must be located in areas known for high seasonal concentration of birds, a bird monitoring program must be established, with at least three years of data collected to determine peak use periods. Data may be collected by direct observation, radar, infrared or acoustic methods. When birds are highly concentrated in or near the site, turbines should be shut down until birds have dispersed.
Decommissioning	None

KANSAS

BACKGROUND

Contact: Jim Hays, Kansas Department of Wildlife and Parks, jamesh@wp.state.ks.us

Installed Utility Scale Wind Power: 364 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: No

Incentives for Industrial and Residential Wind Production:
Kansas has a Renewable Energy Production Tax Credit that exempts renewable energy equipment (including wind) from property taxes for both commercial and residential facilities.

Interconnection and Net Metering Standards:
No net-metering/interconnection standards.

ENERGY SITING PROCESS

Power Siting Authority: The authority to regulate land use in Kansas is under the purview of local governments through the state's planning and zoning statutes. Wind energy siting and permitting requirements vary from county to county based largely on whether or not a county is zoned. Currently, statewide regulations for siting wind projects do not exist. Kansas Energy Council provides coordination with counties and the Kansas Renewable Energy Working Group has developed siting guidelines to assist the counties' in their planning efforts.

Wind Specific Siting Authority? No

Code or Regulations: Planning & Zoning Statutes: (K.S.A. 12-741 et seq.)

Role of State Fish & Wildlife Agency: The guidelines suggest that counties have developers contact the Kansas Department of Wildlife and Parks to outline potential impacts to wildlife and habitat.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Kansas Department of Wildlife and Parks has a position statement on wind projects. In addition, the Kansas Energy Council has developed a Wind Energy Siting Handbook, and the Kansas Renewable Energy Working Group has developed guidelines.

Lead Agency on Guidelines: Kansas Department of Wildlife and Parks, Kansas Renewable Energy Working Group, Kansas Energy Council

Status of Wildlife Guidelines: Final - April 2005

Summary of Guidelines: Wind Siting Handbook provides voluntary guidelines on all aspects of wind power siting based on existing regulations in four counties (land use regulation is solely under the purview of local government in Kansas) and recommends requiring environmental assessment in siting decisions. Recommends developers contact appropriate agencies to assess impacts to potentially sensitive land uses and encourages avoidance of rare or disappearing ecosystems. Outlines biological and environmental assessment prior to development (encourages use of biological and environmental experts, including agency or university personnel. Recommends requiring resource management agency be contacted early in process and careful review of legally protected species' use of area. Provides specific recommendations including burying power lines, minimizing perching areas on turbines and siting away from known migratory routes. Outlines mitigation options for unavoidable impacts which may include ecological restoration, conservation easements, and long-term management agreements.

Web site for Guidelines: Kansas Wind Position Statement: (www.kdwp.state.ks.us search for 'wind power' - see 'wind power position')

The Kansas Department of Wildlife and Parks Wind Power Position Statement:

1) That wind power facilities should be sited on previously altered landscapes, such as areas of extensive cultivation or urban and industrial development, and away from extensive areas of intact native prairie, important wildlife migration corridors, and migration staging areas.
2) To recommend adherence to the siting guidelines for wind power projects Siting Guidelines for Windpower Projects in Kansas produced by the Kansas Renewable Energy Working Group (www.kansasenergy.org/Kansas_Siting_Guidelines.PDF).
3) To support the study of and establishment of standards for adequate inventory of plant and animal communities before wind development sites are selected, during construction, and after development is completed (Manes et al., in review). The resultant improvement in available knowledge of wind power and wildlife interactions obtained through research and monitoring should be used to periodically update guidelines regarding the siting of wind power facilities.
4) That mitigation is appropriate only if significant ecological harm from wind power facilities cannot be adequately addressed through proper siting.
5) To support the establishment of processes to ensure a comprehensive and consistent method in addressing proposed wind power developments.
6) To advocate the direct coupling of energy conservation and efficiency programs with any new measures aimed at increasing energy supply whether renewable or conventional.

Kansas Wind Siting Guidelines:
http://www.naseo.org/energy_sectors/wind/kansas_siting_guidelines.pdf;

	Detailed Summary of Kansas' Voluntary Guidelines
Pre-construction survey	Guidelines from the Kansas Renewable Energy Working Group focus on broad aspects of wind development including natural/biological considerations. Recommends that developers consider the biological setting early in the project evaluation and planning process and to use biological and environmental experts to conduct preliminary reconnaissance of the prospective site. Landscape-level examinations of key wildlife habitats, migration corridors, staging/concentration areas, and breeding and brood-rearing areas should be used to develop general siting strategies. Recommends careful review of rare, threatened or endangered species as well as those species that may not have special protection but are in decline. Recommends considering cumulative regional impacts of multiple wind farm developments when making environmental assessments and mitigation decisions.
Design/Operation Recommendations	Design recommendations include not allowing perching areas on nacelles of turbines and towers should not be lattice-type or other designs that allow perching. Recommends addressing potential adverse effects of warning lights on migrating birds.
Site Development Recommendations	Guidelines recommend focusing on areas where native vegetation is scarce or absent and avoiding native, unfragmented areas in tallgrass, sandsage, mixed grass and short grass habitats. Power lines should be buried, when feasible, and roads and fences should be minimized. In areas where periodic grassland burning is practiced, infrastructure should be built to withstand fire. Turbines should be situated so they do not interfere with important wildlife movement corridors or staging areas. Avoid siting on steep slopes to avoid erosion and try to construct during winter or when soils are dry and native vegetation is dormant.
Consultation with wildlife agency, USFWS	Recommends contacting the appropriate resource management agencies early in the process to determine if there are any resources of special concern in the area under consideration.
Mitigation requirements	When it is impossible to avoid significant ecological damage from wind siting, recommends mitigation for lost habitat including ecological restoration, long-term management agreements, and conservation easements to enhance or protect sites with similar or higher ecological quality to the developed site.

Post-Construction/ Operational Surveys	None
Decommissioning	Recommends anticipating and making provisions for future site decommissioning and restoration.

Kansas Model Zoning: http://www.kansasenergy.org/KEC/documents/wind_siting_handbook.pdf

	Detailed Summary of Kansas Model Zoning Guidelines
Pre-construction survey	Provides voluntary guidelines on all aspects of wind power siting based on existing regulations in four counties (land use regulation is solely under the purview of local government in Kansas) and recommends requiring environmental assessment in siting decisions. Recommends considering the biological setting during zoning or approval process and encourages the use of biological and environmental experts to conduct preliminary reconnaissance of the prospective site area. Recommends requiring careful review if legally protected wildlife, such as threatened and endangered species, are present or potentially present at a wind development site and to recognize that other seriously declining or vulnerable species that have no legal protection may also be present.
Design/Operation Recommendations	No perches should be allowed on the nacelles (the enclosure located at the top of a wind turbine tower that houses the gearbox, generator, and other equipment); towers should not utilize lattice-type construction or other designs that provide perches for avian predators. Potential adverse effects of turbine warning lights on migrating birds should be addressed.
Site Development Recommendations	Suggests discouraging development in large, intact areas of native vegetation. Power lines should be buried when feasible. In regions where grassland burning is practiced, infrastructure should be able to withstand periodic burning of vegetation. Roads and fences should be minimized. Turbines should be situated in a way that does not interfere with important wildlife or livestock movement corridors and staging areas.
Consultation with wildlife agency, USFWS	Recommends requiring that the appropriate resource management agencies be contacted early in the planning process to determine if there are any resources of special concern in the area under consideration.

Mitigation requirements	When it is impossible to avoid significant ecological damage in the siting of a wind power facility, mitigation for habitat loss should be considered. Appropriate actions may include ecological restoration, long-term management agreements, and conservation easements to enhance or protect sites with similar or higher ecological quality to that of the developed site.
Post-Construction/ Operational Surveys	None
Decommissioning	Recommends anticipating and requiring provisions for future site decommissioning and restoration. A decommissioning and reclamation plan should include: when and under what circumstances decommissioning and reclamation occurs; the expected end of the project life; and how the decommissioning and reclamation plan is secured (e.g. bonds, contract).

KENTUCKY

BACKGROUND

Contact: James Bush, Division of Renewable Energy & Energy Efficiency, (502) 564-7192, James.Bush@ky.gov, 500 Mero Street, 12th Floor, Capital Plaza Tower, Frankfort, KY 40601

Installed Utility Scale Wind Power: None

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: No

Incentives for Industrial or "Big Wind" Production:
None

Incentives for Residential and "Small Wind" Production:
TVA Green Power Switch Partners Program - $500 plus $.15/kWh (residential/small-commercial) or $0.20/kWh (large commercial) to purchase entire production of renewable power including wind; systems must be 50 kW or less.

Interconnection and Net Metering Standards:
Current net-metering rules only apply to photovoltaic systems.

ENERGY SITING PROCESS

Power Siting Authority: In general, Kentucky has low wind speeds and therefore limited wind energy potential. Most likely development would be for individual use which would be regulated by local zoning. If there were utility grade wind power developments, the Kentucky State Board on Electric Generation and Transmission Siting (Siting Board) or the Public Services Commission would likely have authority. The Siting Board reviews generating facilities that sell power on the wholesale market and are commonly known as merchant power plants. Siting Board approval is required for merchant plants with a generating capacity of 10 MW or more.

Wind Specific Siting Authority? No

Code or Regulations: KRS 278.700 to 278.716

Role of State Fish & Wildlife Agency: The Secretary of the Environment and Public Protection Cabinet is one of 7 members of the Siting Board. Siting board review covers environmental matters not covered by permits issued by the Kentucky Department for Environmental Protection. The Department issues permits for air emissions, water withdrawals and discharges and solid waste disposal. The Siting Board review covers matters such as noise and visual impacts, among others.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No Guidance

LOUISIANA

BACKGROUND

Contact: Erik Baka, Biologist Manager, LA Dept. of Wildlife and Fisheries, Avian Nongame Program, (225) 765-2359, ebaka@wlf.louisiana.gov, PO Box 98000 Baton Rouge, LA 70898-9000

Installed Utility Scale Wind Power: None

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: No

Incentives for Industrial or "Big Wind" Production:
None

Incentives for Residential and "Small Wind" Production:
None

Interconnection and Net Metering Standards:
Net-metering program that allows interconnection of residential renewable systems up to 25 kW and nonresidential systems up to 100 kW.

ENERGY SITING PROCESS

Power Siting Authority: Onshore wind power generation is very limited in Louisiana. Offshore development has more potential in Louisiana and possible siting might be on abandoned oil and gas platforms. This development would likely be regulated through Coastal Zone Management Act or Coastal Use Permits implemented by the LA Department of Natural Resources.

Wind Specific Siting Authority? No

Role of State Fish & Wildlife Agency: LA Dept. of Fisheries and Wildlife is in negotiations to have joint environmental review but this is not finalized yet.

How are wildlife laws applied: Same as any other utility project, State can require mitigation

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No Guidance

MAINE

BACKGROUND

Contact: Tom Hodgman, Wildlife Biologist, MDIFW - Bird Group, (207) 941-4482, tom.hodgman@maine.gov, 650 State St., Bangor, ME 04401

Installed Utility Scale Wind Power: 42 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - 10% new renewable energy capacity by 2017

Incentives for Industrial or Residential Wind Production:
Maine's Renewable Resources Matching Fund (RRMF), provides matching grants for renewable energy demonstration projects by non-profit organizations, as well as research and development of renewable energy technology; provides 50% of cost up to $50,000 for projects less than 100 MW

Interconnection and Net Metering Standards:
Net metering is available to owners of qualified cogeneration and small power-production facilities with a maximum capacity of 100 kW.

ENERGY SITING PROCESS

Power Siting Authority: The Department of Environmental Protection regulates the construction of large structures and developments with a footprint exceeding 20 acres through "Site Law".

Wind Specific Siting Authority? No

Code or Regulations: Maine Site Law - Title 38, Chapter 3, §§ 481-490

Role of State Fish & Wildlife Agency: Department of Inland Fisheries & Wildlife (DIFW) is specifically responsible for Threatened and Endangered species impacts. DIFW has joint environmental review with Department of Environmental Protection (DEP) and Land Use Regulatory Committee (for projects in state's unorganized territories) and advises regulatory agency on issues regarding the fish and wildlife resource.

How are wildlife laws applied: Projects that exceed a certain threshold for size (i.e., footprint) or occur in regulated habitats trigger review. Review includes occurrence of rare, threatened or endangered species and an assessment that the proposed development does not adversely impact Fish and wildlife life cycles. Biological review can overrule other factors and prevent permit issuance. DEP provides a specific guidance on factors considered during wind power development at: http://www.maine.gov/dep/blwq/docstand/windpower.pdf. State has the authority to require mitigation.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Proposed Guidelines

Status of Wildlife Guidelines: Stakeholders group is in preliminary stages of drafting guidelines.

Summary of Guidelines: Department of Inland Fisheries & Wildlife typically asks for studies of bird migration including radar studies of night migrants and daytime counts of raptors. Radar and acoustic surveys for migrating bats. If appropriate, surveys for rare small mammals have been conducted. Rare community and rare plant surveys are commonly conducted as well as full work up for wetlands.

MARYLAND

Background

Contact: Gwen Brewer, Science Program Manager, MD Department of Natural Resources, (410) 260-8558, gbrewer@dnr.state.md.us, or John Sherwell, Power Plant Research Program, (410-260-8667), jsherwell@dnr.state.md.us

Installed Utility Scale Wind Power: A 40 MW project has been permitted, 2 others are in the permitting process.

Incentives for Wind Development

Renewable Portfolio Standard: Yes - Yes - Tier 1: 9.5% in 2022 and beyond; Tier 2: 2.5% in 2006 through 2018; A supplier receives 120% credit toward meeting its Tier 1 obligations through RECs associated with wind energy through December 31, 2005. Beginning in 2006 and through 2008, a 110% credit is in effect.

Incentives for Industrial or "Big Wind" Production:
The Maryland Energy Administration offers a Clean Energy Production Tax Credit of 0.85 cents/kWh against the state income tax, for a five-year period, for electricity generated by wind and other eligible renewable energy sources; the maximum amount of credit over five years is $2.5 million and all credits statewide may not exceed $25 million each year; if credit exceeds tax, the credit may be carried forward for up to 10 years.

Incentives for Residential and "Small Wind" Production:

- The MEA Clean Energy Production Tax Credit described above applies to residential and small wind production as well.
- The Montgomery County Clean Energy Rewards program provides incentives to Montgomery County residents (credit of $.01/kWh), businesses, non-profits, and congregations (credit of $.015/kWh for non-residential) for purchasing clean energy through certified suppliers; allowable project costs may not exceed $120/sq. ft. (whole/base building), $60/sq. ft. (tenant space).
- The State Agency Loan Program (SALP) is a revolving loan program through the Maryland Energy Administration to state agencies for cost-effective energy efficiency improvements in state facilities including installation of renewable energy systems (including wind).

Interconnection and Net Metering Standards:
Net metering is available in Maryland to systems up to 2 MW until the aggregate capacity of all net-metered systems reaches 1,500 MW.

Energy Siting Process

Power Siting Authority: Public Service Commission issues a Certificate of Public Convenience and Necessity (CPCN)for construction of electricity generating facilities. Wind developments were previously included in this process however, legislation enacted in 2007 exempts wind developments 70 MW or below from CPCN process.

Wind Specific Siting Authority? Only if a wind development will exceed 70 MW.

Code or Regulations: Siting Authority: Public Utility Companies Article, §§2-121 and 7-205—7-208, Annotated Code of Maryland; Environmental Requirements: COMAR 20.79.03.02

Role of State Fish & Wildlife Agency: Department of Natural Resources (DNR) is one of the eight State agencies that is an intervener on the application for a CPCN; DNR contributes conditions for operation and siting.

How are wildlife laws applied: Currently same as any other utility project. State endangered species law instructs other state agencies to avoid impacts for listed species. Under the Power Plant Siting Law, more specific mitigation is described.

STATE ENVIRONMENTAL POLICY ACT

Maryland Environmental Policy Act - Annotated Code of Maryland, Natural Resources Title, Subtitle 3, §§ 1-301 to 1-305, State departments have developed their own regulations (e.g. Dept. of Transportation is COMAR 11.01.08.01 to .08), no specific guidelines in DNR title, 1974

Overview:
State actions are first required to fill out an Environmental Assessment Form to determine if the project may have a significant impact on the environment, if yes they must prepare an Environmental Effects Report. Any proposed State action significantly affecting the quality of the environment requires an environmental effects report including, but not limited to, a discussion of: The effects of the proposed action on the environment, including adverse and beneficial environmental effects that are reasonably likely if the proposal is implemented or if it is not implemented; Measures that might be taken to minimize potential adverse environmental effects and maximize potential beneficial environmental effects, including monitoring, maintenance, replacement, operation, and other follow-up activities; and Reasonable alternatives to the proposed action that might have less adverse environmental effects or greater beneficial environmental effects, including the alternative of no action.

Projects Affected by Law:
Applies to significant state actions by state agencies or entities as well as projects funded by state money.

Public Participation Provisions:
Agencies are recommended to solicit public input based on the public notice provisions of § 10-112 of the State Government Article, but no specific requirements for public input or timelines for input are listed.

Applicability to Wind Development?
Only if wind project is receives state funding (the state does have incentives for wind power development) or it is on state land.

Implementing Agency:
Department of Natural Resources

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Maryland has drafted guidelines that would be mandatory as part of power siting regulations if enacted, however a law passed in early 2007 exempts wind power developments up to 70 MW from the Public Service Commission (PSC) process and it has not yet been determined whether or not the guidelines will still be applicable.

Lead Agency on Guidelines: Technical Advisory Group including representatives from DNR, university, federal agency, conservation organization and industry.

Status of Wildlife Guidelines: Awaiting approval by PSC, unclear if they will be approved now and would only affect projects greater than 70 MW.

Summary of Guidelines: The guidelines are comprehensive for pre-siting evaluation, design and construction recommendations, lighting issues, etc. The applicant is required to get an Environmental Review from the State's Wildlife and Heritage Service to assess species and habitats of concern. A consultation with DNR Natural Heritage biologists is required to minimize seasonal (e.g. avian and bat breeding seasons) disturbance during construction and to outline pre-construction studies (one year of monitoring, additional monitoring of species of special concern) that must be undertaken. Studies will continue during development and the developer is required to do three years of monitoring post-construction. Impacts should be avoided or minimized before seeking mitigation; the guidelines outline mitigation options and adaptive management for unforeseen impacts.

Web site for Guidelines: http://www.psc.state.md.us/psc/index.htm; Admin Docket RM24

MASSACHUSETTS

BACKGROUND

Contact: Department of Energy Resources, (617) 727-4732, DOER.Energy@State.MA.US,

Installed Utility Scale Wind Power: 4 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - 4% by 2009 + 1% annual increase

Incentives for Industrial or "Big Wind" Production:

- Massachusetts offers a corporate or personal excise tax deduction for any income received from the sale of a patent or royalty income from a patent deemed beneficial for energy conservation or alternative energy development.
- The Excise Tax Deduction for Solar or Wind-Powered Systems allows businesses to deduct from net income, for state excise tax purposes, the costs incurred from the installation of any solar or wind powered heating/cooling system.
- The Massachusetts Technology Collaborative (MTC), as administrator of the state's Renewable Energy Trust Fund, offers loans between $500,000 and $3 million to companies that currently, or plan to, manufacture renewable energy technology products (new products, existing products or a combination of the two) in Massachusetts; the MTC will provide up to 50% of capital expenses and related spending over a 24-month window; at most 75% of funding can come from public sources, including equity, debt or grant.
- The MTC Clean Energy Pre-Development Financing Initiative offers grants and loans to support the development of grid-connected renewable energy systems (including wind) in any of the 6 New England states; funding is available for feasibility studies (up to $50,000) and for pre-development activities (up to $250,000 for wind), minimum cost-share for each project is 25%; wind systems must be at least 3 MW.
- The MTC matches funds generated by the Clean Energy Choice program (Massachusetts electric customers can choose to pay an additional premium each month to support green power) up to $2.5 million annually in matching grants (up to one dollar in funding for each dollar residents spend on clean energy) for communities, towns and cities to fund clean energy projects within their communities.

Incentives for Residential and "Small Wind" Production:

- The Renewable Energy State Income Tax Credit provides a 15% credit against the state income tax for the cost of a renewable-energy system (including installation) installed on an individual's primary residence up to $1,000; the credit may be carried over if the credit is greater than income tax liability in one year.
- The Renewable Energy Property Tax Exemption allows solar and wind powered devices used as a primary or auxiliary power system for a taxable property qualify for property tax exemptions for a period of 20 years from the date of installation.

- The Renewable Energy Equipment Sales Tax Exemption exempts solar, wind, and heat pump systems and all related equipment from the state sales tax.
- The MTC Large Onsite Renewables Initiative (LORI) provides Feasibility Study Grants (up to $40,000 with cost-share of 15%) and Design & Construction Grants (up to $400,000 or 75% of actual costs) on a competitive basis for grid-tied renewable-energy projects greater than 10 kW in capacity that are located at commercial, industrial, institutional and public facilities that will consume more than 25% of the renewable energy generated by the project on-site.
- MassHousing's Green Affordable Housing Development Program provides feasibility and design grants (up to $30,000 for feasibility; up to $50,000 for design) and grants or loans for construction (up to $500,000) to promote the construction of renewable energy generation systems, including 100 kW or more wind systems, in affordable housing developments financed by MassHousing or the Affordable Housing Trust Fund.
- The MTC Small Renewables Initiative offers rebates of up to $50,000 for design & construction of customer-sited renewable energy projects (including $2.25 per watt for wind electric systems), with a goal of supporting the installation of 400 - 500 systems statewide; projects must be located at residential (will only fund up to 3.6 kW for residential systems), commercial, industrial, or institutional facilities (will only fund up to 10 kW for non-residential systems) that are connected to one of the investor-owned electric distribution utilities in Massachusetts

Interconnection and Net Metering Standards:
Massachusetts' investor-owned utilities must offer net metering up to a maximum individual system capacity of 60 kW.

ENERGY SITING PROCESS

Power Siting Authority: Energy Facilities Siting Board regulates construction of power plants greater than 100 MW - none of Massachusetts current wind power plants would fall under this category. Smaller projects are dealt with through zoning and ordinances of cities and towns. State has developed model zoning by-laws that municipalities can enact. Offshore wind development has much greater potential in Massachusetts.

Wind Specific Siting Authority? No

Code or Regulations: Regulatory Authority for Siting Board: 980 CMR 2.00: M.G.L. c. 164, § 69H

Role of State Fish & Wildlife Agency: The Secretary of the Executive Office of Environmental Affairs is one of nine members of the Siting Board. Numerous agencies, including the Massachusetts Natural Heritage and Endangered Species program and the Department of Environmental Protection, may regulate components of the project (wetlands concerns, species concerns, etc.) no matter what government unit has final say in the project.

How are wildlife laws applied: Same as any development project.

State Environmental Policy Act

Massachusetts Environmental Policy Act - Mass. General Laws, Title III, Ch. 30, §§61, 62-62H, 301 CMR 11.00, 1977

Overview:
A project is subject to Massachusetts Environmental Policy Act (MEPA) jurisdiction when it either meets or exceeds one or more review thresholds (a specific list of categories of Projects or aspects thereof of a nature, size or location that are likely, directly or indirectly, to cause damage to the environment) or the Secretary requires fail-safe review (if there is a petition by one or more Agencies or ten or more Persons, or at the initiative of the Secretary). The process begins with an Environmental Notification Form (ENF) that includes a concise but accurate description of the Project and its alternatives, identify any review thresholds the Project may meet or exceed and any Agency Action it may require, present the Proponent's initial assessment of potential environmental impacts, propose mitigation measures, and may include a proposed Scope. The The full Environmental Impact Report (EIR) requires a stand-alone description of the nature and extent of the proposed project and its environmental impact; all measures being utilized to minimize environmental damage; any adverse short-term and long-term environmental consequences which cannot be avoided should the project be undertaken; and reasonable alternatives to the proposed project and their environmental consequences.

Projects Affected by Law:
MEPA applies to a Project undertaken by an Agency; Agency actions include granting state permits or licenses, providing state financial assistance, or transferring state land. MEPA does not apply to projects needing only local approvals.

Public Participation Provisions:
MEPA review begins by preparing and filing an Environmental Notification Form (ENF) with the Secretary of Environmental Affairs. The ENF is published in the next Environmental Monitor and the MEPA Office, agencies and the public have a 20-Day review period, after which the Secretary determines if the project requires a full Environmental Impact Report. After preparation of the EIR, it is published in the Environmental Monitor and the public has 30 days to review and comment on the proposal after which the Secretary makes the final decision. If approved, the Agency or other project lead may proceed 60 days after the Final EIR is published.

Applicability to Wind Development?
Yes, if the project requires State permits.

Implementing Agency:
Executive Office of Environmental Affairs - MEPA Office

Wildlife Guidelines for Wind

Wildlife Guidelines for Wind Power Siting: No specific guidelines for wildlife, however the Department of Energy Resources and the Executive Office of Environmental Affairs have developed a model wind zoning by-laws to assist Massachusetts cities and towns in establishing reasonable standards for wind power development.

Lead Agency on Guidelines: Department of Energy Resources and Executive Office of Environmental Affairs

Summary of Guidelines: The recommended by-laws are voluntary and are very limited on wildlife related recommendations. The only components are for lighting, to limit non-blinking red lights to reduce attraction for wildlife, and a limited section on habitat impacts, recommending to limit the amount of ground cleared for construction.

Web site for Model County Ordinance: http://www.mass.gov/Eoca/docs/doer/renew/model-allow-wind-by-permit.pdf

	Detailed Summary of Massachusetts' Model Zoning Guidelines
Pre-construction survey	The model zoning language is limited as far as implications to habitat and wildlife specific concerns and focus more on safety and impacts to residential communities. There are some recommended provisions to reduce impacts in the pre-approval and siting time frames. Specific pre-construction components (primarily for utility-scale facilities) include a plan indicating all proposed changes to the landscape of the site, including temporary or permanent roads or driveways, grading, vegetation clearing and planting, exterior lighting, other than FAA lights, screening vegetation or structures.
Design/Operation Recommendations	Recommends that lighting for turbines should only be included if recorded by Federal Aviation Administration and lights for associated structures should have the minimum lighting for safety and operational structures. Monopole towers are recommended as the preferred structure.
Site Development Recommendations	Recommends that clearing of natural vegetation shall be limited to what is necessary for the construction, operation and maintenance of the wind facility and is otherwise prescribed by applicable laws, regulations, and ordinances.
Consultation with wildlife agency, USFWS	None
Mitigation requirements	None
Post-Construction/ Operational Surveys	None
Decommissioning	None

MICHIGAN

BACKGROUND

Contact: Karen Cleveland, Wildlife Biologist, P.O. Box 30444, Lansing, MI 48909-7944

Installed Utility Scale Wind Power: 3 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Proposed - 10% by 2015 and 20% by 2025

Incentives for Industrial or "Big Wind" Production:

- Michigan created the NextEnergy economic-development plan to position the state as a world leader in the research, development, commercialization and manufacture of alternative-energy technologies; NextEnergy industry recruitment programs include a non-refundable Business Activity Credit and a Refundable Payroll Credit for businesses certified by the NextEnergy Authority that locate in the NextEnergy Zone.
- The Alternative Energy Personal Property Tax Exemption includes exemptions for alternative energy systems less than 2 megawatts, or integrated combinations of alternative energy systems of no more than 10 megawatts as well as the personal property of an alternative energy technology business - The exemption applies to companies engaged in the manufacturing or research and development of alternative energy technologies and nonresidential alternative technology owners.

Incentives for Residential and "Small Wind" Production:

- The Michigan Public Service Commission (PSC) energy-efficiency grant program, funded by the state's Low-Income and Energy Efficiency Fund, supports the implementation of energy-efficiency projects and renewable-energy projects by businesses, non-profit organizations, government agencies and/or schools.
- Wisconsin Public Power, Inc. (WPPI) utilities (including these Michigan utilities: Alger Delta CEA, Baraga Electric Utility, Gladstone Power & Light, L'Anse Electric Utility, Negaunee Electric Department, and Norway Power & Light) offers rebates for renewable-energy systems to residential and small commercial customers; for qualifying wind-energy systems rated 20 kW or less, eligible customers will receive a rebate equal to 25% of the system's cost, with a maximum incentive of $10,000; customers may also receive a rebate for 75% (up to $375) for a renewable energy site assessment and 50% rebate (up to $2,500) for both routine maintenance as well as major system repairs.

Interconnection and Net Metering Standards:

The Michigan Public Service Commission (PSC) adopted interconnection standards for 5 levels of distributed generation (DG). The maximum size of electric generators eligible for net metering is less than 30 kW, unless a utility voluntarily sets its limit at less than 150 kW (to match size categories established by the state's interconnection rules). Non-dispatchable generation (e.g. solar and wind) must be sized not to exceed the customer's annual energy needs, measured in kilowatt-hours

ENERGY SITING PROCESS

Power Siting Authority: Local Government manages land use through zoning and ordinances; Some local governmental units (i.e. townships and counties) have adopted local ordinances regarding the siting of wind power.

Wind Specific Siting Authority? No

Code or Regulations: State level: Michigan Tall Structures Act, Michigan Natural Resources and Environmental Protection Act.

Role of State Fish & Wildlife Agency: For projects requiring environmental review, the Department works with developers who contact them to avoid and minimize impacts.

How are wildlife laws applied: Same as any development project. Can require mitigation when Threatened or Endangered Species are involved or on Michigan Department of Natural Resources (DNR) lands.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Michigan Siting Guidelines for Wind Energy Systems

Lead Agency on Guidelines: The Energy Office, Michigan Dept. of Labor and Economic Growth

Status of Wildlife Guidelines: Final – December 14, 2005

Summary of Guidelines: Voluntary guidelines provide recommended local zoning ordinances for set back requirements, sound requirements, environmental impact and avian & wildlife impact analysis, etc. Environmental Impact Analysis to assess impacts to natural environment and outline measures to minimize, eliminate or mitigate for impacts; shall comply with appropriate portions of the Michigan Natural Resources and Environmental Protection Act. Avian & Wildlife Impact Analysis, applicants shall have a third party professional to identify and assess any potential impacts on wildlife and endangered species; outlines siting that requires special scrutiny (near high concentrations of birds or bat hibernacula, etc.) must document plans to minimize, eliminate or mitigate for identified impacts. Must comply with federal and state endangered species laws. Includes guidelines for post-construction mortality study. Directs applicants to USFWS Interim Guidance on Avoiding and Minimizing Wildlife Impacts from Wind Turbines.

Web site for Guidelines:
http://www.michigan.gov/documents/Wind_and_Solar_Siting_Guidlines_Draft_5_96872_7.pdf

	Detailed Summary of Michigan's Model Zoning Guidelines
Pre-construction survey	The model zoning language includes specific requirements for habitat and wildlife specific concerns but focus more on safety and impacts to residential communities. Includes requiring an environmental impact analysis conducted by a third party, qualified professional to identify and assess any potential impacts on the natural environment including, but not limited to wetlands and other fragile ecosystems, historical and cultural sites, and antiquities. In addition requires an avian and wildlife impact assessment by a third party, qualified professional to identify and assess any potential impacts on wildlife and endangered species. At a minimum, the analysis shall include a thorough review of existing information regarding species and potential habitats in the vicinity of the project area. Where appropriate, surveys for bats, raptors, and general avian use should be conducted.
Design/Operation Recommendations	Recommends that power lines be placed underground, when feasible, to prevent avian collisions and electrocutions. All above-ground lines, transformers, or conductors should comply with Avian Power Line Interaction Committee published standards to prevent avian mortality. Recommendations for tubular towers covered under the "Visual Impact" section.
Site Development Recommendations	None
Consultation with wildlife agency, USFWS	None
Mitigation requirements	Requires the applicant take appropriate measures to minimize, eliminate or mitigate adverse impacts to the environment and wildlife that are identified in the preliminary analysis. The applicant must identify and evaluate the significance of any net effects or concerns that will remain after mitigation efforts.
Post-Construction/ Operational Surveys	The pre-siting analysis is required to indicate whether a post construction wildlife mortality study will be conducted and, if not, the reasons why such a study does not need to be conducted.

Decommissioning	The applicant is required to submit a decommissioning plan. The plan shall include: 1) the anticipated life of the project, 2) the estimated decommissioning costs net of salvage value in current dollars, 3) the method of ensuring that funds will be available for decommissioning and restoration, and 4) the anticipated manner in which the project will be decommissioned and the site restored.

MINNESOTA

BACKGROUND

Contact: Steven Colvin, Environmental Review Supervisor, DNR - Division of Ecological Resources, 651-259-5082, Steve.Colvin@dnr.state.mn.us

Installed Utility Scale Wind Power: 897 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes (goal) - 10% by 2015 + Xcel Energy mandate of 1125 MW wind by 2010

Incentives for Industrial or "Big Wind" Production:

- Minnesota issues a payment of 1.0¢ to 1.5¢/kWh for electricity generated by new wind-energy projects less than two megawatts (MW) in capacity. As of May 2006, 211 MW were operating and receiving incentive payments. An additional 13 MW are eligible to receive payments when operational. The program was closed to new applicants on January 1, 2005.
- Minnesota excludes from (real estate) property taxation the value added by solar-electric (PV) or wind systems. However, the land on which a PV or wind system is located is taxable. In addition, all real and personal property of wind-energy systems is exempt from the state's property tax. In lieu of a property tax on large wind-energy systems, a production tax was implemented in 2002. Wind systems greater than 12 MW are taxed at a rate of 0.12 cents/kWh; systems between 2 MW and 12 MW are taxed at a rate of 0.036 cents/kWh; and systems between 250 kW and 2 MW are taxed at a rate of 0.012 cents/kWh. Wind systems under 250 kW are exempt from the production tax.
- Wind-energy conversion systems used as electric-power sources are exempt from Minnesota's sales tax. Materials used to manufacture, install, construct, repair or replace wind-energy systems also are exempt from the state sales tax.

Incentives for Residential and "Small Wind" Production:

- Wind-energy conversion systems used as electric-power sources are exempt from Minnesota's sales tax. Materials used to manufacture, install, construct, repair or replace wind-energy systems also are exempt from the state sales tax.
- Minnesota has a low-interest Agricultural Improvement Loan Program by the Minnesota Rural Finance Authority (RFA) through participating individual lenders that provides loans to farmers for improvements or additions to permanent agricultural facilities including wind-energy systems with a maximum capacity of 1 MW; participation is limited to 45% of the principal amount of the loan or $200,000, whichever is less.
- Minnesota's Energy Investment Loan Program will buy down up to 50% of the loan principal to 0% interest for any specific renewable energy, energy efficiency or energy conservation "capital improvement" measure with a simple payback of 10 years or less in an existing building. Minnesota cities, counties, townships, hospitals and K-12 schools are eligible for this program.

- The Value-Added Stock Loan Participation Program through the RFA is designed to help farmers buy into wind energy and anaerobic-digestion cooperatives, the maximum size of an individual project supported by a wind-energy cooperative is 1 megawatt (MW) - the RFA purchases up to 45% of the loan with an interest rate on the RFA portion of 4.0%.
- Minnesota Power Grant Program offers grants of up to $50,000 to its commercial, industrial, and agricultural customers who use innovative technologies, improve manufacturing processes, undertake renewable electric energy projects or who need project design assistance.

Interconnection and Net Metering Standards:
Minnesota's net-metering law applies to all investor-owned utilities, municipal utilities and rural electric cooperatives. Qualifying facilities up to 40 kilowatts (kW) are eligible for net metering; there is no statewide capacity limit for net metering.

ENERGY SITING PROCESS

Power Siting Authority: Minnesota Public Utility Commission (PUC) issues a Site Permit for a Large Wind Energy Conversion System (LWECS) (> 5MW) - this regulatory authority was transferred to the PUC from the Minnesota Environmental Quality Board in July 2005. New legislation in 2007 would allow counties to assume responsibility for siting LWECSs less than 25MW. The PUC has a specific set of requirements for siting of wind energy facilities (separate from other electric generating facilities). Information on wind siting can be found at: http://energyfacilities.puc.state.mn.us/wind.html.

Wind Specific Siting Authority? Yes

Code or Regulations: Wind siting authority – Minn. Stat. §§ 116C.691-.697; Permitting requirements – Minnesota Rules Chapter 4401

Role of State Fish & Wildlife Agency: The commission requires, among other things, an analysis of the proposed facility's potential environmental and wildlife impacts, proposed mitigative measures, and any adverse environmental effects that cannot be avoided.

How are wildlife laws applied: Much of the wind power development potential is in the southwest portion of the state, so the state conducted one large 4-year avian impact study and a 2-year bat impact study in the area. On the basis of the results of the state-required studies, state and local agencies in Minnesota are not requiring post-construction studies for wind power development in this portion of the state.

STATE ENVIRONMENTAL POLICY ACT

Minnesota Environmental Policy Act - Minnesota Statutes, Ch. 116D, Minnesota Rules, Ch. 4410, 1973

Overview:
Although Minnesota does have a state environmental policy act, the analysis of environmental impacts in a Site Permit Application required through the state wind siting process (Minnesota Statutes Chapter 216F and Minnesota Rules Chapter 7836) satisfies the environmental review

requirements for Minnesota Environmental Policy Act (MEPA) - no Environmental Assessment Worksheets or Environmental Impact Statement are required for Large Wind Energy Conversion System projects. Terms and conditions are outlined in the rule as to the contents of a site permit application including, but not limited to recreational resources, land-based economics, water resources, wildlife, vegetation and rare and unique resources. Items such as pre-construction biological surveys, natural heritage reviews, impact mitigation measures, and prairie management plans are routinely included in the site permits. In addition to these permit requirements, site permit applications include resource information that inventories natural resources in the project area, identifies potential impacts, and proposes methods to avoid or minimize those impacts.

Projects Affected by Law:
The wind siting process applies to Large Wind Energy Conversion Systems, defined as a combination of Wind Energy Conversion Systems with a combined nameplate capacity of 5,000 kilowatts or more.

Public Participation Provisions:
The public has a minimum of 30 calendar days after publication of the draft site permit to provide written comments to the PUC.

Applicability to Wind Development?
No – MEPA does not set statute or rule for Wind siting.

Implementing Agency:
Public Utilities Commission

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No Guidance

MISSISSIPPI

BACKGROUND

Installed Utility Scale Wind Power: None

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: No

Incentives for Industrial or "Big Wind" Production:
None

Incentives for Residential and "Small Wind" Production:
TVA Green Power Switch Partners Program - $500 plus $.15/kWh (residential/small-commercial) or $0.20/kWh (large commercial) to purchase entire production of renewable power including wind; systems must be 50 kW or less.

Interconnection and Net Metering Standards:
No net-metering/interconnection standards

ENERGY SITING PROCESS

Power Siting Authority: There isn't much emphasis on wind power development in the state, and wind energy is not specifically covered by any state regulatory authority.

Wind Specific Siting Authority? No

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No Guidance

MISSOURI

BACKGROUND

Contact: Jane Epperson, Policy Coordination Unit Supervisor, Missouri Department of Conservation, 573-522-4115 ext 3351, jane.epperson@mdc.mo.gov

Installed Utility Scale Wind Power: 4 projects under construction, total of 163 MW.

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - Renewable Energy and Energy Efficiency Objective of 11% by 2020

Incentives for Industrial or "Big Wind" Production:
None

Incentives for Residential and "Small Wind" Production:
The Energy Center of the Missouri Department of Natural Resources provides loans for energy efficiency and renewable energy project for K-12 public schools, public higher education facilities, and city and county governments; Loan amounts are based upon projected energy savings.

Interconnection and Net Metering Standards:
Missouri enacted legislation in June 2007 (SB 54) requiring all electric utilities to offer "true" net metering (previously they had a "dual metering" system) to customers with systems up to 100 kilowatts (kW). The new law takes effect on Jan. 1, 2008 and will be available until the total rated generating capacity of net-metered systems equals 5% of a utility's single-hour peak load during the previous year.

ENERGY SITING PROCESS

Power Siting Authority: No governmental entity in the state regulates siting for wind power; the first commercial grade wind system was installed in the state less than 6 months ago. Missouri's Public Service Commission and Department of Natural Resources will likely have review/oversight but no policies are in place yet. Developments would be subject to standard environmental laws including voluntary review for threatened and endangered species through the Heritage database. Projects may be affected by local zoning if local governments have anything in place.

Wind Specific Siting Authority? No

Role of State Fish & Wildlife Agency: Department of Conservation currently has no formal role in the process but would be involved should development impact existing wildlife related laws and are in contact with Department of Natural Resources which is the agency most involved in wind power issues. State can not require mitigation.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No Guidance

MONTANA

BACKGROUND

Contact: T.O. Smith, Montana Fish, Wildlife & Parks, 406-444-3889, tosmith@mt.gov

Installed Utility Scale Wind Power: 146 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - 15% by 2015

Incentives for Industrial or "Big Wind" Production:

- Montana's Alternative Energy Investment Corporate Tax Credit allows a tax credit for income earned on investments of $5,000 or more in commercial and net metering alternative energy; associated facilities, manufacturing plants producing the alternative energy equipment and industries using the energy generated may use the tax credit and the credit is available to taxpayers purchasing an existing facility as well as to those building a new facility.
- The Corporate Property Tax Reduction for New/Expanded Generating Facilities allows Montana alternative renewable energy generating plants producing 1 megawatt or more are eligible for industry property tax reduction on the local mill levy during the first nine years of operation (subject to approval by the local government); the facility is taxed at 50% of its taxable value in the first five years after the construction permit is issued, the percentage increases each year until the full taxable value is attained in the tenth year. The Generation Facility Corporate Tax Exemption exempts new electricity generating facilities built in Montana with a nameplate capacity of less than 1 MW and using an alternative renewable energy source from property taxes for 5 years after start of operation.
- The Bonneville Environmental Foundation (BEF) provides up to 33% of the funding, through grants, loans, convertible loans, guarantees, and direct investments, for the capital costs for installation of renewable energy, including wind, to local governments, non-profits and tribal governments in the Pacific Northwest (OR, WA, ID, MT); grants and investments may range from a few thousand dollars for small installations, to significant investments in central station grid-connected renewable energy projects.

Incentives for Residential and "Small Wind" Production:

- The Montana Residential Alternative Energy System Tax Credit allows residential taxpayers who install an energy system using a recognized non-fossil form of energy to receive a tax credit equal to the amount of the cost of the system and installation of the system, not to exceed $500; the tax credit may be carried over for the next four taxable years.
- The Northwest Solar Cooperative (NWSC) offers to purchase the rights to the environmental attributes or "Green Tags" derived from grid-connected solar PV- or wind-generated electricity at a rate of $0.05/kWh through December 31, 2009; systems up to 25 kW are automatically approved; > 25 kW approved on case-by-case basis.
- Montana has a residential property tax exemption for recognized renewable energy generation, for single-family residential dwellings the exemption is up to $20,000, for multifamily residential

dwellings or a nonresidential structure the exemption is up to $100,000 and may be claimed for 10 years after installation of the property.

- The Alternative Energy Revolving Loan Program (AERLP) provides 10 year loans of up to $40,000 to individuals, small businesses, local government agencies, units of the university system, and nonprofit organizations to install alternative energy systems that generate energy for their own use.
- NorthWestern Energy's USB Renewable Energy Fund periodically provides funding to its customers for renewable energy projects; the incentive for wind is $2/watt to a maximum of $10,000 per customer.

Interconnection and Net Metering Standards:
Montana's net-metering law allows customers of investor-owned utilities to net meter systems that generate electricity using solar, wind or hydropower systems up to 50 kilowatts (kW). All customer classes are eligible, and no limit on enrollment or statewide installed capacity is specified.

ENERGY SITING PROCESS

Power Siting Authority: Wind power development specifically is generally unregulated at any level of government. However, components of the development may be regulated by the Department of Environmental Quality, for instance if it impacts wetlands, water quality, etc. In addition, if transmission lines greater than 69 kilovolts are necessary a Certificate of Environmental Compatibility might be necessary. Madison County has also enacted an ordinance to regulate the construction of tall towers including Wind Energy Conversion Systems.

Wind Specific Siting Authority? No

Role of State Fish & Wildlife Agency: The Department of Natural Resources and Conservation may require easements or leases when state lands are used or crossed. But Montana Department of Fish, Wildlife & Parks is not specifically included in the process unless there are Threatened & Endangered species issues.

How are wildlife laws applied: Same as any development project.

STATE ENVIRONMENTAL POLICY ACT

Montana Environmental Policy Act - MCA Title 75, C. 1, Pts. 1-3, Administrative Rules of Montana (ARM) Ti. 17, Ch. 4, Subch. 6: 17-4-601 through 17-4-636, 1971

Overview:
If an agency's action has a potential impact on the human environment (adverse, beneficial, or both) and if that action is neither categorically excluded (a determination, based on the rulemaking or programmatic review, that the proposed agency action satisfies all of the criteria for exclusion) nor exempt from Montana Environmental Policy Act "MEPA" review, then some form of environmental review is required. If it is unclear whether the proposed action may generate impacts that are significant, then an agency may prepare an Environmental Assessment (EA) in order to determine the potential significance and decide if a full Environmental Impact Statement (EIS) is necessary; an EA may also be prepared if it is clear that there will be no significant impact to the

human environment. An EIS is a more detailed evaluation of the project than the EA and should include: a description of the purpose and need for the proposed action; a description of the affected environment; a description and analysis of the alternatives, including the no action alternative; and an analysis of the impacts to the human environment of the different alternatives, including an evaluation of appropriate mitigation measures.

Projects Affected by Law:
A state "action" is defined as a project, program, or activity directly undertaken by a state agency; a project or activity supported through contract, grant, subsidy, loan, or other form of funding assistance from a state agency; or a project or activity involving the issuance of a lease, permit, license, certificate, or other entitlement for use or permission to act by an agency.

Public Participation Provisions:
Public participation is required several times in the process however public participation is discretionary during the EA review and mandatory during the EIS review. During the EIS process, the agency must invite comments on the purpose and need for the pending action (scoping); provide a 30 day comment period on the draft EIS and a 15 day review of the final EIS (all public comments and the agency's response to the comments must be included in the final EIS); and inform the public of the agency's decision and the justification for that decision.

Applicability to Wind Development?
Yes, through permitting process and likely through state funding incentives for wind development.

Implementing Agency:
Environmental Quality Council - created by MEPA, made up of 6 state senators, 6 state representatives, 4 members of the public and 1 nonvoting member representing the governor.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Uses US Fish & Wildlife Service's interim guidelines.

Summary of Guidelines: The State Department of Environmental Quality's wind power website (http://deq.mt.gov/Energy/Renewable/WindWeb/indexWindinMT.asp) references the U.S. Fish & Wildlife Service's Interim Guidance and provides information on the Service's recommended ranking system, developed in Montana, that focuses on pre-development evaluation of proposed sites based on the potential impacts to wildlife. These are voluntary recommendations.

NEBRASKA

BACKGROUND

Installed Utility Scale Wind Power: 73 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: No

Incentives for Industrial or "Big Wind" Production:

- Nebraska offers a production-based Renewable Energy Tax Credit (personal or corporate) to any producer of electricity generated by wind, solar, geothermal, hydropower, fuel cells or methane gas (no limit on size of facility), the credit may be used to reduce income tax liability or for a refund of state sales and use taxes; the credit ranges between $0.0005/kWh and $0.001/kWh depending on the year and can be claimed for 10 years after a facility goes into production, the total amount of renewable energy tax credits that may be used by all taxpayers is limited to $750,000.
- Nebraska's Sales and Use Tax Exemption for Community Wind Projects allows an exemption from the sales and use tax imposed on the gross receipts from the sale, lease, or rental of personal property for use in a community-based energy development (C-BED) project; for a C-BED project that consists of more than two turbines, the project is owned by qualified owners with no single qualified owner owning more than 15% of the project and with at least 33% of the power purchase agreement payments flowing to the qualified owner or owners or local community; or for a C-BED project that consists of one or two turbines, the project is owned by one or more qualified owners with at least 33% of the power purchase agreement payments flowing to a qualified owner or local community.

* Public ownership of electric utilities in Nebraska precludes wind projects from federal wind energy Production Tax Credit.

Incentives for Residential and "Small Wind" Production:
The Dollar and Energy Savings Loans program, adminstered by the Nebraska Energy Office, provides low interest loans for residential and commercial energy efficiency improvements (Residential: $35,000 - $75,000 Non-Residential: $75,000 - $175,000), renewable energy projects are eligible under one of two criteria. A project may be eligible if it is included in a list of "pre-qualified improvements" or if there is an energy audit that verifies that the project will create net energy savings.

Interconnection and Net Metering Standards:
No net-metering/interconnection standards

ENERGY SITING PROCESS

Power Siting Authority: Electric utility facilities are all publicly owned in Nebraska (by historical precedent, not by statute) so wind power facilities must first be approved by the local utility district.

The project is then brought before the Nebraska Power Review Board (PRB) which approves construction for new electric generating facilities; one of the PRB's primary focuses is on ensuring "least cost" construction and power production to reduce costs for rate payers which could undermine some wind development. Local government has authority over small, consumer-scale wind power.

Wind Specific Siting Authority? No

Code or Regulations: Nebraska Power Review Board authority: Neb. Rev. Stat. §§ 70-1001 through 70-1027; construction review: §§ 70-1012 through 1014

Role of State Fish & Wildlife Agency: Environmental review and considerations do not appear to be part of the Power Review Board permitting process.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No Guidance

NEVADA

BACKGROUND

Contact: Shawn Espinosa, Nevada Department of Wildlife, sespinosa@ndow.org, 1100 Valley Road Reno, NV 89512

Installed Utility Scale Wind Power: None, 3 projects proposed.

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - 20% by 2015

Incentives for Industrial or "Big Wind" Production:

- Nevada's Portfolio Energy Credits (PEC) are a production incentive that can be earned by any renewable energy producer (1 PEC/kWh for renewables other than solar) and can then be sold to utilities to allow utilities to meet their renewable portfolio standards.
- Renewable Energy Producers Property Tax Abatement is a 10-year 50% abatement in real and personal property taxes for renewable electricity generation facilities.

Incentives for Residential and "Small Wind" Production:

- Nevada's Portfolio Energy Credits (PEC) are a production incentive that can be earned by any renewable energy producer (1 PEC/kWh for renewables other than solar) and can then be sold to utilities to allow utilities to meet their renewable portfolio standards.
- Renewable Energy Property Tax Exemption allows any value added by a qualified renewable energy system to be subtracted from the assessed value of any residential, commercial or industrial building for property tax purposes.

Interconnection and Net Metering Standards:
The Nevada Public Utilities Commission (PUC) has interconnection standards for customers of Nevada Power and Sierra Pacific Power with on-site generation up to 20 megawatts (MW) in capacity. In addition, net-metering is available to systems up to 1 MW in capacity although systems greater than 100 kilowatts (kW) in capacity may be subject to certain costs at the utility's discretion.

ENERGY SITING PROCESS

Power Siting Authority: Because much of Nevada is federally owned public lands, federal agency (BLM, FWS, NPS, etc.) requirements and NEPA could affect much wind development in the state. Public Utilities Commission of Nevada issues a permit for construction of electrical facilities, this includes renewable energy generating facilities greater than 150 KW.

Code or Regulations: NRS 704.820 through 704.900

Wind Specific Siting Authority? No

Role of State Fish & Wildlife Agency: Department of Natural Resources has integrated resource management and joint environmental review for projects

How are wildlife laws applied: Utility regulator considers trade-offs and decides. State does not have the authority to require mitigation.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Use US Fish & Wildlife Service interim guidelines as well as Oregon and Washington state guidelines.

NEW HAMPSHIRE

BACKGROUND

Contact: Michael Marchand, Wildlife Biologist, NH Fish & Game, michael.marchand@wildlife.state.nh.us, 11 Hazen Drive, Concord NH 03301

Installed Utility Scale Wind Power: 1 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - 23.8% by 2025

Incentives for Industrial or "Big Wind" Production:
The New Hampshire Business Resource Center and Ocean National sponsor the Renewable Energy and Energy Efficiency Business Loan Program that offers small businesses a reduced interest rate loan of at least $10,000 for the purchase of renewable energy systems and energy efficiency improvements.

Incentives for Residential and "Small Wind" Production:
New Hampshire allows each city and town to offer an exemption on residential property taxes in the amount of the assessed value of a renewable-energy system used on the property.

Interconnection and Net Metering Standards:
Net metering is available to all electric-generating systems powered by "renewable" energy with a maximum system capacity of 100 kW and the aggregate capacity of net-metered systems in a utility's service territory is 1.0% of the utility's annual peak energy demand.

ENERGY SITING PROCESS

Power Siting Authority: New Hampshire Energy Facility Siting Evaluation Committee (SEC) provides a Certificate for Site and Facility for energy facilities over 30 MW; developers of facilities less than 30 MW can opt-in to the SEC process to preempt local jurisdiction or to access the aggressive schedule (within 9 months from application) that the SEC is required to pursue. If not going through the SEC process, wind development would fall under local jurisdiction. The state is currently going through their first wind power siting evaluation.

Wind Specific Siting Authority? No

Code or Regulations: RSA 162-H

Role of State Fish & Wildlife Agency: The Executive Director of the New Hampshire Fish & Game Department (NHFG) is one of 15 officials from 8 state agencies that sit on the Siting Evaluation Committee. NH Fish & Game Department has review of the project for impacts to wildlife especially threatened & endangered species. Department of Environmental Services is responsible for wetlands, alteration of terrain

How are wildlife laws applied: The siting application includes an evaluation of potential impacts on the environment and plans to study and resolving environmental problems.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Proposed guidance, using Vermont's guidance as a basis.

Lead Agency on Guidelines: A stakeholders group led by NH Audubon and Appalachian Mountain Club (AMC) with representatives from NHFG, USFWS, non-profits (Audubon, AMC, TNC) and wind representatives is drafting the guidelines.

Status of Wildlife Guidelines: Preliminary draft submitted by Wind Energy Facility Siting Guidelines Working Group on May 29 2007 to NH Energy Policy Committee Wind Siting Subcommittee for review.

Summary of Guidelines: Evaluation of whether project is likely or less likely to have major impacts. Projects are placed into categories. For wildlife, pre- and post-monitoring studies are outlined.

	Detailed Summary of New Hampshire's Draft Voluntary Guidelines
Pre-construction survey	Proposed guidelines recommend preliminary consultation with a proposed state coordinator to evaluate initial data collection needs. After initial data compilation, the developer should do a pre-application consultation with a proposed wind power advisory group to make a preliminary assessment on the proposal's suitability and concerns for resources, and to then provide recommendations for more complete studies necessary for the project. The proposed guidelines then include a detailed overview of resource and social issues that should be considered including rare plants, natural communities, soils and topography, water and wetlands, wildlife, existing land use and infrastructure, recreational use, etc. For wildlife, required pre-permitting surveys should include radar and acoustical surveys of birds and bats for at least one year; visual surveys for diurnal migrating birds and bats for a minimum of one spring and one fall season; breeding bird surveys for a minimum of one breeding season. Recommended surveys for wildlife (only if deemed necessary from initial data compilation) should include surveys for rare, threatened or endangered species, identification of suitable habitat for lynx and marten, surveys for small footed bat, March to August surveys of peregrine falcons and mapping of beech, oak and mountain ash occurrence.
Design/Operation Recommendations	None

Site Development Recommendations	None
Consultation with wildlife agency, USFWS	None
Mitigation requirements	None
Post-Construction/ Operational Surveys	None
Decommissioning	None

NEW JERSEY

BACKGROUND

Contact: Dave Golden, dgolden@gtc3.com; Ted Nichols: tnichols@gtc3.com

Installed Utility Scale Wind Power: 8 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes – 22.5% by 2021

Incentives for Industrial or "Big Wind" Production:

- New Jersey's Renewable Energy Business Venture Assistance Program (REBVAP) provides recoverable grants of $50,000 to $500,000 for the development of businesses, technologies, service and market infrastructure in support of the state's renewable-energy industry; the program budget is approximately $5 million and there is a 25% cost-share requirement.
- New Jersey offers a full exemption from the state's 7% sales tax for all solar and wind energy equipment. This exemption is available to all taxpayers.

Incentives for Residential and "Small Wind" Production:

- New Jersey offers a full exemption from the state's 7% sales tax for all solar and wind energy equipment. This exemption is available to all taxpayers.
- New Jersey has a Clean Energy Rebate Program for renewable energy systems where output will not exceed 100% of energy used by the building or home, wind systems are currently eligible for incentive levels beginning at $5 per watt (60% maximum) for systems up to 10 kW in capacity.
- Larger systems receive incrementally lower rebate amounts, with a 30% maximum. (Single-family rebate applications are limited to the first 10 kW of project capacity.)

Interconnection and Net Metering Standards:
Residential and small commercial wind systems up to 2 megawatts (MW) in capacity are eligible for net metering up to 0.1% of state peak demand or total impact of $2 million. New Jersey's interconnection standards are widely considered to be among the best in the United States.

Power Siting Authority: Department of Environmental Protection (NJDEP) through environmental regulations. Local governments through planning/zoning commission. Most wind power potential is offshore and would be subject to state coastal zone management rules.

Wind Specific Siting Authority? No

Code or Regulations: NJDEP Coastal Zone Management Rules

Role of State Fish & Wildlife Agency: Agency is a primary decision-maker regarding siting.

State Environmental Policy Act

Executive Order 215 (Kean, 1989) - §§ 7:22-10.1 to 7:22-10.12 of the NJ Administrative Code provides the guidelines on environmental assessment for projects receiving state funding, 1989

Overview:
Level I projects (anticipated construction costs in excess of $1 million) are subject to the preparation of an environmental assessment; Level 2 projects (both construction costs in excess of $5 million and land disturbance in excess of five acres) are subject to the preparation of an environmental impact statement. An EIS should include the purpose and need for the proposed project; a detailed evaluation of all alternatives and an identification of the preferred alternative; a description of the environmental consequences including unavoidable adverse impacts and mitigation alternatives.

Projects Affected by Law:
Applies to projects directly initiated by departments, agencies, or authorities of the State, as well as projects in which the State departments, agencies or authorities are granting at least 20 percent financial assistance

Public Participation Provisions:
A public informational meeting is required for a draft EIS at least 30 days after it is published, and the Department of Environmental Protection must accept comments for 15 days following the meeting - a similar process is required for the final EIS. The DEP is required to make a decision on a project within 60 days of receiving a final EA or EIS

Applicability to Wind Development?
Only if wind project is receives state funding (the state does have incentives for wind power development) or it is on state land.

Implementing Agency:
Department of Environmental Protection

Wildlife Guidelines for Wind

Wildlife Guidelines for Wind Power Siting: No Guidance

NEW MEXICO

BACKGROUND

Contact: Matthew Wunder, Division Chief, Conservation Services Division, New Mexico Department of Game and Fish, 505-476-8101, matthew.wunder@state.nm.us

Installed Utility Scale Wind Power: 496 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - Investor-owned utilities: 20% by 2020; Rural electric cooperatives: 10% by 2020

Incentives for Industrial or "Big Wind" Production:

- Corporate Renewable Energy Production Tax Credit of $.01/kWh for wind and biomass, up to 400,000 MWh per year for 10 years, for producers of greater than 1 MW of renewable energy - can not claim both the personal credit and the corporate credit.
- The Alternative Energy Product Manufacturers tax credit of up to 5% of taxpayer's qualified expenditures may be claimed for manufacturing alternative energy products and components.

Incentives for Residential and "Small Wind" Production:
Personal Renewable Energy Production Tax Credit of $.01/kWh for wind and biomass, up to 400,000 MWh per year for 10 years, for residential systems producing of greater than 1 MW of renewable energy - can not claim both the personal credit and the corporate credit.

Interconnection and Net Metering Standards:
Interconnection standards for facilities up to 80 MW, and simplified rules for small residential facilities up to 10 kW.

ENERGY SITING PROCESS

Power Siting Authority: The New Mexico Public Regulation Commission has jurisdiction over electricity generating projects over 300 MW (so far there are no wind projects of this size but some may be developed soon). For projects less than 300 MW in size and producing no emissions, there is no official process for review by the New Mexico Public Regulation Commission. Counties regulate wind power siting through zoning approval, requirements vary by county. Building permits from the Construction Industries Division (CID) of the New Mexico Regulation and Licensing Department are necessary for all wind power developments in the state.

Wind Specific Siting Authority? No

Role of State Fish & Wildlife Agency: The state recommends a "fatal flaw" analysis, similar to general NEPA guidelines, to assess specific siting considerations including wildlife; developers are recommended to consult with the New Mexico Game & Fish Department in this process.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Impacts of Wind Energy Development on Wildlife

Lead Agency on Guidelines: New Mexico Game & Fish Department (NMGFD)

Status of Wildlife Guidelines: January, 2004; NMGFD expects to update the guidelines in 2008.

Summary of Guidelines: Based on the U.S. Fish & Wildlife Service's Interim Guidance, the New Mexico Game & Fish Department's voluntary guidelines focus on Site Development recommendations and Turbine Design and Operation recommendations. The Siting recommendations focus on avoiding important wildlife habitat including bird migration pathways, bat hibernacula, etc. The guidelines specifically recommend avoiding known Lesser Prairie Chicken habitat recommending a 5 mile buffer from known leks. In addition, habitat restoration and mortality studies post-construction are encouraged. The turbine design component references both the FWS guidance and NMGFD guidelines on towers and power line trenching. Recommend and focuses on specific design concepts to minimize roosting and avoid air strikes. Seasonal shut-downs during migratory times are encouraged as necessary.

In addition, The NM Energy, Minerals & Natural Resources Department (http://www.emnrd.state.nm.us/ecmd/Wind/wind.htm) publishes four documents for wind energy project proponents. The Guidelines for Developers and Investors and the Screening Model do not mention wildlife resources. The Wind Development Handbook mentions them peripherally in the context of "Fatal Flaw Analysis." The Case Study Report describes a "Phase I Avian Risk Assessment" (literature review, consultation, site survey) and identifies the likely need for further survey activity.

Web site for Guidelines:
http://www.wildlife.state.nm.us/conservation/habitat_handbook/WindEnergyGuidelines.htm

	Detailed Summary of New Mexico's Voluntary Guidelines
Pre-construction survey	None
Design/Operation Recommendations	Design recommendations in New Mexico are adapted from the USFWS Interim Guidelines. Recommends using tubular supports with pointed tops rather than lattice supports and avoiding external ladders, platforms on tubular towers and guy wires for turbine or meteorological tower support. Guy wires should be marked with recommended bird deterrent devices. Recommends lighting should conform to minimum FAA requirements and only the minimum number, minimum intensity, and minimum number of flashes per minute of white strobe lights should be used at night. Where the height of the rotor-swept area produces a high risk for wildlife, tower heights should be adjusted where feasible to reduce the risk of strikes, and

	electric power lines should be placed underground or on the surface as insulated, shielded wire to avoid electrocution of birds.
Site Development Recommendations	New Mexico's site development guidelines have been adapted from the USFWS Interim Guidelines. This includes: avoiding placing turbines in documented locations of any species of wildlife, fish or plant protected under the Federal Endangered Species Act; avoid locating turbines in known local bird migration pathways or in bird concentration areas; avoid placing turbines near known bat hibernation, breeding, and maternity/nursery colonies, in migration corridors, or in flight paths between colonies and feeding areas; configure turbine locations to avoid areas or landscape features known to attract raptors; configure turbine arrays to avoid potential avian mortality where feasible; avoid fragmenting large, contiguous tracts of undisturbed or native wildlife habitat; avoid placing turbines in habitat known to be occupied by Lesser Prairie Chickens (avoid placing turbines within 5 miles of known leks) or other species that exhibit extreme avoidance of vertical features and/or structural habitat fragmentation; minimize roads, fences, and other infrastructure; develop a habitat restoration plan for proposed sites that avoids or minimizes negative impacts on vulnerable wildlife while maintaining or enhancing habitat values for other species; reduce carrion to avoid attracting Golden Eagles and other raptors.
Consultation with wildlife agency, USFWS	None
Mitigation requirements	None
Post-Construction/ Operational Surveys	Post-development mortality studies should be a part of any site development plan in order to determine if or to what extent mortality occurs. Where high seasonal concentrations of birds occur in areas with critical power generation, an average of three years monitoring data (e.g., acoustic, radar, infrared, or observational) should be collected and used to determine peak use dates for specific sites. Where feasible, turbines should be shut down during periods when birds are highly concentrated at those sites. When upgrading or retrofitting turbines, mortality studies should be used to retrofit or relocate older turbines that have had high mortality at specific older turbines.
Decommissioning	None

NEW YORK

BACKGROUND

Contact: Brianna Gary, Avian Ecologist, NYSDEC, 518-402-8858, bmgary@gw.dec.state.ny.us, 625 Broadway, 5th Floor, Albany, NY 12233-4756

Installed Utility Scale Wind Power: 390 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - 25% by 2013

Incentives for Industrial or "Big Wind" Production:
The New York State Energy Research and Development Authority's (NYSERDA) Renewable Energy Technology Manufacturing Incentive Program is designed to expand in-state manufacturing of electricity-generating, clean-energy products; total of $10 million is available with a maximum project award is $1 million and a minimum 75% cost-share is required.

Incentives for Residential and "Small Wind" Production:

- Qualifying energy-conservation improvements (including wind power) to single-family or up to 4-family homes are exempt from property tax on the increased value of the home.
- Solar, Wind & Biomass Energy Systems Property Tax Exemption is a 15-year exemption from real property taxes for these systems applicable to commercial, industrial, residential and agricultural sectors.
- The New York Energy $mart Loan Fund, administered by the New York State Energy Research and Development Authority (NYSERDA), provides reduced-interest rate loans to finance renovation or construction projects that incorporate renewable energy systems; any commercial, industrial, retail, agricultural, non-profit, residential, or multifamily facility that is an electric distribution customer of one of the State's six investor-owned utilities is eligible. NYSERDA also offers an unsecured loan (100% of costs up to $20,000) for the installation of qualified energy efficient and renewable energy measures in private residences.
- NYSERDA provides incentives of up to $150,000 per site for wind systems 800 W to 250 kW; incentives vary based on specific model and the classification of the wind system owner; incentive paid directly to qualified installer and then passed on to owner.
- The NYSERDA Peak Load Reduction Program provides a wide variety of incentives for reducing electricity use during peak times including permanent demand reduction from wind systems and other renewable systems that have been in place for more than 5 years with proven energy reduction; minimum project size of 20 kW to 100 kW so focuses on buildings with large consumption - program participants can receive the lesser of 65% of project costs or $300/kW to $600/kW depending on location.

Interconnection and Net Metering Standards:
New York has interconnection standards for systems up to 2 MW. Net-metering is available to residential wind turbines up to 25 kW and farm-based wind turbines up to 125 kW (other

renewables have different thresholds), customers can participate on a first-come, first-served basis until aggregate wind system capacity is 0.2% of 2003 demand.

ENERGY SITING PROCESS

Power Siting Authority: Local government manages land use including wind energy development through zoning permits within requirements for state and local environmental review; State Public Service Commission approves construction of facilities over 80 MW.

Wind Specific Siting Authority? No

Role of State Fish & Wildlife Agency: Dept. of Environmental Conservation will participate in environmental review of project but may not have discretionary authority over siting

STATE ENVIRONMENTAL POLICY ACT

State Environmental Quality Review Act - Environmental Conservation Law Sections 3-0301(1)(B), 3-0301(2)(M) and 8-0113, 6 NYCRR Part 617, 1978

Overview:
New York's State Environmental Quality Review Act (SEQR) requires all state and local government agencies to consider environmental impacts equally with social and economic factors during discretionary decision-making. This means these agencies must assess the environmental significance of all actions they have discretion to approve, fund or directly undertake. SEQR outlines Type I projects (those that may meet the threshold for environmental review but may not need an EIS; e.g. nonresidential projects physically altering 10 or more acres of land or zoning changes affecting 25 or more acres) and Type II (those that are exempt from environmental review). If an action is determined to have potentially significant adverse environmental impacts, an Environmental Impact Statement is required. The SEQR process uses the EIS to examine ways to avoid or reduce adverse environmental impacts related to a proposed action including an analysis of all reasonable alternatives to the action. SEQR requires the sponsoring or approving governmental body to identify and mitigate the significant environmental impacts of the activity it is proposing or permitting.

Projects Affected by Law:
SEQR applies to all state or local government agencies including districts and special boards and authorities whenever they must approve or fund a privately or publicly sponsored action. It also applies whenever an agency directly undertakes an action. Applicants who seek project approval or funding may be responsible for preparing an EIS.

Public Participation Provisions:
After a draft environmental impact statement is filed, the public has at least 30 days to comment on the project, the comment period must continue 10 days after the public hearing if one is held. A hearing must be held within 60 days from the filing of the DEIS, but at least 15 days after a notice of the public hearing is published.

Applicability to Wind Development?
Yes, through local government permitting process.

Implementing Agency:
SEQR is self-enforcing, each agency of government is responsible to see that it meets its own obligations to comply. The Department of Environmental Conservation issues regulations, but has no oversight.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Draft Guidelines, currently not public.

Lead Agency on Guidelines: New York State Department of Environmental Conservation

Summary of Guidelines: NYS Department of Environmental Conservation is in the process of developing voluntary guidelines for conducting pre-and post-construction bird and bat studies at proposed and operating wind projects. A draft is currently under review by staff biologists, and will be available for public comment prior to finalizing the document.

NORTH CAROLINA

BACKGROUND

Installed Utility Scale Wind Power: None

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - 12.5% of 2020 retail sales by 2021 for investor-owned utilities; 10% of 2017 retail sales by 2018 for electric cooperatives and municipal utilities

Incentives for Industrial or "Big Wind" Production:
NC GreenPower Production Incentive Payment offers production payments for grid-tied renewable electricity producers less than 10 MW including wind, generators are required to enter into power-purchase agreements with their utility and with NC GreenPower; the incentives, which include payments from utility power-purchase agreements, are made on a per-kWh basis and vary by technology.

Incentives for Residential and "Small Wind" Production:

- Renewable Energy Tax Credit provides for a tax credit of 35% of the cost of renewable energy property (including wind, maximum of 35 kWh battery storage capacity per kW) installed during the tax year, may not exceed 50% of a taxpayer's liability for the year - maximum of $10,500 for residential use; maximum of $2,500,000 on commercial and industrial facilities.
- TVA Green Power Switch Partners Program - $500 plus $.15/kWh (residential/small-commercial) or $0.20/kWh (large commercial) to purchase entire production renewable power including wind; systems must be 50 kW or less.
- The Energy Improvement Loan Program (EILP) provides loans with an interest rate of 1% for certain renewable-energy projects (including wind) to North Carolina businesses, local governments, public schools and nonprofit organizations.

Interconnection and Net Metering Standards:
North Carolina has net-metering and interconnection standards that allow small power producers (up to 20 kW residential and 100 kW for non-residential) to connect to utilities power grid up to an aggregate limit of 0.2% of the utility's North Carolina retail peak load for the previous year.

ENERGY SITING PROCESS

Power Siting Authority: North Carolina Utilities Commission (NCUC) provides a certificate of public convenience and necessity for energy producing facilities including small renewable energy power producers less than 80 MW. Small wind energy facilities are typically handled by County Planning Boards, specific consideration or ordinances relating to wind power are variable. Watauga county has an ordinance in place for permitting small facilities

Wind Specific Siting Authority? No

Code or Regulations: NCUC Rule R1-37 requires a certificate of public convenience and necessity for small energy producers defined in General Statute 62-3(27a) to include renewable power producers less than 80 MW.

STATE ENVIRONMENTAL POLICY ACT

North Carolina Environmental Policy Act (SEPA) - North Carolina General Statutes, Ch. 113A, §§ 113A-1 to 113A-13, North Carolina Administrative Code, Title 15a, Ch. 01, Subch. 01C.0101-0411 (1 NCAC 25), 1971

Overview:
Most North Carolina State agencies have developed rules establishing minimum thresholds based on the size and type of the project or activity. In cases where the project or activity falls below the minimum threshold, agencies may be exempt from SEPA, or they may be required to submit only general environmental information. However, if there is reasonable evidence that a project or activity has significant impacts, a state agency can call for an environmental document to be prepared, even if it is normally listed as exempt from SEPA. The process may start with an Environmental Assessment (EA) which is a brief outline of the project and potential impacts, upon review the project will be granted a Finding of No Significant Project or will be required to develop a full Environmental Impact Statement.

Projects Affected by Law:
Every state agency is subject to SEPA. Any project meeting all the following "triggers" is subject to SEPA: (1) the project is carried out with public funds (any expenditure on the project by federal, state, local, or quasi-public entities) and/or uses state land, (2) a project requires a state approval action (licensing, certification, permitting, etc.) in order to be implemented, and (3) a project has the potential for an environmental impact.

Public Participation Provisions:
Public notification of the environmental documents available for review is through the Environmental Bulletin distributed by the Clearinghouse. Upon review of the comments received, the DOA submits a recommendation back to the state agency making the SEPA compliance review; this process typically takes between 30 and 45 days.

Applicability to Wind Development?
Yes, when development requires state permits.

Implementing Agency:
The State Environmental Review Clearinghouse in the Department of Administration is responsible for daily implementation and administration of the SEPA review process.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No Guidance

NORTH DAKOTA

Background

Contact: John Schumacher, Resource Biologist, ND Game & Fish Dept, (701) 328-6321, jdschumacher@nd.gov

Installed Utility Scale Wind Power: 178 MW

Incentives for Wind Development

Renewable Portfolio Standard: Yes - Renewable and Recycled Energy Objective of 10% by 2015

Incentives for Industrial or "Big Wind" Production:
North Dakota reduces property taxes by 70% for wind facilities of 100 kW or larger. To be eligible, construction must begin by January 1, 2011. The state also has a sales tax exemption for these systems.

Incentives for Residential and "Small Wind" Production:

- North Dakota allows any taxpayer -- an individual or corporation – to claim an income tax credit of 3% per year for five years for the cost of equipment and installation of a system that generates electricity using geothermal, solar, biomass or wind energy and that is installed after December 31, 2000.
- North Dakota exempts any solar, wind, or geothermal energy device from local property taxes for 5 years after installation.

Interconnection and Net Metering Standards:
North Dakota's net-metering rules apply both to renewable-energy generators and cogenerators (combined-heat-and-power systems) up to 100 kilowatts (kW) in capacity; available to all customer classes, and there is no statewide limit on the total capacity of all net-metered systems. There are no specific interconnection standards in the state.

Energy Siting Process

Power Siting Authority: North Dakota Public Service Commission (PSC) regulates siting of wind power facilities greater than 100 MW by providing a Certificate of Site Compatibility, facilities smaller than 80 MW may choose to receive certification by the PSC. Smaller facilities may be regulated by local zoning but this is highly variable by township or county board.

Wind Specific Siting Authority? Yes

Code or Regulations: North Dakota Administrative Code, Title 69-06

Role of State Fish & Wildlife Agency: The Game & Fish Department has joint environmental review and is one of 21 designated state agencies entitled to receive notice on energy facility siting reviewed by PSC (69-06-01-05).

How are wildlife laws applied: Same as any other utility project. The PSC can require mitigation as part of the permitting process for facilities greater than 100 MW.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Uses US Fish & Wildlife Service's interim guidelines.

OHIO

BACKGROUND

Installed Utility Scale Wind Power: 7 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: No

Incentives for Industrial or "Big Wind" Production:

- Ohio exempts certain property used in "energy conversion" (i.e. replacement of fossil-fuel resources with alternative fuels or technologies) from real and personal property taxation, the state's sales and use tax, and the state's corporate franchise tax where applicable; upon receipt of certification from the tax commissioner, such property is exempt from Ohio's sales and use tax, is not considered to be an improvement on the land for purposes of real property taxation or as 'used in business' for purposes of personal property taxation and is also not considered in the assessment of Ohio's corporate franchise tax.
- The Ohio Wind Production & Manufacturing Incentive Program provides production-based incentives to utility-scale wind-energy projects (more than five megawatts) and to community wind-energy projects (500 kilowatts to five megawatts); the incentive rate varies, in 2007 generators will receive a production incentive of $0.01 per kilowatt-hour (kWh) for up to five years, or until the entire amount of the grant approved has been earned by the wind-energy project, whichever occurs first. A higher incentive rate of $0.012 was available for projects that utilize "Ohio-manufactured" (at least 30% manufactured in OH) wind turbines.

Incentives for Residential and "Small Wind" Production:

- The Ohio Department of Development's Office of Energy Efficiency (OEE) offers grants through the Energy Loan Fund for the installation of new non-residential or residential renewable-energy projects; non-residential wind-energy systems are eligible for a grant of $2.50 per watt. The maximum grant award for a wind-energy system is $150,000 or 50% of the project's cost, whichever is less; residential wind-energy systems are eligible for a grant of $2.50 per watt or 50% of the project's cost, whichever is less. The maximum grant award for a wind-energy system is $25,000.
- The Renewable Energy Loan Program reduces the interest rate, by approximately half, on standard bank loans for qualifying Ohio residents and businesses that borrow money to implement energy efficiency projects or renewable energy projects; loans for residential projects range from $500 to $25,000, whereas loans for commercial and institutional projects range from $5,000 to $500,000.

Interconnection and Net Metering Standards:

Ohio's interconnection standards provide for three levels of review for the interconnection of distributed generation systems up to 20 megawatts (MW) in capacity. Ohio's net-metering law requires electric distribution utilities and competitive retail electric service providers to offer net metering to customers who generate electricity using wind energy, solar energy, biomass, landfill gas, hydropower, fuel cells or microturbines, a net-metered system must be "intended to offset part or all of the customer-generator's electricity requirements", each utility is only required to offer net metering until the total generating capacity of all participating customers equals 1% of the utility's aggregate customer peak demand in Ohio.

ENERGY SITING PROCESS

Power Siting Authority: Ohio Power Siting Board (OPSB) must provide a certificate of environmental compatibility and public need prior to construction of major utility facility (50 MW or more). Smaller facilities fall under local jurisdiction.

Wind Specific Siting Authority? No

Code or Regulations: Siting of major facilities is guided by Ohio Revised Code, Chapter 4906 and Ohio Administrative Code, Chapter 4906.

Role of State Fish & Wildlife Agency: Ohio Department of Natural Resources (ODNR) is a member of OPSB

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: 1) Siting New Energy Infrastructure in Ohio - A Guidance Document (General Siting Manual) 2) Summary of the Ohio Dept. of Natural Resources Authorities & Guidance for the Siting & Operation of Wind Power Generating Facilities in Ohio

Status of Wildlife Guidelines: OPSB Manual - February 2005; ODNR Guidance - 11/21/05 Draft

Summary of Guidelines: Ohio has two documents that are relevant to wind siting. The first is a manual developed by the Ohio Power Siting Board that outlines the process including application, review, hearings etc. for receiving approval to develop a major utility facility. This siting manual does not provide details on wildlife or environmental concerns, but lists the ODNR divisions that might review siting proposals. The ODNR Guidance provides general guidance of the permits, project reviews, authorities, etc. within the Divisions and Offices of ODNR as they relate to the siting and operation of wind power generating facilities. The guidance outlines how each division/office might be involved in reviewing permits and environmental assessments for each project and provides the codes and authorities that relate to specific areas of concern. This is a more detailed overview of a table that is included in the OPSB Siting Manual.

Web site for Guidelines: OPSB Siting Manual -
http://www.puco.ohio.gov/emplibrary/files/media/OPSB/OhioSitingManual.pdf

OKLAHOMA

BACKGROUND

Contact: Russ Horton, Lands & Wildlife Diversity Supervisor, OK Dept. of Wildlife Conservation, (405) 202-5901, rhorton270@sbcglobal.net,

Installed Utility Scale Wind Power: 595 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: No - Legislation has been introduced but has failed to pass so far

Incentives for Industrial or "Big Wind" Production:
Oklahoma's Zero-Emission Facilities Production Tax Credit provides a state income tax credit of between $0.0025/kWh - $0.0075/kWh (amount varies depending on when the facility is placed in operation and when electricity is generated) for 10 years for a facility tbat sells its power and has a rated production capacity of one megawatt (1 MW) or greater

Incentives for Residential and "Small Wind" Production:
Oklahoma offers an income tax credit to the manufacturers of small wind turbines (rated capacity of between 1 kW and 50 kW) of $25 per square foot for the rotor swept area; the turbine must incorporate advanced technologies such as new airfoils, new generators, and new power electronics and at least one unit of each model must have been installed for testing at the US-DOE National Wind Technology Center

Interconnection and Net Metering Standards:
Net metering is available to all customer classes in Oklahoma with a system size of 100 kW or 25,000 kWh/year (whichever is less); there is no limit on the amount of aggregate net-metered capacity. There are no specific interconnection standards in Oklahoma.

ENERGY SITING PROCESS

Power Siting Authority: Wind power can go through voluntary review by the Oklahoma Corporation Commission.

Wind Specific Siting Authority? No

How are wildlife laws applied: Same as any other utility project. State has the authority to require mitigation.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Uses US Fish & Wildlife Service's interim guidelines.

OREGON

BACKGROUND

Contact: Rose Owens, Habitat Special Projects Coordinator, Oregon Department of Fish and Wildlife, 503-947-6085, rose.m.owens@state.or.us

Installed Utility Scale Wind Power: 438 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - Large utilities: 25% by 2025; Small utilities: 10% by 2025; Smallest utilities: 5% by 2025.

Incentives for Industrial or "Big Wind" Production:
The Bonneville Environmental Foundation (BEF) provides up to 33% of the funding, through grants, loans, convertible loans, guarantees, and direct investments, for the capital costs for installation of renewable energy, including wind, to local governments, non-profits and tribal governments in the Pacific Northwest (OR, WA, ID, MT); grants and investments may range from a few thousand dollars for small installations, to significant investments in central station grid-connected renewable energy projects.

Incentives for Residential and "Small Wind" Production:

- Oregon's Business Energy Tax Credit (BETC) is for investments in energy conservation, recycling, renewable energy resources, or less-polluting transportation fuels, the 35% tax credit is taken over five years: 10% the first and second years and 5% for each year thereafter, any unused credit can be carried forward up to eight years; those with eligible project costs of $20,000 or less may take the tax credit in one year.
- The Residential Energy Tax Credit is available to homeowners and renters who invest in energy efficiency or purchase renewable energy systems; Solar space and water heating systems, wind systems, and fuel cells are eligible for a credit of 60 cents per kWh saved during the first year, up to $1,500.
- The Northwest Solar Cooperative (NWSC) offers to purchase the rights to the environmental attributes or "Green Tags" derived from grid-connected solar PV- or wind-generated electricity at a rate of $0.05/kWh through December 31, 2009; systems up to 25 kW are automatically approved; > 25 kW approved on case-by-case basis.
- Oregon's property tax exemption states that the added value to any property from the installation of a qualifying renewable energy system not be included in the assessment of the property's value for property tax purpose, this exemption is intended for end users and does not apply to property owned by anyone directly or indirectly involved in the energy industry.
- The Oregon Small Scale Energy Loan Program (SELP) provides low interest loans for a variety of energy projects including renewable systems, loans are available to individuals, businesses, schools, cities, counties, special districts, state and federal agencies, public corporations, cooperatives, tribes, and non-profits; loans generally range from $20,000 to $20 million.

Interconnection and Net Metering Standards:
Oregon's net-metering law includes interconnection requirements for systems up to 25 kilowatts (kW) in capacity. Residential and commerical customers are eligible until the total installed capacity of net-metered energy systems exceeds 0.5% of a utility's historic single-hour peak load.

ENERGY SITING PROCESS

Power Siting Authority: Energy Facility Siting Council (EFSC) approves site certificates for wind power plants with an average electric generating capacity of 105 MW or more. Land use approval can either be through local jurisdiction or the Siting Council can make the land use decision. The site certificate serves as a consolidated state permit. Smaller wind generating facilities are regulated by zoning laws at city or county level. Developers would initially apply to the land use planning authorities in local jurisdictions where wind facilities are proposed and follow their procedures to obtain conditional use permits. Concurrently, developers would need to contact all appropriate state agencies to ensure that proposed wind facilities would qualify under all other permitting regulations.

Wind Specific Siting Authority? Yes

Code or Regulations: OR Rev. Stat. §§469.300 – 469.560 OR Admin. Rules Chapter 345

Role of State Fish & Wildlife Agency: Oregon Department of Fish & Wildlife is involved in siting review of habitat and threatened or endangered species issues by EFSC standards.

How are wildlife laws applied: Energy Siting Council Standards require compliance with Oregon Department of Fish & Wildlife (ODFW) habitat mitigation goals and standards; also requires documentation of potential threatened and endangered species and consultation with ODFW if facility will impact state or federally listed species. ODFW has specific Administrative Rules outlining fish & wildlife habitat mitigation policy for development (OAR 635-415 0000 to 0025).

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Energy Facility Siting Standards and model ordinance.

Lead Agency on Guidelines: Energy Siting Council for siting standards; Oregon Department of Energy developed model ordinance

Status of Wildlife Guidelines: Final

Summary of Guidelines: The Energy Siting Council Standards, codified in OAR Chapter 345, Divisions 22-24, are mandatory but apply only to wind energy facilities with a generating capacity of 105 megawatts or more. Siting Standards require that the proposed facility comply with the habitat mitigation goals and standards of the Oregon Department of Fish and Wildlife (ODFW). The Council must determine whether the applicant has done appropriate site-specific studies to characterize the fish and wildlife habitat at the site and nearby. The applicant must provide appropriate studies of the site to identify threatened or endangered species that the proposed facility could affect. If the facility might adversely affect either a state or federally-listed threatened or endangered wildlife species, the applicant should consult with the Oregon Department of Fish and Wildlife. If a potential risk to the survival or recovery of a threatened or endangered species exists, the applicant must redesign or relocate the facility to avoid that risk or propose appropriate mitigation measures. The Oregon Department of Energy has developed a model ordinance for local planning departments to utilize in the permitting process for wind energy projects that do not go through the Oregon Department of Energy's mandatory siting requirements.

Web site for Energy Siting Standards:
http://www.oregon.gov/ENERGY/SITING/standards.shtml

	Detailed Summary of Oregon's Siting Rule (for facilities >105MW)
Pre-construction survey	The Energy Siting Standards require energy facilities to assess impacts to fish and wildlife habitat through appropriate site-specific studies that characterize the fish and wildlife habitat at the site and nearby. In addition, they are required to comply with Oregon's land use planning goals adopted by the Land Conservation and Development Commission, or, alternatively, to comply with the local government's acknowledged comprehensive plan and land use regulations if the applicant chooses to seek land use approval from the local jurisdiction. The wind project applicant must also provide appropriate studies of the site to identify threatened or endangered species that the proposed facility could affect.
Design/Operation Recommendations	Before a site certificate for a wind facility (these requirements are found in wind specific rules) is approved by the Siting Council, the applicant must show they can design the facility to reduce cumulative adverse environmental effects in the vicinity including: designing the facility to reduce the risk of injury to raptors or other vulnerable wildlife in areas near turbines or electrical equipment, designing the components of the facility to minimize adverse visual features, using the minimum lighting necessary for safety and security purposes and using techniques to prevent casting glare from the site, except as otherwise required by the Federal Aviation Administration or the Oregon Department of Aviation. If the facility might adversely affect either a state or federally-listed threatened or endangered wildlife species, the applicant should consult with the Oregon Department of Fish and Wildlife. If a potential risk to the survival or recovery of a threatened or endangered species exists, the applicant must redesign or relocate the facility to avoid that risk or propose appropriate mitigation measures.
Site Development Recommendations	Before a site certificate for a wind facility (these requirements are found in wind specific rules) is approved by the Siting Council, the applicant must show they can construct the facility to reduce cumulative adverse environmental effects in the vicinity including: using existing roads to provide access to the facility site, or if new roads are needed, minimizing the amount of land used for new roads and locating them to reduce adverse environmental impacts, using underground transmission lines and

	combining transmission routes, connecting the facility to existing substations, or if new substations are needed, minimizing the number of new substations.
Consultation with wildlife agency, USFWS	Applicants for Energy Facility Siting certificates must consult with the Oregon Department of Fish & Wildlife (ODFW) for biological surveys. For potential impacts to Threatened and Endangered Species, the applicant must consult with the ODFW (for fish & wildlife species) or the Oregon Department of Agriculture (for plant species).
Mitigation requirements	Proposed facilities are required to comply with the habitat mitigation goals and standards of the Oregon Department of Fish and Wildlife (ODFW). If impacts cannot be avoided, the applicant must provide a habitat mitigation plan. The plan must provide for appropriate mitigation measures, depending on the habitat category affected by the proposed facility. The plan may require setting aside and improving other land for fish and wildlife habitat to make up for the habitat removed by the facility. If a potential risk to the survival or recovery of a threatened or endangered species exists, the applicant must redesign or relocate the facility to avoid that risk or propose appropriate mitigation measures
Post-Construction/ Operational Surveys	None
Decommissioning	None

Web site for model ordinance for cities and counties:
http://www.oregon.gov/ENERGY/SITING/docs/ModelEnergyOrdinance.pdf

	Detailed Summary of Oregon's Model Zoning Guidelines
Pre-construction survey	The model ordinance provides general standards on a host of issues relating to energy siting (including visual, noise, soil impacts, etc.). The General Standard for Fish, Wildlife and Native Plant Protection recommends that the energy project be designed, constructed and operated without significant adverse impact to fish, wildlife and native plant resources, including fish and wildlife habitat, migratory routes and state or federally-listed threatened or endangered fish, wildlife or plant species. There is a specific wind generation section that includes details for wildlife resource issues primarily targeting commercial grade facilities with towers typically greater than 200 feet and typically producing more than 500 kW. This includes conducting biologically appropriate baseline wildlife surveys in the areas affected by the proposed wind energy project to determine wildlife species present and patterns of habitat use.

Design/Operation Recommendations	Much of the Design recommendations for wind generation facilities fall under the visual impacts section. These include using underground energy collection wires, minimizing lighting to only what is required for safety and security, using existing roads or minimizing land used for new roads, etc. Recommendations specifically associated with wildlife issues include: selecting turbine locations to reduce the likelihood of significant adverse impacts on wildlife based on expert analysis of baseline data; designing turbine towers to reduce horizontal surfaces for perching; designing turbine towers and pad-mounted transformers to avoid creation of artificial habitat or shelter for raptor prey; spreading gravel on turbine pad areas to minimize weeds and to avoid creation of habitat for raptor prey; using anti-perching protection devices on transmission line support structures and appropriate spacing of conductors.
Site Development Recommendations	Recommends avoiding construction activities near raptor nesting locations during sensitive breeding periods and using appropriate no-construction buffers around known nest sites.
Consultation with wildlife agency, USFWS	Recommends that the local government should consult with the Oregon Department of Fish and Wildlife regarding the protocols for baseline wildlife surveys and the potential for adverse impacts on wildlife and wildlife habitat.
Mitigation requirements	There are no specific mitigation requirements but it is recommended that mitigation of significant adverse impacts should be considered if higher-than-average fatality rates occur.
Post-Construction/ Operational Surveys	Zoning language includes developing a plan for post-construction monitoring of the wind energy project site using appropriate survey protocols to measure the impact of the project on wildlife in the area. Discussion in the recommendations suggest requiring monitoring for at least 2 years after construction in order to determine the statistical fatality rate among avian and bat species for comparison with wind generation projects in other areas.
Decommissioning	Includes decommissioning requirements under the General Standards that the applicant shall submit a plan that ensures that the site will be restored to a useful, non-hazardous condition without significant delay. These include restoration of soil and revegetation with native seed, removal of aboveground and underground equipment, structures and foundations, etc. The decommissioning applies even if construction is never completed and the applicant is required to file a bond or letter of credit to cover costs of decommissioning should the owner fail to adequately restore the area.

PENNSYLVANIA

BACKGROUND

Contact: William A. Capouillez, Bureau Director, Pennsylvania Game Commission, (717) 787-6818, wcapouille@state.pa.us, 2001 Elmerton Ave., Harrisburg PA 17110

Installed Utility Scale Wind Power: 179 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - 8% Tier I, 10% Tier II by 2020 (wind is Tier I)

Incentives for Industrial or "Big Wind" Production:

- FirstEnergy (formerly GPU) established the Metropolitan Edison Company Sustainable Energy Fund and Penelec Sustainable Energy Fund to provide funding in the form of loans or equity investments (a limited number of grants may be available) to businesses that advance the fund's objectives: the development and use of renewable energy and clean-energy technologies; energy conservation and efficiency; sustainable-energy businesses; and projects that improve the environment in the companies' service territories; loans typically do not exceed $500,000 and grants typically do not exceed $25,000.
- The Sustainable Development Fund Grant Program (PECO Territory) provides financial assistance in the form of grants, commercial loans, subordinated debt, royalty financing, and equity financing for Sustainable Energy Business Planning Grants, Sustainable Energy Demonstration Grants, and other grants that follow the SDF's mission of "promoting renewable energy, energy conservation and sustainable energy businesses"; grants average approximately $25,000 and are available for up to 75% of the cost of the work.
- The West Penn Power Sustainable Energy Fund (WPPSEF) promotes the use of renewable energy and clean energy among commercial, industrial, institutional and residential customers, funding for eligible projects may include grants, commercial loans, equity investment, subordinated debt and royalty financing; commercial loans are available to manufacturers, distributors, retailers and service companies involved in renewable and advanced clean energy technologies, as well as energy efficiency and conservation products and services to end-user companies and community-based organizations.
- The Sustainable Energy Fund of Central Eastern Pennsylvania (SEF) disburses a limited number of grants and loans to organizations seeking funding for projects consistent with the Fund's mission "to promote research and invest in clean and renewable energy technologies, energy conservation, energy efficiency and sustainable energy enterprises that provide opportunities and benefits for PP&L ratepayers"; research projects are not eligible for grant financing.
- The Pennsylvania Energy Development Authority (PEDA) offers periodic grant and loan funding to provide support for innovative, advanced energy projects, and for businesses interested in locating or expanding their alternative-energy manufacturing or production operations in Pennsylvania; Commercial, Industrial, Nonprofit, Schools, Local Government, Agricultural sectors are eligible and the maximum individual award is $1 million.

Incentives for Residential and "Small Wind" Production:

- Pennsylvania law provides that wind turbines and related equipment (including towers and foundations) may not be counted by tax assessors when setting property values, instead the valuation of real property used for the purpose of wind-energy generation is developed by the county assessor utilizing the income capitalization approach to value (the capitalized value of the land-lease agreements, supplemented by a sales comparison data approach).
- Pennsylvania's Energy Harvest program provides financing for the implementation of clean and renewable-energy technologies that have measurable benefits in terms of pollution reduction, environmental quality and reduced energy use; grants are intended to address the dual concerns of energy and environmental quality so proposals must simultaneously reduce or supplement the use of conventional energy sources and lead to improvements in water or air quality.
- The Keystone Home Energy Loan Program (HELP) is a low-interest loan program for homeowners to make their homes more energy efficient or to install wind, solar or geothermal systems; maximum loan amount is $10,000 with a 10-year repayment term and 8.99% interest rate, some low-income participants may qualify for a lower 6.99% interest rate.

Interconnection and Net Metering Standards:
Pennsylvania's interconnection standards include provisions for four levels of interconnection for generators up to two megawatts (MW) in capacity. The Commonwealth's investor-owned utilities must make net metering available to residential customers with systems up to 50 kilowatts (kW) in capacity; nonresidential customers with systems up to one megawatt (MW) in capacity; and customers with systems greater than 1 MW but no more than 2 MW who make their systems available to the grid during emergencies, or where a microgrid is in place in order to maintain critical infrastructure

ENERGY SITING PROCESS

Power Siting Authority: Local government has the authority to plan and regulate land use.

Wind Specific Siting Authority? No

Code or Regulations: Land use authority granted to local government in Municipalities Planning Code

Role of State Fish & Wildlife Agency: Department of Conservation & Natural Resources and Pennsylvania Game Commission and PA Fish & Boat Commission all can review proposal; mandatory for Threatened or Endangered Species, wetlands etc.

How are wildlife laws applied: Mitigation is mandatory only when impacting T&E species.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Wind Energy Voluntary Cooperative Agreement

Lead Agency on Guidelines: Pennsylvania Game Commission

Status of Wildlife Guidelines: Final – February 2007

Summary of Guidelines: The Pennsylvania Game Commission developed a voluntary cooperative agreement to help avoid, minimize and potentially mitigate any adverse impacts the development of wind energy may have on the state's wildlife resources; the agreement has been signed by 12 wind power companies ("Cooperator"). Included with the agreement are standardized protocols for wildlife monitoring and impact review procedures primarily for migrating raptors - particularly eagles - and bats. The Game Commission has also outlined steps for appropriate post-construction mortality studies and in 2005 finalized guidelines for development of wind facilities on Game Lands.

Web site for Guidelines:
http://www.pgc.state.pa.us/pgc/lib/pgc/programs/voluntary_agreement.pdf

	Detailed Summary of Pennsylvania's Voluntary Guidelines
Pre-construction survey	Pre-construction surveys are required as part of the Cooperative Agreement for both birds and bats. Migrating raptor studies are required in both spring and fall and if the area is a known eagle migratory route than an additional spring eagle survey would be required. If the project area is within an Important Bird Area (IBA) as previously designated by the Audubon process, or within an area supporting birds identified as those priority species of "greatest conservation concern" within the Pennsylvania Comprehensive Wildlife Conservation Strategy, a survey (consisting of three days of effort one day in May, two in June, separated by at least one week) to confirm or deny the presence of the species will be required. The cooperator is responsible for surveying the project area for any caves, abandoned mine portals, or other openings that may harbor bats to be surveyed by a qualified bat biologist in order to determine those bat hibernacula existing within 5 miles of the project area that may induce additional avoidance and minimization measures due to anticipated adverse bat impacts from project operations. The cooperator will conduct pre- and post-construction acoustic surveys based on priority level to assess the level of bat activity for both hibernating and tree bats. Specific pre-construction monitoring protocols for both birds and bats that describe habitat priority levels as well as duration and extent of surveys are outlined in addendums to the cooperative agreement.
Design/Operation Recommendations	The Cooperator agrees to utilize to the greatest extent possible, all reasonable and feasible generally accepted wind industry and Commission best management practices relevant to the conservation of wildlife resources during construction and subsequent operation of the wind-energy facility.
Site Development Recommendations	None

Consultation with wildlife agency, USFWS	The agreement with the Game Commission provides that the Commission will be notified of a pending development at least 14 months prior to construction. The Commission in consultation with the Cooperator will determine the risk level for monitoring and survey efforts. The Commission and Cooperator agree to share relevant information concerning wildlife resources under the jurisdiction of the Commission in and around the project area and the potential adverse impact to those resources. The Commission will to the extent feasible, be made available to provide consistency and oversight management for all conducted surveys. Commission recommendations or decisions under the Cooperative Agreement do not supersede any comments, decisions, or recommendations of the United States Fish & Wildlife Service.
Mitigation requirements	In the event that an incidental take occurs upon a Pennsylvania listed threatened or endangered species of bird or mammal during the operation of any of the Cooperator's wind-energy facilities, the Cooperator agrees to take all reasonable measures as deemed appropriate by the Commission and the Cooperator to further avoid, minimize and/or mitigate such wildlife losses in the future.
Post-Construction/ Operational Surveys	The Cooperator is required to perform bird and bat mortality monitoring for a minimum of two years post-construction. Mortality studies shall be conducted from April 1 through November 15 by a qualified biologist(s) having expertise in the identification of bats and/or birds. Detailed overviews of mortality studies are included as addendums to the cooperative agreement.
Decommissioning	None

RHODE ISLAND

BACKGROUND

Installed Utility Scale Wind Power: 1 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - 15% by 2020

Incentives for Industrial or "Big Wind" Production:
The Rhode Island Office of Energy Resources, as administrator of the Rhode Island Renewable Energy Fund, offers financial incentives to in-state retail electricity suppliers who make available eligible green-power products to residential and small business consumers in the state; the program rewards suppliers who enroll up to 15,000 new residential and small commercial customers in eligible green-power products before June 30, 2008, the incentives are first-come, first-served at a rate of $125 per customer for the first 6,000 customers statewide, and $75 per customer thereafter until funds are fully allocated.

Incentives for Residential and "Small Wind" Production:

- Rhode Island offers a personal tax credit of equal to 25% of the system cost for renewable-energy systems at residential installations - wind-energy systems must have a rotor diameter of at least 44 inches and a minimum factory-rated output of at least two 250 watts at 28 miles per hour; wind-energy systems up to $15,000 are eligible for the full 25% credit. (Owners of wind-energy systems that exceed $15,000 in cost will receive a credit based on a $15,000 system cost.)
- Rhode Island law specifies that for purposes of local municipal property tax assessment, certain renewable energy systems cannot be assessed at more than the value of a conventional system that otherwise could be necessary to install in a building; in addition certain renewable energy systems and equipment sold in Rhode Island are exempt from the state's sales and use tax.

Interconnection and Net Metering Standards:
The Rhode Island Public Utilities Commission (PUC) requires Narragansett Electric (a subsidiary of National Grid), an investor-owned utility that serves 99% of the state's mainland customers, to offer net metering to all customers generating electricity using renewable-energy systems - temporary limits (set to expire in 2010) are 1.65 MW for systems owned by cities, towns or the Narragansett Bay Commission, and 1 MW for systems owned by other customers; the limit on the aggregate capacity of all net-metered systems is 5 MW of which 1 MW is reserved for systems less than 25 kW. Rhode Island does not have formal interconnection standards, however Narragansett Electric has a simple interconnection agreement for net-metered systems.

ENERGY SITING PROCESS

Power Siting Authority: Rhode Island Energy Facility Siting Board, operating under the Public Utilities Commission, licenses energy facilities capable of operating at a gross capacity of 40 MW or more.

Wind Specific Siting Authority? No

Code or Regulations: RI Gen. Laws Section 42-98-1

Role of State Fish & Wildlife Agency: The Director of the Department of Environmental Management is one of three members of the Energy Facility Siting Board.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No Guidance

SOUTH CAROLINA

BACKGROUND

Contact: Lauren Chestnut, Law Clerk, SCDNR, (803) 734-4006, ClerksL@dnr.sc.gov, P.O. Box 167,1000 Assembly Street, Columbia, SC 29202

Installed Utility Scale Wind Power: None

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: No

Incentives for Industrial or "Big Wind" Production:
None

Incentives for Residential and "Small Wind" Production:
None

Interconnection and Net Metering Standards:
The South Carolina Public Service Commission has interconnection standards for small distributed generation (DG) addressing renewable-energy systems and other forms of DG up to 20 kW in capacity for residential systems, and up to 100 kW in capacity for non-residential systems.

ENERGY SITING PROCESS

Power Siting Authority: Wind power is currently unregulated at any level of government. Legislation has been introduced in the State House to establish a committee to determine feasibility of establishing wind energy production farms. (www.scstatehouse.net; House Bill H 3533). State Public Service Commission (PSC) regulates major utility facilities (electric generating facilities greater than 75 MW) - wind is not specifically part of the PSC jurisdiction at this time. SC's wind potential may be limited, but a Joint Resolution to create a Wind Energy Production Farms Feasibility Study Committee was introduced in the state legislature on Feb. 15, 2007.

Wind Specific Siting Authority? No

Code or Regulations: SC Code of Law 58-33-10 to 170

Role of State Fish & Wildlife Agency: SC Department of Natural Resources is a party to PSC certification proceedings.

How are wildlife laws applied: State can require mitigation under Section 401 of the Clean Water Act.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No Guidance

SOUTH DAKOTA

Background

Contact: Silka Kempema, South Dakota Department of Game, Fish and Parks (SDGFP), (605) 773-2742, silka.kempema@state.sd.us, 523 East Capitol Avenue, Pierre, SD 57501

Installed Utility Scale Wind Power: 44 MW

Incentives for Wind Development

Renewable Portfolio Standard: No

Incentives for Industrial or "Big Wind" Production:
The wind energy property tax assessment does not include the wind turbine or blades (these are considered personal property) and only takes into account the base, foundation, tower, and substations; in addition, wind energy companies are not subject to discretionary property tax formulas and all commercial wind facilities, regardless of ownership, are assessed at the local level.

Incentives for Residential and "Small Wind" Production:
The South Dakota Renewable Energy Systems Exemption exempts renewable energy systems on residential and commercial property from local property taxes for three years after installation (after which a portion can be claimed based on a set schedule) - for residential systems, the exemption applies to the entire assessed value of residential systems and can be transferred when the property is sold; for commercial systems, the exemption applies to 50% of the installed cost of commercial systems, and cannot be transferred when the property is sold.

Interconnection and Net Metering Standards:
No net-metering/interconnection standards

Energy Siting Process

Power Siting Authority: South Dakota Public Utility Commission (SDPUC) has permitting authority for energy conversion and transmission facilities and has regulatory authority to provide siting guidelines for wind power projects greater than 100 MW. Smaller projects are subject to local government review, only a few counties currently have regulations specific to wind power.

Wind Specific Siting Authority? Yes

Code or Regulations: SDCL 49-41B provides SDPUC regulatory authority; SDPUC Energy Facility Siting Rules (20:10:22); South Dakota Environmental Policy Act (SDCL 34A-9).

Role of State Fish & Wildlife Agency: SDPUC has agreed to distribute siting guidelines developed by SD Department of Game, Fish & Parks to stakeholders involved in the development of wind power in South Dakota.

How are wildlife laws applied: Prior to the issuance of a permit, the SDPUC may prepare or require the preparation of an environmental impact statement and applicants must demonstrate that all applicable state water and air quality standards and regulations (administered by SD Department of Environment and Natural Resources) are met. State does not have the authority to require mitigation. The state Endangered and Threatened Species law (SDCL 34A-8) does not allow for take except as provided for in the statute.

State Environmental Policy Act

South Dakota Environmental Policy Act - South Dakota Codified Laws, 34A9-1 through 34A9-13, 1974

Overview:
South Dakota's Environmental Policy Act (SDEPA) provides for the preparation of an environmental impact statement for major actions which may have a significant impact on the environment. The act does not make the preparation of an EIS mandatory but states that the agency may prepare or have prepared by contract such a statement. The purpose of an environmental impact statement is to provide detailed information about the effect which a proposed action is likely to have on the environment, to list ways in which any adverse effects of the action might be minimized, and to suggest alternatives to the action.

Projects Affected by Law:
The SDEPA affects all state agencies including departments, offices, boards, commissions, and other units of the state government. Actions subject to SDEPA include: new and continuing projects or activities directly undertaken by any public agency, or supported in whole or part through contracts, grants, subsidies, loans, or other forms of funding assistance from one or more public agencies; policy, regulations, and procedure-making; or the issuance by one or more public agencies of a lease, permit, license, certificate, or other public entitlement to an applicant.

Public Participation Provisions:
Prior to the preparation of the environmental impact statement, the responsible agency is required to hold scoping meetings in the county in which the proposed action is to be located to solicit public input on what should be included in the environmental impact statement. After a draft environmental impact statement is finalized it must be circulated to state and federal agencies as well as members of the interested public. Any comments to the draft are incorporated and the EIS is made available to the public at least 30 days before the agency proceeds with the action.

Applicability to Wind Development?
Yes, through application for a permit from the Public Utilities Commission

Implementing Agency:
Department of Environment and Natural Resources

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Siting Guidelines for Wind Power Projects in South Dakota

Lead Agency on Guidelines: Department of Game, Fish & Parks

Status of Wildlife Guidelines: Final

Summary of Guidelines: South Dakota's voluntary guidelines were developed using Kansas Renewable Energy Working Group Environmental and Siting Committee's Siting Guidelines for Wind power Projects in Kansas and the National Wind Coordinating Committee's Permitting of Wind Energy Facilities: A Handbook. The guidelines address activities and concerns associated with siting and permitting wind turbines. Items addressed within the guidelines are divided into eleven categories. These categories are as follows: 1) land use, 2) natural and biological resources, 3) noise, 4) visual resources, 5) public interaction, 6) soil erosion and/or water quality, 7) health and safety, 8) cultural, archaeological, and paleontological resources, 9) socioeconomic, public service, and infrastructure, 10) solid and hazardous wasters, and 11) air and climate.

Web site for Guidelines: http://www.sdgfp.info/Wildlife/Diversity/windpower.htm

	Detailed Summary of South Dakota's Voluntary Guidelines
Pre-construction survey	Guidelines recommend pre-construction efforts that include land-use assessments (avoiding special areas, considering all local land-use relationships and objectives to minimize land use conflicts, etc.), natural and biological resources (key wildlife habitats, migration corridors, breeding/brood-rearing areas, legally protected wildlife, avoid native habitats, etc.). It is recommended that the developer consider the biological setting early in project evaluation and planning and use biological and environmental experts to conduct a preliminary biological reconnaissance of the likely site area.
Design/Operation Recommendations	Guidelines recommend that developers avoid lattice-designed towers or other designs providing perches for avian predators, minimize potential adverse affects of turbine warning lights on migrating birds and bats, consider turbine designs or deterrents that minimize potential impacts on flying animals such as birds and bats.
Site Development Recommendations	Developers are encouraged to consider timing of construction and maintenance activities (including mowing) to minimize impacts on native plants and animals, avoid construction and maintenance activities during breeding season (April to July) and, if possible, during migration (April – June and August – October). Developers should bury power lines and/or place turbines near existing transmission lines and substations, where possible and to minimize the number of roads and fences.

Consultation with wildlife agency, USFWS	It is recommended that developers consult early and frequently with South Dakota Game, Fish & Parks and the U.S. Fish & Wildlife Service, as well as local/regional resource agency offices and conservation organizations. It is also advised to start a public outreach and education process early in the project to engage local communities in the site establishment.
Mitigation requirements	Developers are encouraged to mitigate for habitat loss in areas where there is ecological damage in the siting of a wind power facility and to consider possible cumulative regional impacts from multiple wind energy projects when conducting environmental assessments and making mitigation decisions. Appropriate mitigation actions include but are not limited to ecological restoration, long-term management agreements, conservation easements, or fee title acquisitions to protect lands with similar or higher ecological quality as that of the wind power site.
Post-Construction/ Operational Surveys	None
Decommissioning	None

TENNESSEE

BACKGROUND

Installed Utility Scale Wind Power: 29 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: No

Incentives for Industrial or "Big Wind" Production:
In Tennessee, wind energy systems operated by public utilities, businesses or industrial facilities are taxed at not more than one-third of their total installed cost, applies to the initial appraisal and subsequent appraisals.

Incentives for Residential and "Small Wind" Production:

- TVA Green Power Switch Partners Program - $500 plus $.15/kWh (residential/small-commercial) or $0.20/kWh (large commercial) to purchase entire production of renewable power including wind; systems must be 50 kW or less.
- The State of Tennessee Economic and Community Development Energy Division offers a pilot grant program for businesses to install renewable energy systems (including wind) at their facilities, the grants are 40% of the installed cost between $5,000 and $75,000.

Interconnection and Net Metering Standards:
No net-metering/interconnection standards

ENERGY SITING PROCESS

Power Siting Authority: It was recommended in the State Energy Policy that power producers apply to Tennessee's Department of Economic & Community Development (TECD) for permitting of merchant power plants greater than 50 MW. It is unclear if this has been codified in law or regulation.

Wind Specific Siting Authority? No

Role of State Fish & Wildlife Agency: TECD performs an initial review for baseline information about project need, transmission and economic needs. If the application is recommended for further consideration it is forwarded to the TN Department of Environment & Conservation for environmental permitting which includes review of potential impacts to Threatened & Endangered Species.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No Guidance

TEXAS

BACKGROUND

Contact: Kathy Boydston, Texas Parks & Wildlife Department, Kathy.Boydston@tpwd.state.tx.us

Installed Utility Scale Wind Power: 3352 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - 5880 MW by 2015, 2280 by Jan. 2007 which was exceeded in summer 2006

Incentives for Industrial or "Big Wind" Production:

- A corporation in Texas engaged solely in the business of manufacturing, selling, or installing solar energy devices (wind devices are included in this definition) is exempted from the franchise tax. The franchise tax is Texas's equivalent to a corporate tax; their primary elements are the same. There is no ceiling on this exemption, so it is a substantial incentive for solar manufacturers.
- Texas allows a corporation to deduct the cost of a solar energy device (this includes wind energy devices) from the franchise tax in one of two ways: (1) the total cost of the system may be deducted from the company's taxable capital; or, (2) 10% of the system's cost may be deducted from the company's income. Both taxable capital and a company's income are taxed under the franchise tax, which is Texas's equivalent to a corporate tax.

Incentives for Residential and "Small Wind" Production:
The Texas property tax code allows an exemption of the amount of the appraised property value that arises from the installation or construction of a solar or wind-powered energy device that is primarily for on-site use, or devices used to store that energy

Interconnection and Net Metering Standards:
The Public Utility Commission of Texas has interconnection standards for electrical generating facilities (consisting of one or more on-site distributed-generation units) located at a customer's point of delivery, with a maximum capacity of 10 MW and connected at a voltage less than 60 kilovolts. Texas has limited net-metering rules - any integrated investor-owned utility (this amounts to only about 25% of the state since deregulation) to provide specific net-metering options for customers that operate qualifying facilities of 100kW or less that use non-renewable-energy resources, and to qualifying facilities of 50 kW or less that use renewable-energy resources.

ENERGY SITING PROCESS

Power Siting Authority: Voluntary Review; unregulated by any level of government - county board can choose not to give a tax abatement if there is public opposition.

Wind Specific Siting Authority? No

Role of State Fish & Wildlife Agency: If Texas Parks & Wildlife Department (TPWD) is asked by industry to review a project, they will review it as if it were a development project regulated by NEPA.

How are wildlife laws applied: Same as any other development or utility project. Texas Parks and Wildlife works under NEPA, ESA, Clean Water Act, etc. TPWD has own code that states they will review projects that impact fish and wildlife resources and make recommendations to minimize those impacts, which would include recommendations for appropriate mitigation (TPWD Code §12.0011).

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Draft Guidelines in review process

Summary of Guidelines: Current draft recommends pre- and post-construction surveys, with a step down method. This would require 3 years pre-construction surveys (birds and bats) in an area where no wind development has occurred, 2 years where there have been other wind farms and preconstruction surveys performed, 1 year where the preconstruction surveys and post construction surveys support little or no use of the area and minimal mortality. Asking for a minimum of 2 years post-construction surveys for both species. Also looking at voluntary mitigation, based on habitat impacts. TPWD is still in negotiations on these guidelines.

UTAH

BACKGROUND

Contact: Bill James, Energy Development / NEPA Coordinator, Utah Division of Wildlife Resources, billjames@utah.gov

Installed Utility Scale Wind Power: 1 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: No

Incentives for Industrial or "Big Wind" Production:

- The Utah State Energy Program administers the Renewable Energy Systems Tax Credit for both corporate and residential systems for commercial wind, geothermal electric, and biomass systems with a total capacity of 660 kW or greater, the credit is 0.35¢/kWh ($0.0035/kWh) for four years with no limt on total costs.
- Utah Code exempts the purchase or lease of equipment used to generate electricity from renewable resources (20 kW or greater) from the state sales tax; a facility that has its generation capacity increased by one or more MW as a result of the machinery or equipment may also be eligible for the exemption.

Incentives for Residential and "Small Wind" Production:

- The Utah State Energy Program administers the Renewable Energy Systems Tax Credit for both corporate and residential systems; the individual income tax credit for residential systems is 25% of the reasonable installed system costs up to a maximum credit of $2,000 per residential systems; the individual income tax credit for commercial systems less than 660 kW is 10% of the reasonable installed costs up to $50,000.
- The City of St. George offers a rebate of $2,000 per kilowatt-AC (kW-AC) to customers who install photovolaic (PV) systems or wind-energy systems between 1 kW and 10 kW; the rebate is limited to $6,000 for residential systems and $20,000 for commercial systems - all customers that receive a rebate must also participate in the utility's net-metering program.

Interconnection and Net Metering Standards:

Utah's net-metering law requires all electric utilities and cooperatives to allow customers to connect solar-energy systems, wind-energy systems and hydroelectric systems up to 25 kW to the grid; maximum enrollment is 0.1% of 2001 peak demand..

ENERGY SITING PROCESS

Power Siting Authority: There is no single Utah State government agency with primary responsibility for electric generation plant siting. Public Service Commission of Utah, Utah Division of Public Utilities and many others are included in the list and it is the developer's responsibility to contact each agency to determine the necessary requirements for the specific proposed project.

Wind Specific Siting Authority? No

Role of State Fish & Wildlife Agency: The Utah Department of Natural Resources, Division of Wildlife Resources are listed as agencies that developers must contact for their specific project.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No Guidance

VERMONT

BACKGROUND

Contact: Julie Moore, Agency of Natural Resources, (802) 241-3687, julie.moore@state.vt.us

Installed Utility Scale Wind Power: 6 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes – Renewable Energy meets load growth by 2012; draft legislation to require 100MW from wind by 2017 but no action has been taken on the bill.

Incentives for Industrial or "Big Wind" Production:
The Vermont Department of Public Service (DPS) Clean Energy Development Fund Grant program provides grants up to $250,000 for large-scale (greater than 15 kW), grid-connected renewable energy systems (including wind), projects must provide a 50% match no more than 25% of which can be in-kind - Pre-Project Financial Assistance is also available up to $25,000 with a 20% cash match.

Incentives for Residential and "Small Wind" Production:

- Vermont has a sales tax exemption for renewable-energy systems up to 15 kW that are either net-metered or not connected to the grid; on-farm systems up to 150 kW are eligible.
- The Vermont Department of Public Service (DPS) Clean Energy Development Fund Grant program provides grants up to $60,000 for small-scale renewable energy systems (including wind microturbines no greater than 15 kW), projects must provide a 50% match no more than 25% of which can be in-kind - Pre-Project Financial Assistance is also available up to $25,000 with a 20% cash match.
- Vermont's Solar and Small Wind Incentive Program provides funding for new solar water heating, solar electric (photovoltaic) and wind energy system installations; for wind, individuals and businesses can receive $2.50/W DC (up to $4/W with Vermont-made components) up to $12,500; Schools, farms, and local/state governments - $4.50/W DC, up to lesser of $20,000 or 50% of total installed cost.

Interconnection and Net Metering Standards:
Any electric customer in Vermont may net meter on a first-come, first-served basis after obtaining a "Certificate of Public Good" from the Vermont Public Service Board (PSB) until the cumulative capacity of net-metered systems equals 1% of the utility's peak demand during 1996 or the peak demand during the most recent full calendar year, whichever is greater; generating capacity is generally limited to 15 kilowatts (kW) for systems however farm systems are allowed to net meter systems up to 150 kW.

ENERGY SITING PROCESS

Power Siting Authority: Vermont Public Service Board provides Certificate of Public Good for all wind power facilities except where it is operated solely for on-site consumption by the owner.

Wind Specific Siting Authority? Yes

Code or Regulations: 30 V.S.A. § 248, 10 V.S.A. § 1424a(d) and § 6086(a)(1) through (8) and (9)(K)

Role of State Fish & Wildlife Agency: The Vermont Agency of Natural Resources is a statutory party to the proceedings of utility-scale projects subject to the reviewing authority of the Vermont Public Service Board under state statute. In this capacity the Agency acts as an advisor to the Board on matters pertaining to natural resource protection, impact assessment, and mitigation associated with public utility projects subject to their regulatory authority.

How are wildlife laws applied: Same as any other development project, different standards/processes apply. Agency of Natural Resources can require mitigation

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Guidelines for the Review and Evaluation of Potential Natural Resources Impacts from Utility-Scale Wind Energy Facilities in Vermont

Lead Agency on Guidelines: Vermont Agency of Natural Resources

Status of Wildlife Guidelines: Draft - April 2006

Summary of Guidelines: The draft voluntary guidelines establish a process for the Agency of Natural Resources (ANR) to review proposals and applications for Certificates of Public Good (CPGs) related to the development of utility-scale wind power facilities. The guidelines provide a detailed outline of expectations for pre- and post-construction data collection as well as general guidelines for construction, operation and maintenance of utility-scale wind facilities. Included are recommendations for preliminary site assessment, resource analysis and inventory of wildlife including rare, threatened or endangered species. ANR provides consultation, preferably at the earliest stages of development, that includes site visits, review of initial resource assessments and guidance on pre-construction studies and land management plans. Finally, the guidelines outline components of post-construction studies and operational protocols with detailed information about possible mitigation options should surveys find the project is having undue adverse impacts on the natural environment.

Web site for Guidelines: http://www.anr.state.vt.us/site/html/plan/DraftWindGuidelines.pdf

	Detailed Summary of Vermont's Voluntary Guidelines
Pre-construction survey	The initial resource assessment recommended by the Agency of Natural Resources (ANR) includes a site analysis (including, water resource features, ravines or gullies, highly erodible soils, slope in excess of 20% and existing structures within 1,000 feet of facility), a wildlife habitat inventory including an evaluation of bird and bat migratory activity, and a rare, threatened or endangered species inventory using the VT Fish & Wildlife Department database, and an aesthetic evaluation that takes into account viewsheds and measures that will be taken to minimize nighttime lighting. Pre-construction fish and wildlife surveys include radar and acoustical studies for bird/bat migratory activity; surveys for rare, threatened or endangered species, notes in particular Bicknell's Thrush, Indiana Bat and Small-footed Bat; a resident avian and breeding bird survey, diurnal surveys for raptors; wildlife habitat surveys including migratory corridors, black bear feeding, deer and moose winter habitat; and identification of wetland areas with significant or unique wildlife values. Land use evaluation should include site location and existing site condition map, grading and drainage plans, public access controls, and habitat restoration management and reclamation plans.
Design/Operation Recommendations	None
Site Development Recommendations	ANR may recommend the developer hire an independent engineer to oversee construction in particular with regard to erosion control and impacts to water quality and habitat.
Consultation with wildlife agency, USFWS	Recommends a scoping meeting with the ANR to outline the components that will be necessary for an initial resource assessment. After the initial resource assessment, the more detailed agency consultation process begins where ANR identifies a project coordinator and Agency team (including stream and water quality experts, wetlands experts, fisheries and wildlife biologists, storm water staff and attorney(s)); the team reviews initial materials, takes a site visit and outlines scope and protocols for pre-construction surveys. ANR reviews all pre-construction surveys and coordinates testimony they will submit to the Public Service Board for certificate approval. ANR will continue to be involved in reviewing post-construction monitoring and may conduct independent surveys to improve understanding of impacts of utility-scale wind facilities.

Mitigation requirements	If post-construction surveys show adverse impacts the ANR may require mitigation which may include modified operation (including seasonal shut-downs, technological improvements, etc.), modified lighting, on-site habitat management (including modification of vegetative cover or forest openings, perching or nesting sites, etc.), and habitat protection or compensatory mitigation.
Post-Construction/ Operational Surveys	Post-construction surveys are likely to include bird and bat surveys (possible research methods may include radar, acoustic, mortality, thermal imaging); habitat fragmentation impact assessment, particular for black bear, Bicknell's thrush and other nesting birds; operational protocols; and the role of adaptive management. Formal post-construction monitoring is expected to take place for 3 to 5 years unless significant adverse impacts are found where additional monitoring or operational changes may be necessary.
Decommissioning	Department of Public Service addresses decommissioning, but the ANR will review site restoration plans and progress and will monitor restoration for invasive plant species for an estimated 5 years.

VIRGINIA

BACKGROUND

Contact: Rick Reynolds, Virginia Department of Game and Inland Fisheries, (540) 248-9360, Rick.Reynolds@dgif.virginia.gov, P.O. Box 996, Verona, VA 24482

Installed Utility Scale Wind Power: None

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - State goal of 12% by 2022

Incentives for Industrial or "Big Wind" Production:
None

Incentives for Residential and "Small Wind" Production:
TVA Green Power Switch Partners Program - $500 plus $.15/kWh (residential/small-commercial) or $0.20/kWh (large commercial) to purchase entire production of renewable power including wind; systems must be 50 kW or less.

Interconnection and Net Metering Standards:
Virginia's net-metering rules allow interconnection of renewable systems (10 kW residential and 500 kW non-residential) up to 1% of a utility's peak load for previous year.

ENERGY SITING PROCESS

Power Siting Authority: The Virginia State Corporation Commission provides a certificate of convenience and necessity for siting new public utility facilities. Small wind power is regulated at the local level only.

Wind Specific Siting Authority? No

Code or Regulations: Power Siting Law - 56-265.1 to 9

Role of State Fish & Wildlife Agency: With respect to wildlife, the VA State Corporation Commission (SCC) has an MOU with the VA Dept. of Environmental Quality to review and consider environmental issues concerning power projects in VA. DEQ compiles comments from the other state natural resource agencies and provides these to the SCC for their consideration

How are wildlife laws applied: Same as any other development/utility project, State Threatened and Endangered Species law and state code prohibits unauthorized take of wildlife. State cannot require mitigation.

STATE ENVIRONMENTAL POLICY ACT:

Code of Virginia §10.11188 through 1192, 1973

Overview:
The purpose of environmental review is to identify and evaluate the environmental effects of proposed state facilities, and to guide facility siting and design decisions in order to protect important environmental resources. The analysis needed to prepare an environmental impact report helps agencies to assess the effects of development proposals, and to consider alternative actions and mitigating measures to avoid or reduce adverse impacts. Information requirements include the environmental impacts of the project, adverse environmental effects that are unavoidable, measures taken to minimize impacts, any alternatives to the proposed construction and irreversible environmental changes.

Projects Affected by Law:
The law applies to State agencies, boards, commissions, authorities, any branch of State government, and state supported institutions of higher learning. State agencies are required to prepare and submit environmental impact reports for construction of facilities that will cost $100,000 or more. The requirement also covers acquisition of land for construction, which includes leases, and expansion of existing facilities.

Public Participation Provisions:
Public input is not directly solicited for projects. An environmental review is circulated among state agencies as well as to localities and district commissions.

Applicability to Wind Development?
No - the law only applies to state built facilities.

Implementing Agency:
The DEQ's Office of Environmental Impact Review coordinates the review process and prepares a single state response for consideration by the Secretary of Administration, representing the Governor.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No state guidelines, state has been required to develop potential siting areas and fish & wildlife considerations is expected to be part of that.

WASHINGTON

BACKGROUND

Contact: Greg Hueckel, Assistant Director, Washington Dept. of Fish & Wildlife, hueckgjh@dfw.wa.gov,

Installed Utility Scale Wind Power: 818 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes - 15% by 2020

Incentives for Industrial or "Big Wind" Production:
The Bonneville Environmental Foundation (BEF) provides up to 33% of the funding, through grants, loans, convertible loans, guarantees, and direct investments, for the capital costs for installation of renewable energy, including wind, to local governments, non-profits and tribal governments in the Pacific Northwest (OR, WA, ID, MT); grants and investments may range from a few thousand dollars for small installations, to significant investments in central station grid-connected renewable energy projects.

Incentives for Residential and "Small Wind" Production:

- The Chelan County Public Utility District (PUD) Sustainable Natural Alternative Power (SNAP) program encourages customers to install alternative power generators such as solar panels and wind turbines up to 25 kW and connect them to the District's electrical distribution system by offering an incentive payment based on the system's production; the amount paid (up to a maximum of $1.50 per kWh) depends on the total amount contributed by SNAP Purchasers through the utility's green pricing program and the total amount generated by all SNAP Producers.
- The Okanogan County PUD SNAP with net metering program (modeled after the successful Chelan County PUD program) encourages members to install renewable energy generators and connect them to their utility's electrical distribution system by offering an incentive payment based on the system's production on a $/kWh basis (maximum payment is $1.00/kWh); the production payment is in addition to any net metering credit the producer may receive from the utility.
- Orcas Power and Light (OPALCO) provides a production-based incentive for residential and commercial members who generate energy from wind and micro-hydroelectric sources, members must sign an Agreement for Interconnection granting OPALCO rights to the system's Green Tags (renewable energy certificates) - for wind and microhydroelectric systems, the member receives $1.50 per kWh for half of the estimated first-year production, at the end of the year, a "true up" is paid based on the actual generation as determined by an OPALCO meter minus the initial estimate; the total incentive may not exceed $4,500.
- The Northwest Solar Cooperative (NWSC) offers to purchase the rights to the environmental attributes or "Green Tags" derived from grid-connected solar PV- or wind-generated electricity at

a rate of $0.05/kWh through December 31, 2009; systems up to 25 kW are automatically approved; > 25 kW approved on case-by-case basis.

- Washington has production incentives of 12¢ to 54¢ per kilowatt-hour (capped at $2,000 per year) for individuals, businesses, or local governments that generate electricity from solar power, wind power or anaerobic digesters. The incentive amount paid to the producer is adjusted according to how the electricity was generated by multiplying the incentive by the following factors: for electricity produced using a solar or wind generator equipped with an inverter manufactured in Washington state: 1.2; for electricity produced using an anaerobic digester, by other solar equipment, or using a wind generator equipped with blades manufactured in Washington state: 1.0; for all other electricity produced by wind: 0.8. The state's utilities will pay the incentives and earn a tax credit equal to the cost of those payments. The credit may not exceed the greater of $25,000 or 0.25% of a utility's taxable power sales. The incentive amount may be uniformly reduced if requests for the incentive exceed the available funds.
- In Washington State, tax does not apply to the sales of equipment used to generate electricity from wind, the exemption applies to labor and services related to the installation of the equipment, as well as to the sale of equipment and machinery; eligible systems must have a generating capacity of at least 200 watts

Interconnection and Net Metering Standards:
The Washington Utilities and Transportation Commission (UTC) adopted final interconnection rules in March 2006 for all distributed-generation (DG) systems up to 25 kW in capacity (WUTC is currently developing interconnection standards for customer-owned DG greater than 25 kW in capacity. Although the rules apply only to investor-owned utilities, the UTC has indicated that all Washington utilities likely will adopt the commission's rules. Washington's net-metering law applies to renewable energy systems up to 100 kW in capacity, all customer classes are eligible, and all utilities – including municipal utilities and electric cooperatives – must offer net metering. Net metering is available on a first-come, first-served basis until the cumulative generating capacity of net-metered systems equals 0.25% of a utility's peak demand during 1996. This limit will increase to 0.5% on January 1, 2014.

ENERGY SITING PROCESS

Power Siting Authority: The State Energy Facility Site Evaluation Council (EFSEC) has jurisdiction over all major energy facilities (greater than 350 MW) and any sized renewable energy facilities that choose to participate in the EFSEC review process. Local governments permit smaller projects and those that choose not to go through the EFSEC review. Projects are subject to State Environmental Policy Act and the Washington Legislature passed HB 2402 in March 2006, which provides for expedited review for those facilities that pass the State Environmental Policy Act checklist for renewable energy applications.

Wind Specific Siting Authority? No

Code or Regulations: State Energy Facility Site Evaluation Council – Wash. Rev. Code §§80.50.010 - 80.50.904 and Wash. Admin. Code chaps. 463-06 - 463-78; State Environmental Policy Act – Wash. Rev. Code 80

Role of State Fish & Wildlife Agency: Regulatory agency must consult with Dept. of Fish & Wildlife and provide opportunity to comment on project through State Environmental Policy Act. WDFW is one of 5 Agencies represented on EFSEC.

How are wildlife laws applied: There are no State Statutes that require protection of wildlife habitat unless EFSEC process is selected. The State does not have authority to require mitigation

STATE ENVIRONMENTAL POLICY ACT

Revised Code of Washington 43.21C, Washington Administrative Code 197-11, 1971

Overview:
The State Environmental Policy Act (SEPA) requires all state and local governments to identify and evaluate probable environmental impacts and develop mitigation measures that will reduce adverse environmental impacts. If the project does not involve an agency action, or there is an action but the project is exempt, environmental review is not required, if it does, a preliminary assessment and proposal is begun. After review, the lead agency issues either a determination of nonsignificance (DNS), which may include mitigation conditions, or if the proposal is determined to have a likely significant adverse environmental impact, a determination of significance/scoping notice (DS/Scoping) is issued which starts the environmental impact statement (EIS) process. The EIS will analyze alternatives and possible mitigation measures to reduce the environmental impacts of the proposal.

Projects Affected by Law:
SEPA environmental review is required for any state or local agency decision that meets the definition of an "action" and is not categorically exempt. Actions are divided into two categories, "project actions" and "nonproject actions". Project actions are agency decisions to license, fund, or undertake a specific project including construction or alternation of public buildings or facilities, private projects such as subdivisions, shopping centers, other commercial buildings, and industrial facilities. Nonproject actions are agency decisions on policies, plans, and programs, including adoption or amendment of: rules, ordinances, or regulations that will regulate future projects, such as water quality rules, critical area ordinances, and other state and local regulations.

Public Participation Provisions:
If there is a determination of nonsignificance, the public has the opportunity to comment on the finding and a DNS can be changed if comments provide new information in the decision. During the EIS process, SEPA requires agencies to involve the public during the "scoping" period, where agencies, tribes, and the public are invited to comment on the range of alternatives, areas of impact, and possible mitigation measures that should be evaluated within the EIS (21 to 30 days); and the draft EIS review period, where comments are requested on the merits of the alternatives and the adequacy of the environmental analysis (30 days with a possible 15 day extension). Agencies may take action on the proposal seven days after the final EIS has been issued.

Applicability to Wind Development?
Yes, through the permit process with the State Energy Facility Site Evaluation Council or if it is a small project through the local jurisdiction.

Implementing Agency:
Department of Ecology's SEPA Unit

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Baseline & Monitoring Studies for Wind Projects

Status of Wildlife Guidelines: Final - August 2003

Summary of Guidelines: The voluntary Wind Power Guidelines are used by the Department for its comments on wind energy projects through the State Environmental Policy Act. The guidelines outline pre-project assessment with the goal of avoiding or minimizing avian and bat mortality. It also provides information on operational monitoring after construction and recommends the establishment of a Technical Advisory Committee to review monitoring data and make adaptive management recommendations. The guidelines also provide alternatives for mitigation by directing development to previously disturbed habitats (as opposed to undisturbed native habitat) and provides ratios for replacement habitat as mitigation for projects. In addition, it provides an alternative mitigation option to streamline the mitigation process and ensure that mitigation dollars are spent on acquiring, restoring and managing strategically important habitat. Over the course of this next year, Washington State's "Wind Power Guidelines" document will be re-evaluated and updated as needed to ensure the document accurately describes wind power development impacts on Washington's natural resources and their habitats, while providing guidance to avoid, minimize and ultimately mitigate for those impacts. The current document is comprised of three sections that relate to monitoring (pre and post construction), conventional mitigation and alternative mitigation. We expect to broaden these categories and address additional issues in the update. Potential new issues may include buffers and set backs, turbine construction methods, survey protocol, micro-siting, abandonment plans and adaptive management plans.

Web site for Guidelines: http://wdfw.wa.gov/hab/engineer/windpower/index.htm

	Detailed Summary of Washington's Voluntary Guidelines
Pre-construction survey	Pre-project assessment studies are recommended to collect information suitable for predicting the potential impacts of the project on wildlife and plants Specific components include information review, habitat mapping, raptor nest survey (at least one nest site survey during breeding season within 1 mile of project site), general avian use surveys (At a minimum one full season of avian use surveys, particularly during spring/summer; additional seasonal surveys may be necessary), and surveys for threatened, endangered or sensitive species.
Design/Operation Recommendations	Developers should design the project layout so that impacts on biological resources are avoided and minimized. Specific design recommendations include: use of tubular towers to reduce the ability of birds to perch on towers and reduce the risk of collision (discourage the use of lattice towers with horizontal cross-members or towers that use guy wires), discourage the use of rodenticides to control rodent burrowing around towers, minimize use of overhead power lines or use designs that avoid and minimize impacts to raptors and other birds (e.g., adequate conductor spacing, use of perch guards), minimize the use of lights on towers because they may attract flying wildlife to the vicinity of the turbines in certain conditions.

Site Development Recommendations	Site construction should be done to avoid or minimize impacts to biological resources. Specific recommendations include: encourage development in agricultural and already disturbed lands, including using existing transmission corridors and roads where possible, and to encourage the protection of priority habitats; avoid high bird concentration areas, especially concentration areas of sensitive status species, and breeding sites; encourage the control of noxious weeds and the control of detrimental weedy species that invade existing habitat as a result of disturbance from construction and operation; encourage the requirement of a complete road siting and management plan, including vehicle-driving speeds that minimize wildlife mortality; and encourage the requirement of a fire protection plan.
Consultation with wildlife agency, USFWS	A Technical Advisory Committee (TAC) is recommended to be responsible for reviewing results of monitoring data and making suggestions to the permitting agency regarding the need to adjust mitigation and monitoring requirements based on results of initial monitoring data and available data from other projects. Potential members include state and federal wildlife agencies, the developers, environmental groups, landowners, and county representatives
Mitigation requirements	The Guidelines have very specific mitigation recommendations for permanent habitat impacts and temporary impacts, no mitigation will be required for development in already disturbed areas. For mitigation through acquisition of alternate habitats WDFW recommends like-kind (e.g., shrub-steppe for shrub-steppe; grassland for grassland) and/or of equal or higher habitat value than the impacted area, with legal (conservation easement, fee acquisition) protection of the habitat in the same geographic area as the project that will protected from degradation during the life of the project. Specific ratios of acquired mitigation habitat to destroyed habitat are recommended; the ratios are lower for mitigation for temporary impacts and restoration of habitat from temporary impacts is encouraged. The guidelines also include an alternative mitigation pilot program where developers would pay an annual fee of $55/acre/year (adjustable up or down up to 25% depending on habitat quality) to WDFW for each acre of habitat that would be owed using the conventional mitigation requirements.
Post-Construction/ Operational Surveys	Monitoring studies, such as carcass surveys, using current state-of-the-art protocols are required to determine the actual direct impacts of the wind farm on birds. The duration and scope of the monitoring should depend on the size of the project, and the availability of existing monitoring data at projects in comparable habitat types.
Decommissioning	None

WEST VIRGINIA

BACKGROUND

Contact: Curtis Taylor, Chief Wildlife Resources, WV Dept. of Natural Resources, 304-558-2771, curtistaylor@wvdnr.gov

Installed Utility Scale Wind Power: 66 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: No

Incentives for Industrial or "Big Wind" Production:
West Virginia has reduced the Business and Operation Tax (B&O) on utilities using wind-power generation from 40% of the generating capacity of the unit to 5% of the wind turbine generating capacity. For the purposes of property tax assessment, utility-owned wind projects are considered to have a value equal to their salvage value, lowering the property tax basis from 100% to 5% of assessed value.

Incentives for Residential and "Small Wind" Production:
None

Interconnection and Net Metering Standards:
West Virginia allows net-metering for systems up to 25 kW up to 0.1% of the utility's total load participation.

ENERGY SITING PROCESS

Power Siting Authority: State Public Service Commission has sole authority to regulate development though local government can exert authority through zoning laws.

Wind Specific Siting Authority? No

Role of State Fish & Wildlife Agency: State Public Service Commission requires wildlife assessments in their siting review, but the Department of Natural Resources is not involved in the review. WV Department of Natural Resources (DNR) has the same rights as the public and can intervene and provide testimony regarding concerns, but no formal role.

How are wildlife laws applied: Same as any other development project. The DNR has the ability to require mitigation through replacement costs for impacts to mammals and birds that are taken above any threshold set by the agency.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Wildlife Assessments are required by the Public Service Commission through the siting process in the *Rules Governing Siting Certificates*. The agency is considering drafting guidance for the wind power industry that addresses the many wildlife issues brought forward by the wind industry.

Status of Guidelines: Final

Summary of Guidelines: The Public Service Commission includes some wildlife related requirements in their siting review, the guidelines are mandatory under siting law. Applicants are required to perform bird and bat assessments for the area as well as consult with the DNR and U.S. Fish and Wildlife Service (FWS) on threatened and endangered species issues. The siting certificate also requires a post-construction survey one year after the facility goes into production. There are some design and construction requirements, but none are related to wildlife considerations.

Web site for Guidelines: http://www.wvsos.com/csrdocs/worddocs/150-30.doc

	Detailed Summary of West Virginia's Siting Rules
Pre-construction survey	Applicants are required to file copies of, and state the results of, a Spring and Fall avian migration study; a Phase I Avian Risk Assessment, and a risk assessment regarding bats; and an avian and bat lighting study from empirical data available on similar facilities.
Design/Operation Recommendations	None
Site Development Recommendations	None
Consultation with wildlife agency, USFWS	Applicants are required to file an affidavit listing any and all permits that the applicant will be required to obtain from the US Fish and Wildlife Service, the West Virginia Department of Natural Resources, or any other government authority, with respect to threatened or endangered species. If the the applicant shows that it is not required by other governmental agencies to follow any process or permitting requirements with respect to threatened or endangered species, other parties may petition the Commission to consider the impact on species.
Mitigation requirements	None

Post-Construction/ Operational Surveys	After the facility has been in operation for one year, the applicant shall perform and file with the Commission the results of an avian and bat lighting study conducted for one year after operation begins.
Decommissioning	Applicants must describe post useful life demolition, removal, disposal, and restoration plans for facilities.

WISCONSIN

BACKGROUND

Contact: Steve Ugoretz, DNR Office of Energy, (608) 266-6673, steven.ugoretz@dnr.state.wi.us,

Installed Utility Scale Wind Power: 53 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: Yes (goal) - 10% by 2015

Incentives for Industrial or "Big Wind" Production:
Wisconsin Focus on Energy offers several grant programs to support the development of renewable energy, Feasibility Study Grants provide financial support for assessing the feasibility of using renewable-energy systems, up to 50% of project costs will be funded, with a maximum grant of $10,000; Implementation Grants provide financial support for large renewable-energy projects, grant amounts are based on a calculated estimate of the quantity of electricity and/or thermal energy the system will produce in one year - for wind energy systems, the maximum amount is 35% or $45,000; maximum system size of 250 kW

Incentives for Residential and "Small Wind" Production:

- In Wisconsin, any value added by a solar-energy system or a wind-energy system is exempt from general property taxes.
- Focus on Energy offers Cash-Back Rewards for installing or expanding renewable-energy systems on businesses and homes, ayments are based on the estimated amount of electricity or thermal energy produced annually by an eligible system, maximum cash-back for wind energy systems (20 kW or less) is 25% of project cost or $35,000.
- Wisconsin Public Power, Inc member utilities offer low-interest loans (from $2,500 to $20,000, at an interest rate of 1.99%) for renewable-energy systems (including wind up to 20 kW) to residential and small business customers, loan terms vary from three to 10 years.
- Wisconsin Public Power, Inc. (WPPI) utilities offer rebates for renewable-energy systems to residential and small commercial customers; for qualifying wind-energy systems rated 20 kW or less, eligible customers will receive a rebate equal to 25% of the system's cost, with a maximum incentive of $10,000; customers may also receive a rebate for 75% (up to $375) for a renewable energy site assessment and 50% rebate (up to $2,500) for both routine maintenance as well as major system repairs.

Interconnection and Net Metering Standards:
Wisconsin's interconnection standards cover all distributed generation (DG) facilities up to 15 megawatts (MW) in capacity. All regulated utilities allow net metering to customers that generate electricity with systems up to 20 kilowatts (kW) in capacity, We Energies allows wind energy systems up to 100 kW

ENERGY SITING PROCESS

Power Siting Authority: Public Service Commission of Wisconsin (PSC) provides Certificate of Public Convenience & Necessity for projects over 100MW and these projects also require an EIS. PSC Certificate of Authority may be necessary for smaller facilities depending on project cost. Smaller projects may be subject to local approval where zoning regulations include wind energy provisions.

Wind Specific Siting Authority? No

Code or Regulations: Wis. Stat. ch. 196.491. Includes environmental, socio-economic and power system considerations

Role of State Fish & Wildlife Agency: Department of Natural Resources (DNR) has a cooperative agreement with PSC to ensure cooperative review and approval of energy projects. Environmental review is centralized in DNR's Office of Energy.

How are wildlife laws applied: Same as any other utility project, wildlife considerations are balanced against other factors. The DNR has the ability to require mitigation through the PSC siting statute.

STATE ENVIRONMENTAL POLICY ACT

Wisconsin Environmental Policy Act - Wisconsin Statutes, Ch. 1, 1.11(1) through 1.11(5), Wisconsin Administrative Code, NR 150.01 through NR 150.40, 1972

Overview:
The Wisconsin Environmental Policy Act (WEPA) requires the DNR and other state agencies to gather relevant environmental information and use it in their decision-making. Each state agency makes its own rule to implement WEPA, including a list categorizing actions as: Type 1 – Environmental Impact Statement (EIS) automatically required, Type 2 - environmental assessment (EA) prepared (may conclude EIS is needed), Type 3 - press release indicating no other WEPA documents were required, Type 4 - no notice or other action required. Agencies must look at appropriate alternatives to the particular course of action they are proposing. If the action is a "major action significantly affecting the quality of the human environment," the law requires agencies to consult with other agencies about possible environmental impacts, prepare and circulate an EIS, and hold a public hearing. EA's are similar to EIS's in both content and process, the primary difference is the requirement for a formal administrative hearing on an EIS.

Projects Affected by Law:
WEPA applies only to the actions of state agencies. It does not apply to local governments or private parties unless their actions involve state agency regulation or funding.

Public Participation Provisions:
The public has the opportunity to comment on the EA prior to the decision to do an EIS. When an EIS is completed, the draft is circulated and available to the public for comment for 45 to 90 days. The DNR is required to hold a public informational hearing not less than 30 days after issuance of the EIS on the proposed action and the EIS prior to making its decision.

Applicability to Wind Development?
Yes through state regulatory process or possibly state funding (Wisconsin has several incentive programs for wind energy). If a certificate is required by the Public Service Commission (generally for power generating projects over 100 MW) then the PSC's WEPA rules apply, otherwise, the DNR would be responsible for the EIS through their Type categories.

Implementing Agency:
Department of Natural Resources Science Services unit

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: Considering Natural Resource Issues in Wind Farm Siting in Wisconsin

Status of Wildlife Guidelines: Final - August 29, 2005

Summary of Guidelines: Voluntary guidelines outline specific habitat types and areas that need to be considered when siting wind farms. Recommends site characterization studies that consist of identifying habitat resources, the communities and species likely to use them, and the numbers and timing (seasonal & daily) of use. Recommends using U.S. Fish & Wildlife Service and National Wind Coordinating Collaborative guidelines for wildlife studies. Developers encouraged to contact DNR Office of Energy early in the process to coordinate with agency wildlife and endangered resource experts. Outlines potential mitigation measures to minimize collisions and recommends use of Avian/Power Line Interaction Committee (APLIC) technologies. Recommends monitoring and evaluating collisions and mortalities for 2 years, to determine of modifications to the wind farm or mitigation is necessary, and encourages an adaptive management approach.

Web site for Guidelines: http://dnr.wi.gov/org/es/science/energy/wind/guidelines.pdf

	Detailed Summary of Wisconsin's Voluntary Guidelines
Pre-construction survey	Recommends identifying viable development sites that use GIS mapping with overlays of wildlife areas, migration corridors, current or proposed major state ecosystem acquisition or restoration areas, state and local parks and recreation areas, active landfills, wetlands, wooded corridors, major tourist/scenic areas, and airport landing strip or other lighted areas. Using the maps should identify potential areas and allow recommended setbacks from areas of potential concern. Site characterization studies to identify habitat resources in the area, the communities and species likely to use them, and the numbers and timing (seasonal and daily) of use should be conducted. Wildlife surveys should characterize resident and migratory bird and bat populations on a seasonal and day/night basis, including migrations and breeding seasons. Use by raptors, waterfowl, shorebirds and wading birds, gulls and terns, songbirds and bats should be evaluated for at least one year, with emphasis on the Spring and Fall migrations.

Design/Operation Recommendations	Mitigation measures proven to minimize collisions and mortality should be designed into the wind farm. Towers and electric lines should also be sited, designed, and installed using measures to reduce the likelihood of bird and bat mortality. Placing electric lines underground is highly recommended, as is the use of perch guards on above ground poles, and other Avian/Powerline Interaction Committee (APLIC) endorsed technologies. An adaptive management approach to planning, design, construction and operations is highly recommended.
Site Development Recommendations	None
Consultation with wildlife agency, USFWS	Potential wind farm developers are strongly encouraged to contact the DNR Office of Energy early in the process to get in touch with agency wildlife and endangered resources experts. The site study plan should be submitted in advance to the DNR and discussed with staff experts to ensure its acceptability.
Mitigation requirements	None
Post-Construction/ Operational Surveys	Bird and bat use and interactions with wind turbines and supporting facilities should be monitored for an adequate period (at least two years is recommended) after installation, using accepted standard methods. This should be done for the first wind farms in any ecological region of the state. The monitoring should evaluate any collisions and mortality that occur to determine whether the facility can be modified to prevent future collisions, or if mitigation is needed. Wildlife avoidance and other behavioral changes should also be evaluated.
Decommissioning	None

WYOMING

BACKGROUND

Contact: Vern Stelter, Wyoming Game & Fish Department, (307) 777-4587, Vern.Stelter@wgf.state.wy.us

Installed Utility Scale Wind Power: 288 MW

INCENTIVES FOR WIND DEVELOPMENT

Renewable Portfolio Standard: No

Incentives for Industrial or "Big Wind" Production:
Wyoming exempts equipment used to generate electricity from renewable resources (limited to equipment to make a system operational up to the point of interconnection with an existing transmission grid) from the state excise tax.

Incentives for Residential and "Small Wind" Production:
None

Interconnection and Net Metering Standards:
Wyoming's net-metering law includes basic interconnection requirements for systems up to 25 kilowatts (kW) in capacity that generate electricity using solar, wind, hydropower or biomass resources; there is no overall enrollment level specified.

ENERGY SITING PROCESS

Power Siting Authority: State Industrial Siting Council, if capital construction costs exceed $160 million (amount adjusted based on construction costs)

Wind Specific Siting Authority? No

Code or Regulations: W.S. 35-12-104

Role of State Fish & Wildlife Agency: Wyoming Game and Fish Department is asked for input on what requirements they would like to have included in the permit (monitoring, siting considerations, impact mitigation). If the Council agrees, those requirements become part of the permit.

How are wildlife laws applied: Same as any other development project. The Industrial Siting Council has the authority to require mitigation in the permit.

WILDLIFE GUIDELINES FOR WIND

Wildlife Guidelines for Wind Power Siting: No formal guidance, projects are dealt with on a case by case basis. Agency typically asks for monitoring of impacts on wildlife (the specifics depending on the site), some siting considerations (e.g., towers built back from ridge edges), and mitigation for unavoidable losses.

Calculating wind power's environmental benefits

June, 2009

Summary

Energy analyst Tom Hewson provides details on new wind power generation and whether the claimed benefit of avoided emissions is overstated.

It's commonly believed that new wind power generation will displace coal and natural gas-fueled power plants and thereby avoid all their associated greenhouse gas (GHG) emissions such as carbon dioxide (CO2), nitrous oxide (NOX) and sulfur dioxide (SO2). The benefits of these avoided emissions have become a major factor in wind developers gaining public support for their plans to site wind farms. These purported benefits also are the reason for the large subsidies governments have provided to offset wind's higher power production costs.

Unfortunately, some of these environmental claims are built upon incorrect assumptions about how U.S. environmental regulations actually work and the type of generation a new wind project will displace. On any given power project, the benefits of avoided air emissions can be calculated as the simple difference between whether a designated project is built versus if the project is not built. This simple calculation has been incorrectly done by several renewable project developers and their consultants. Their mistakes have led them to incorrectly claim large air emission benefits from building new wind facilities.

Effects of Environmental Regulation

Any analysis of the benefits of avoided air emissions must first correctly account for existing environmental regulations and their impact on utility emissions. Much of the power industry's emissions are currently regulated under strict emission cap and trade programs. Under this framework, the government establishes an emissions tonnage cap. This cap is enforced by issuing a specified number of allowances that can be allocated and/or purchased by affected emission sources. All affected emitters must hold sufficient allowances to cover their emissions of the regulated pollutant. Since the number of distributed allowances is constant, the industry's total regulated emissions will not change based upon the generation mix or renewable generation level. Any displaced generator can sell its unused allowance credits to another power provider, enabling this entity to emit even more. Therefore, any air pollutant subject to a cap and trade program may be displaced but not avoided.

Currently, all power plants in the Lower 48 states are subject to an existing SO2 cap and trade program. In addition, power plant NOX and CO2 emissions are also subject to existing and/or future regional cap and trade programs as shown in Figures 1 and 2. Therefore, no new Northeastern or Midwestern wind project can offer any incremental avoided emission benefit of CO2, NOX or SO2. If Congress adopts a national CO2 cap and trade program as part of climate change legislation, wind projects may no longer claim any additional future incremental avoided CO2 emission benefit in the United States.

Second, many studies advocating avoided emissions benefits from wind power incorrectly model the two cases (with and without the identified project). Two common mistakes are made:

Project operating period: Most analyses compare a wind project's output distribution over a prior historical year. The proper comparison is to look at it over the time the project will operate. Given that the generation mix constantly changes with time, displaced units on the margin continue to get cleaner as stricter environmental requirements are adopted. This trend is illustrated by an annual analysis of marginal emission rates by ISO New England (2006 New England Marginal Emission Analysis, September 2008, ISO New England) to calculate benefits of energy efficiency measures (Figure 3). Therefore, by selecting any historic year, one will tend to overestimate any displaced emissions.

Closed and protected renewable power markets: Developer analyses sometimes incorrectly calculate the baseline emissions (no project case). By selecting a historical year, the baseline has no new facilities, so the wind project generation would be replaced with conventional fossil fuel generation sources. This assumption is incorrect for closed power markets where projects are built to meet a renewable portfolio standard (RPS), such has been adopted in 28 states (Figure 4) or if a new national renewable portfolio standard is adopted by Congress.

Any analysis of wind power's potential for emissions displacement must begin with a distinction between the 28 states with an RPS in place and those without one. Renewable standards set aside a protected portion of the market that can only be met by qualifying renewable sources. Since renewables are not yet competitive in the open market with fossil fuels, all wind projects currently being built are to meet this special set-aside market demand.

In these states, the proper comparison is not to look at wind versus coal or gas, but wind generation versus other qualified renewable technologies competing for this special set-aside market (in other words, solar, biomass, geothermal, landfill gas). If wind were not used, utilities would replace it with another qualifying renewable resource in an effort to meet RPS goals. For these markets, displaced emissions for a given wind project will be the net difference between the project emissions (zero) and other competing renewable project emissions such as solar, geothermal or biomass that would also be zero.

Therefore, no avoided air emission benefit exists if wind generation displaces another renewable project generation to meet a state (or future national) renewable portfolio standard.

Open Power Markets

Until a U.S. carbon cap and trade program and/or national RPS is adopted by Congress, only a few select areas remain in which wind could even compete in an open power market and create potential avoided CO2 emission benefits. In these few areas, new wind generation will displace highest incremental cost generation on the regional power pool margin. This regional marginal generator constantly changes throughout the day due to continuing load fluctuations. This constantly changing power market makes it extremely difficult to predict what resources would be displaced throughout a given year.

Without use of a regional dispatch model in combination with the project generation profile, wind developer consultants may make simplified and often flawed assumptions. These assumptions often center on displaced generation being either coal-fired generation or a weighted average regional blend of fossil fuel generation. Given that higher cost gas and oil can be on the margin, a weighted average fossil fuel mix that better reflects the dominant baseload generation resources (more heavily coal based) produces an overestimated picture of displaced emissions for their selected historical period. This is also an error as previously outlined.

For example, a report for the DOE's Clean Energy/Air Quality Integration Initiative uses EPA emissions data to analyze the aggregate avoided emissions of three proposed wind projects with 160 MW of capacity in a mid-Atlantic state. Since no site-specific data exist for the three plants, the report used "typical performance data on comparable wind generation facilities" and determined marginal differences existed. Additionally, since hourly generation records from comparable fossil fuel plants are not available, the study constructs it using hourly CO2 emissions and generation average CO2 emission rates per megawatthour as reported to the EPA. The report's methodology compares typical hour-by-hour generation output of wind plants and fossil-fueled units in the regional power market. Hour-by-hour analysis proves difficult and inaccurate because the marginal generating unit changes frequently due to load fluctuations over the course of the day.

Despite the report's tendency to overlook the incompleteness and general inadequacy of its data, the authors leave little room for doubt in concluding that when wind energy is available, it will displace generation at high operating cost fossil-fueled units. Unfortunately, the methodology used to calculate the fossil fuel-weighted average emission rate and its inherent displaced emissions does not reflect this observation. The paper simply states the emissions from those fossil fuel generating units are then avoided.

Impact of Wind Variability

While wind energy may be able to displace some fossil fuel emissions in an open power market, integrating it into a generation mix poses additional problems that offset a portion of any projected benefits. Electric grids require reliable power delivery to meet their grid reserve margins. Wind's nature means it contributes little towards meeting a grid's reserve margin capacity requirements. To compensate for wind's limited capacity credit, regional power providers must still build additional capacity -usually gas-powered units-to make up for gradual yet nonetheless significant swings in wind energy output to achieve regional reserve margin requirements.

In **Cost and Quantity of Greenhouse Gas Emissions Avoided by Wind Generation**, Peter Lang analyzes the challenges associated with using gas turbines as back-up units to meet power shortages caused by wind's unpredictability. He details two classes of gas-powered turbines, open cycle gas turbine (OCGT) and combined cycle gas turbine (CCGT) as best able to follow the load changes created by wind power. While OCGT may be well-suited to back up wind, doing so becomes more expensive and actually produces a negligible reduction in GHG emissions when compared to using a cleaner burning CCGT plant alone.

"Because wind cannot be called up on demand, especially peak demand, installed wind generation does not reduce the amount of installed conventional capacity required," Lang states. "Wind is simply an additional capital investment."

To estimate wind's potential to displace emissions and its inherent costs, Lang compares CCGT plants versus wind generation plus OCGT back-up. For wind and OCGT to generate the same amount of power, it would only be 11 percent less carbon intensive and more than double the cost (Table 1).

Finally, proponents who suggest that wind is able to entirely displace CO2 overlook a fact fundamental to energy generation: wind's unpredictability means it truly has no generating capacity value and its construction will not displace building any new coal or natural gas generating capacity. Grid reserve margins require wind back up and the inefficiency of quickly firing up a natural gas unit to meet erratic wind generation output means any emissions displacement is minimal. Wind is simply an additional capital cost which proves to be more than twice as expensive for the ratepayer.

Conclusions

Any analysis of wind power's potential to displace fossil fuel generation must first correctly reflect current environmental regulations. Any air pollutant subject to a cap and trade program covering SO2, NOX and regional CO2 may be displaced but not avoided. Emission levels will remain at the same capped levels with or without wind project development. With the eventual implementation of a federal cap and trade law regulating CO2 emissions appearing likely, wind power will likely offer no future incremental greenhouse gas emission reduction benefit.

One must also distinguish between closed market states with renewable portfolio standards and those open market states without them. Those competing in these closed set-aside protected markets are competing against other renewable projects and not in the open market against lower cost conventional power sources. In these closed markets, no incremental carbon reduction benefits exist between competing renewable power projects. However, these closed power markets were established though regulation and/or legislation and their creation carved out a portion of the open market that reduced the demand for conventional power generation and non-capped fossil fuel emissions. In any case, any avoided emissions benefit is not attributable to a single wind developer, but to regulatory action that has created the closed market for wind and other renewables.

Creating a federal renewable portfolio standard would create a nationwide closed market for renewables, meaning wind projects would again offer no incremental emissions benefits given their direct competition with other renewables and not coal or natural gas. Unfortunately, many of the claims made regarding wind's supposed avoided air benefits are overstated.

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Web link: http://online.qmags.com/PE0709/Default.aspx
Attachment:
HEWSONCalculating the cost of wind power.pdf

Arnold Schwarzenegger
Governor

PERMITTING SETBACK REQUIREMENTS FOR WIND TURBINES IN CALIFORNIA

PIER INTERIM PROJECT REPORT

Prepared For:
California Energy Commission
Public Interest Energy Research Program

Prepared By:
California Wind Energy Collaborative

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PUBLIC INTEREST ENERGY RESEARCH
"Research Powers the Future"

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Preface

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program, managed by the California Energy Commission (Energy Commission), conducts public interest research, development, and demonstration (RD&D) projects to benefit the electricity and natural gas ratepayers.

The PIER program strives to conduct the most promising public interest energy research by partnering with RD&D entities, including individuals, businesses, utilities, and public or private research institutions.

PIER funding efforts are focused on the following RD&D program areas:

- Buildings End-Use Energy Efficiency
- Energy-Related Environment Research
- Energy Systems Integration
- Environmentally Preferred Advanced Generation
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy Technologies
- Transportation

Permitting Setback Requirements for Wind Turbines in California is an interim report for the Windplant Optimization project (contract number 500-02-004, work authorization number MR-017) conducted by the California Wind Energy Collaborative. The information from this project contributes to PIER's Renewable Energy Technologies program.

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Abstract

The California Wind Energy Collaborative was tasked to look at barriers to new wind energy development in the state. Planning commissions in the state have developed setback standards to reduce the risk of damage or injury from fragments resulting from wind turbine rotor failures. These standards are usually based on overall turbine height. With the trend toward larger capacity, taller towers and longer blades, modern wind turbines can be "squeezed out" of parcels thus reducing the economic viability of new wind developments.

Current setback standards and their development are reviewed. The rotor failure probability is discussed and public domain statistics are reviewed. The available documentation shows rotor failure probability in the 1-in-1000 per turbine per year range. The analysis of the rotor fragment throw event is discussed in simplified terms. The range of the throw is highly dependent on the release velocity, which is a function of the turbine tip speed. The tip speed of wind turbines does not tend to increase with turbine size, thus offering possible relief to setback standards. Six analyses of rotor fragment risks were reviewed. The analyses do not particularly provide guidance for setbacks. Recommendations are made to use models from previous analyses for developing setbacks with an acceptable hazard probability.

Keywords: Wind turbines, wind power, wind energy, permitting, zoning, ordinances, hazards

Executive Summary

Introduction

California counties have adopted setbacks for wind turbines primarily to account for the risk of fragments from the rotor. These setbacks are usually based on overall turbine height, which includes the tower height and the radius of the blade. With evolution in the industry to larger turbines, these setbacks increase in total distance and become a hindrance to wind energy development. The authors present a hypothetical example where the total energy production of a windplant is reduced with the application of larger, modern turbines.

Purpose

The purpose of this report is to summarize wind turbine setbacks in California and to describe any connection between rotor failure and windplant setback requirements.

Project Objectives

The objectives of this study of wind turbine setbacks were to:

- Document and compare current wind turbine setbacks in California
- Report on how the setbacks were developed
- Report on the probability of rotor failure
- Study existing analyses of the rotor fragment hazard and determine if setback criteria can be developed with existing information.

Project Outcomes

The outcomes of the project were:

- The authors gathered information regarding turbine setbacks by interviewing county planning personnel, studying the county ordinances, and conducting a literature search of the subject. Wind turbine setbacks were documented for California counties with existing and future wind energy development, including Alameda, Contra Costa, Kern, Merced, Riverside, and Solano counties. Comparisons were made between the various ordinances.
- From this data the authors developed a picture of how the turbine setbacks were established. The majority of the ordinances were developed by ad hoc groups of local interests and the fledgling wind energy industry.
- The authors conducted a literature survey regarding the probability of rotor failure. Several sources of information were obtained. These include failure reports of turbines in Alameda County, failure data from Denmark and Germany reported in the WindStats periodical, and a Dutch report on European rotor

failures. The probability of rotor failure varied from 1-in-100 to 1-in-1000 turbines per year.

- The authors present a simplified analysis of the rotor fragment hazard to compare to more complex analyses. The analyses of six researchers were found in a literature survey of varying complexity. Results were compared to determine if setback criteria could be developed.

Conclusions

Wind turbine setbacks vary by county. The counties typically base the setback on the maximum of a fixed distance or a multiple of the overall turbine height. A common setback is three times the overall turbine height from a property line.

There is no evidence that setbacks were based on formal analysis of the rotor fragment hazard.

The most comprehensive study of wind turbine rotor failures places the risk of failure at approximately 1-in-1000 turbines per year.

The maximum range of a rotor fragment is highly dependent on the release velocity that is related to the blade tip speed. Tip speed tends to remain constant with turbine size; therefore, the maximum range will tend to remain constant with turbine size. In the analysis of rotor fragment trajectories, the most comprehensive models yielded results that showed the shortcomings of simpler methods. Overall, the literature shows the possibility of setbacks for larger turbines may be based on a fixed distance and not the overall height.

Recommendations

The authors recommend that a comprehensive model of the rotor fragment hazard be developed based on the results of the literature review. This tool would then be used with a variety of turbine sizes with the objective to develop risk-based setback standards.

Benefits to California

The information provided in this report can be used by California planning agencies as a background for evaluating wind turbine setbacks. Researchers can also use the information as background for developing models of the rotor fragment hazard.

1.0 Introduction

1.1. Background and Overview

California has played a pivotal role in the creation and evolution of the wind-based electric power generation industry. Wind power is unique in the visibility and exposure to the public as compared to other forms of power generation. By necessity, communities have become involved in planning for the development of wind power in their jurisdiction. Both the regulation and technology of wind power evolved together in the last two decades.

Particular attention was made to protect the public from hazards. With the advent of a new technology, the probability of failure tends to be higher because the physics are not well understood. The engineering of the technology must also be balanced with economics, and the balance is very tenuous at the beginning of a new venture. Equipment and business failures plagued the industry in the last two decades, and legacy equipment still fails at a relatively high rate today.

One hazard possibility of wind turbines is the failure of a portion of the rotor resulting in fragments being thrown from the turbine. Concerns over public exposure to this risk led the counties to develop setbacks from adjacent properties and structures. The development of county ordinances took place independently of each other; however in most cases the fledgling wind power industry was involved in the development (McClendon and Duncan 1985). In general, the setbacks were based on the heights of the turbines.

Utility scale turbines installed in California have evolved from 50 kilowatt (kW) machines of 25 meter (m) overall height to 3.0 megawatt (MW) machines of 126 m overall height. The nature of that evolution, in general, is that manufacturers stop production of smaller turbines due to improved economics of the new larger turbines. With increased overall height, the setback distance is increased, and modern turbines can be "squeezed out" of developments.

The California Wind Energy Collaborative (CWEC, http://cwec.ucdavis.edu/), through its "Windplant Optimization" task, was directed to prepare this white paper on permitting issues in regards to the rotor fragment risk. The concern over restrictions on development was the impetus to study current ordinances and the rotor fragment risk. Two possibilities offer the potential for relief in this area. Modern wind turbines might offer higher reliability, thus lowering the risk of rotor failure. Second, in the event of a rotor failure, the hazard area is governed by the blade tip speed. The tip speed tends to remain constant with turbine size. Therefore, more appropriate setbacks might be a fixed distance, and not a function of the turbine size. These possibilities, along with background research, are discussed in this report.

1.2. Example Windplant and the Problem with Current Setbacks

Setbacks are established to minimize risk of damage or injury from component failure on property and personnel. The setbacks are usually a multiple of the total turbine height, from tower base to upper extreme point of the rotor (see Figure 1). Generally the setbacks can vary from 1.25 to 3 times the overall machine height. Larger setbacks are sometimes required for special areas. In contrast to these standards, counties in California with more rural development, such as Merced and San Joaquin, use building setbacks and do not distinguish wind turbines separately.

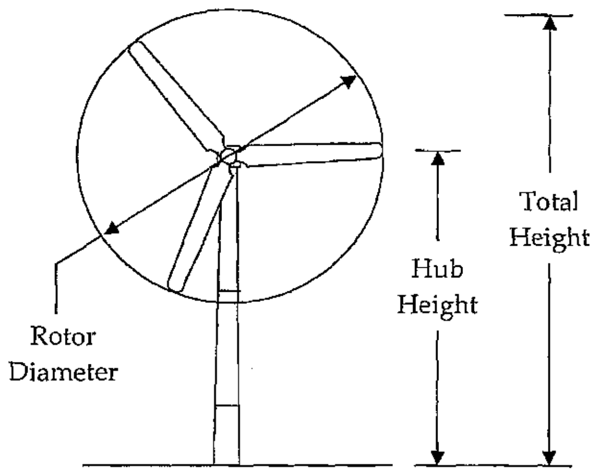

Figure 1. Wind turbine dimensions

As an illustration of the potential of setbacks limiting modern wind energy development, consider the following hypothetical situation. A developer has a 1000 by 1000 m (1 square kilometer or 247 acres) parcel of land available in a county requiring a setback three times machine total height. The site has a strong prevailing wind direction, and the machines are to be spaced in consideration of wake effects of 3 diameters crosswind and 10 diameters downwind. Two machines are considered:

1.2.1. 1. Vestas V-47

- 660-kW full rating
- 47 m rotor diameter
- 50 m tower height

1.2.2. 2. General Electric GE 1.5s

- 1500-kW full rating
- 70.5 m rotor diameter
- 65 m tower height

The layouts are shown in Figure 2 and Figure 3, with shaded zones representing the setback areas. The overall height is the sum of the tower height plus half the rotor diameter.

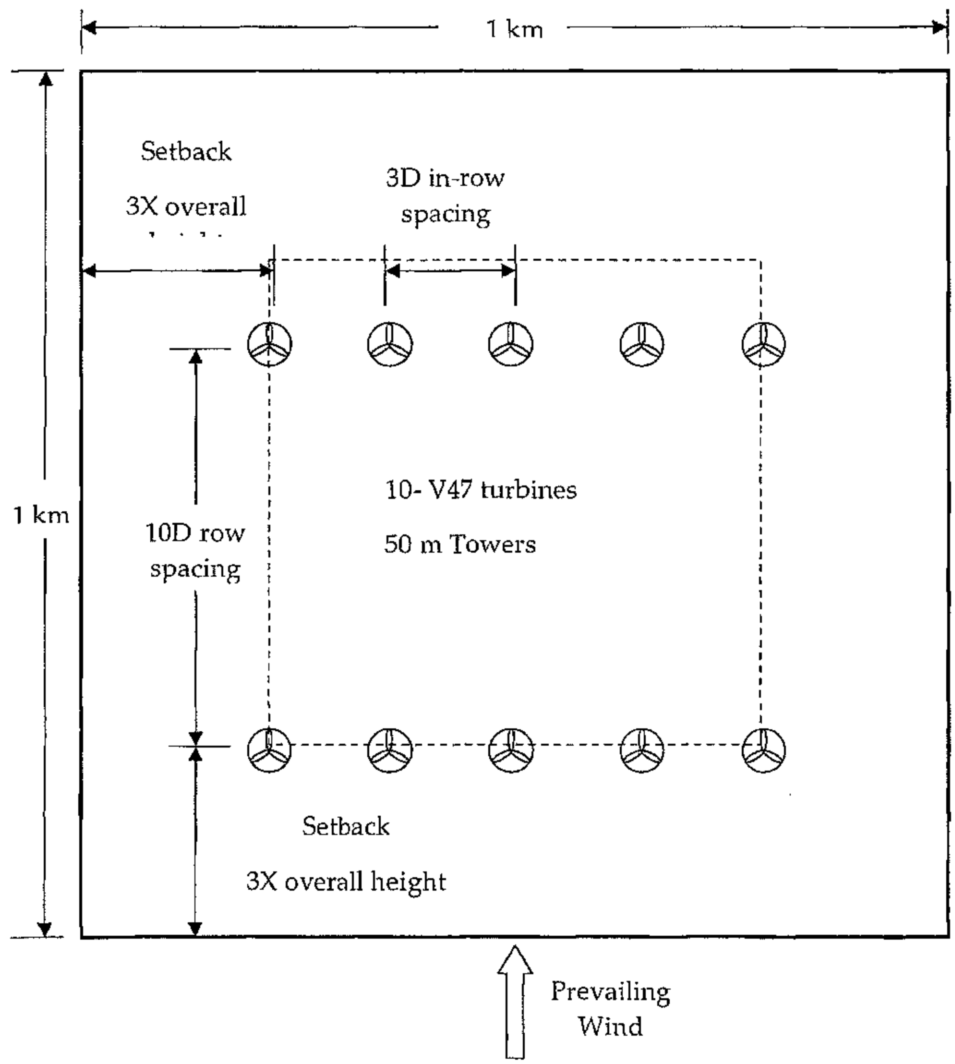

Figure 2. Layout for V-47 wind turbines based on setback requirement of three times total turbine height

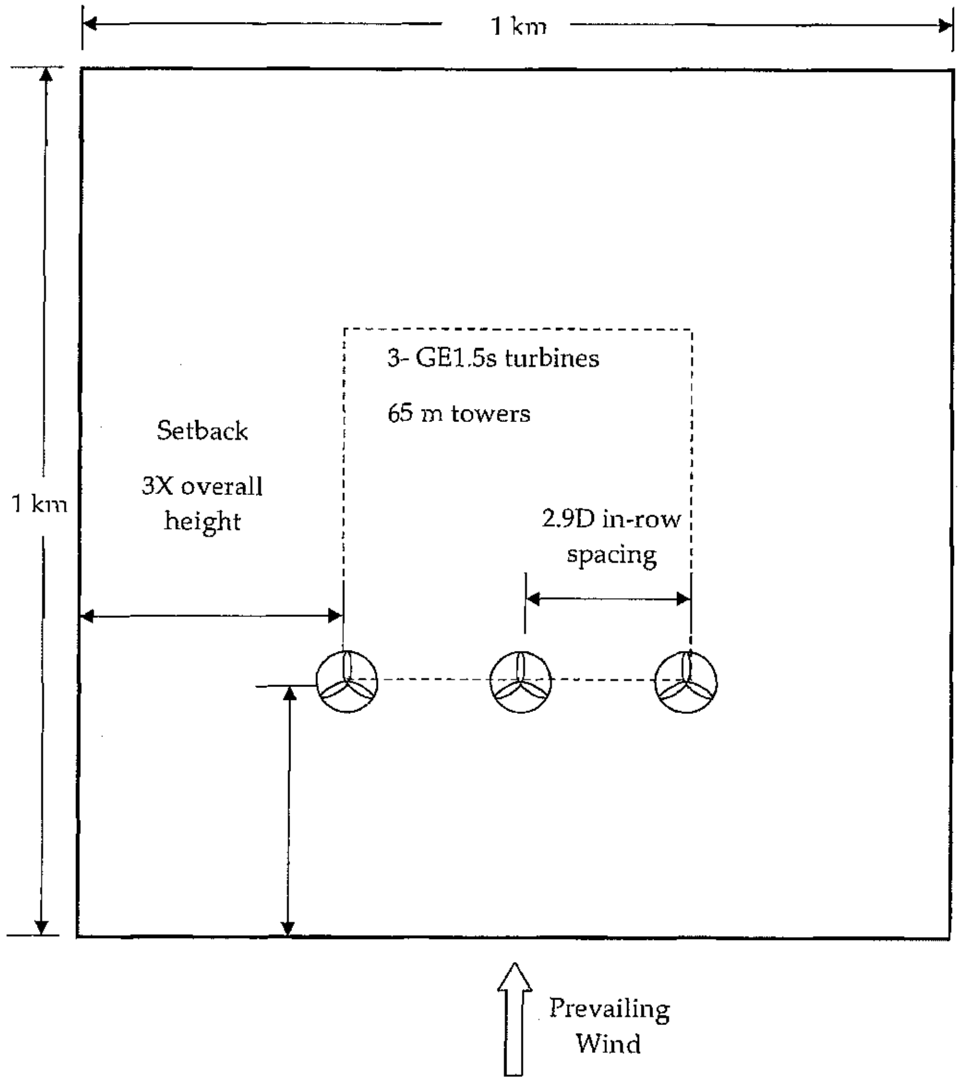

Figure 3. Layout for GE 1.5s machines based on setback requirements of three times total turbine height

For the V47 machine, the spacing requirements and setbacks allow for 10 machines with total rating of 6.6 MW. In contrast, the requirements allow only three GE 1.5 turbines with total rating of 4.5 MW. The crosswind spacing in this case would probably be reduced slightly. Downwind spacing requirements would force a second row of turbines off the parcel. The setback requirements for this example result in lower energy production with the application of larger, modern machines. The options available to a developer are further constrained with the current trend of manufacturers producing larger machines, and phasing out the production of smaller machines such as the V-47.

1.3. Project Objectives

Project objectives for this study were to:

- Document and compare current wind turbine setbacks in California
- Report on how the setbacks were developed
- Report on the probability of rotor failure
- Study existing analyses of the rotor fragment hazard and determine if setback criteria can be developed with existing information.

Wind turbine setbacks are codified for reasons other than safety. Scenic corridors might be established so that views are not adversely impacted by new structures. Acoustic emissions from turbines might limit siting. Maximum sound pressure levels might be established at property lines or dwellings, constraining the placement of turbines. This report deals specifically with the issue of the rotor fragment hazard.

2.0 Project Approach

For each of the project objectives, the authors took the following approaches:

- Document and compare current wind turbine setbacks in California

The authors considered only counties with existing utility-scale wind power development. These counties are Alameda, Contra Costa, Kern, Merced, Riverside, San Joaquin, and Solano. The authors obtained the majority of the county ordinances from the Internet. Many counties have their codes residing on Ordlink (http://ordlink.com/), a LexisNexis product. All county planning departments were contacted for any additional information. In some cases, the wind energy ordinance was a separate document (Solano 1987) or part of an Environmental Impact Report (Alameda 1988b). The setbacks were organized into a tabular format for comparison.

- Report on how the setbacks were developed

The authors conducted interviews with county planning personnel on this topic. The authors also conducted a literature survey on the Internet and reviewed the conference proceedings of the American Wind Energy Association, the British Wind Energy Association, and the European Wind Energy Association.

- Report on the probability of rotor failure

The authors conducted a literature survey on this topic with the sources mentioned above, and searched the annual conference proceedings of the American Society of Mechanical Engineers technical conference on wind energy.

During the study, CWEC obtained records of Alameda County turbine failures. These data were compiled and analyzed. The authors also compiled failure data from European turbines reported in *WindStats*, a quarterly newsletter of Windpower Monthly. CWEC also translated and reviewed an interim report on rotor failures prepared by the Netherlands Energy Agency.

- Study existing analyses of the rotor fragment hazard and determine if setback criteria can be developed with existing information.

The authors conducted a literature survey with sources mentioned above, and developed a simple model of the rotor fragment hazard to outline certain characteristics of the problem. The method and results for each researcher is described. Where possible, the results are compared across analyses.

3.0 Project Outcomes

3.1. Current Wind Energy Ordinances

The majority of the county ordinances were obtained from the Internet. The authors strongly suggest checking the current information available on the websites. Checking the requirements is especially important during the lifetime of a development project. Current ordinances and their safety setback requirements are summarized in Table 1.

Table 1. Setback references in California county ordinances

	Internet Site	Ordinance	Setback Reference
Alameda	Code for wind energy not available on internet	Draft Environmental Impact Report, Repowering a Portion of the Altamont Pass Wind Resource Area, Appendix A, Alameda County Windfarm Standard Conditions	Paragraph 15. Safety Setback
Contra Costa	http://www.co.contra-costa.ca.us/	County Code, Title 8 Zoning, Ch. 88-3 Wind Energy Conversion Systems	88-3.602 Setback Requirements
Kern	http://ordlink.com/codes/kerncoun/	Title 19 Zoning, Chapter 19.64 WIND ENERGY (WE) COMBINING DISTRICT	19.64.140 Development standards and conditions
Merced	http://web.co.merced.ca.us/planning/zoningord.html	Zoning Code (Ordinance) Ch. 18.02, Agricultural Zones	Table 5 Agricultural Zones Development Standards
Riverside	http://www.tlma.co.riverside.ca.us/planning/ord348.html	Ordinance 348, Section 18.41, Commercial Wind Energy Conversion Systems Permits	18.41.d(1) Safety Setbacks
Solano	Code for wind energy not available on internet	Wind Turbine Siting Plan and Environmental Impact Report 1987	Page 17 Safety Setbacks

Table 2 compares setbacks for several of the counties organized by feature that the turbine must be displaced from, such as a property line. The distances are stated in multiples of overall turbine height (Figure 1). If a fixed distance is included with the multiple, then the maximum of the two values must be used for the setback.

Table 2. Safety setback comparison. Note: for reference purposes only. Check counties for current zoning requirements.

	Property Line	Dwelling	Roads	Reductions in Setbacks
Alameda County	3x/300 ft (91 m), more on slope	3x/500 ft (152 m), more on slope	3x/500 ft (152 m), 6x/500 ft from I-580, more on sloped terrain	maximum 50% reduction from building site or dwelling unit but minimum 1.25x, road setback to no less than 300 ft (91 m)
Contra Costa County	3x/500 ft (152 m)	1000 ft (305 m)	None	exceptions not spelled in ordinance can be filed with county
Kern County	4x/500 ft (152 m) <40 acres or not wind energy zone, 1.5x >40 acres	4x/1000 ft (305 m) off-site	1.5x	With agreement from adjacent owners to no less than 1.5x
Riverside County	1.1x to adjacent Wind Energy Zones	3x/500 ft (152 m) to lot line with dwelling	1.25x for lightly traveled, 1.5x/500 ft (152 m) for highly traveled.	None
Solano County	3x/1000 ft (304 m) adjacent to residential zoning, 3x from other zonings	3x/1000 ft (304 m)	3x	Setback waived with agreement from owners of adjacent parcels with wind turbines

Table 2 shows that counties have different requirements. Riverside County maintains the minimum setback distances to properties with adjacent wind energy zoning.

Alameda County has adjustments for sloping terrain. If the ground elevation of the turbine is two or more times the height of the turbine above the feature, the setback distance increases from three times to four times. With the exception of Riverside County, all allow for reduction of the setback distance with special consideration. The Altamont Repowering EIR (Alameda County 1998) is an example of a reduced setback, which resulted from a developer submitting a rotor fragment risk analysis as substantiation for the reduction.

Merced County has some wind energy development in the Pacheco Pass area, and utilizes standard building setbacks for wind turbines in agricultural districts. San Joaquin County has similar requirements for the development in the Altamont Pass area.

3.2. Setback Development

With the exception of Solano County, the ordinances are not explanatory documents. Background information is not provided. The most comprehensive paper on the subject of wind energy permitting in California comes from McClendon and Duncan. Although this paper was written in 1985, it captures the essence of the process at the time and generally, not much has changed in the interim. Another paper by Throgmorton (1987) focuses on Riverside County development exclusively. Further clues to the development of standards are found in Environmental Impact Reports written for the counties on specific developments. The counties are discussed separately below.

References in the literature to safety setbacks are scarce. One is found in Taylor (1991). Taylor proposed setbacks for a 30 m diameter rotor machine, but no tower height is mentioned. The proposed setbacks were 120–170 meters from a habitation or village, 50 meters from a lightly traveled road, and 100 meters from a heavily traveled road. A Windpower Monthly article regarding a rotor failure in Denmark (Møller 1987) mentions setbacks for safety. A setback of 90 meters plus 2.7 times the rotor diameter was proposed. The Wind Energy Permitting Handbook available from the National Wind Coordinating Committee (NWCC 2002) provides no guidance on setbacks. In all the above references, there is no discussion of the technical basis for the setbacks.

3.2.1. Alameda County Ordinance

Alameda County, encompassing most of the Altamont pass, was one of the first regions in the world to have large-scale wind energy development. Until recently, the Altamont Pass area has been isolated from population centers, lowering the possibility of conflict with the community. The McClendon and Duncan paper (1985) reported that concerns over safety and reliability of wind turbines resulted in an ad-hoc public/industry group to develop new standards. The setbacks as they stand today are found in Resolution Number Z-5361 of the Zoning Administrator of Alameda County, dated September 5, 1984. There is no known technical description on how the setbacks were developed.

3.2.2. Contra Costa County Ordinance

Contra Costa encompasses the northern portion of the Altamont pass. The zoning language is much less specific than Alameda County, but the setbacks are similar.

3.2.3. Kern County Ordinance

According to county personnel and McClendon and Duncan (1985), the standards for Kern County were developed with an ad-hoc committee of wind energy people and other interests, as in the case with Alameda County. Kern has stricter setbacks for properties not zoned for wind energy development, but is less restrictive for roads (see Table 2).

3.2.4. Riverside County Ordinance

Riverside County is an area of intense development. Regulations were established after an extensive Environmental Impact Report (EIR) by Wagstaff and Brady (Riverside County California, United States Bureau of Land Management et al. 1982). Clues to the majority of the setback distances are in the report. Although there is no technical basis for the original setback of three times the total height of the turbine, one can infer that this distance arose from the discussion of wake effects. It was expected that in-row spacing for wake effects would be six diameters, and adjacent wind energy parcels would require a spacing of at least half this distance. The report also mentions an estimate of the fragment throw distance for the MOD-0A, an early Westinghouse machine. The stated value of 500 ft (152 m) translates to three times overall height for this turbine. Evolution of the ordinance resulted in reduction of some of the setbacks, which now seem to offer a buffer for the possibility of tower collapse.

3.2.5. Solano County Ordinance

Solano County also developed wind turbine requirements with industry involvement in 1985. The outcome of this work was the Solano County Wind Turbine Siting Plan (Solano County 1987), which remains the guide for permitting in the county. The plan supercedes the current language in the zoning ordinance that has setbacks of 1.25 times the overall turbine height. This plan was developed by the authors of the Riverside County EIR, and proposes a "three times" setback. The estimated rotor fragment risk of the MOD-0A is again mentioned. There is a comparison of the setbacks with the rotor fragment risk of the MOD-2 turbine. The throw distance of this turbine in a vacuum was estimated to be 1300 feet (396 m, 3.7 times overall turbine height) for a broken tip and 700 feet (213 m, 2 times overall turbine height) for the whole blade. There is no technical discussion for these values and they are not tied into the proposed spacing. The Montezuma Hills EIR (Solano County and Earth Metrics 1989), proposed a three times diameter safety setback, with no consideration for turbine height. Neither reference provides a technical basis for the setback distance.

3.3. Rotor Failure Probabilities

This section discusses the probability of a rotor failure occurring. Probabilities will be discussed in terms of ratios. For example, a coin toss with heads has a one in two probability, represented equally as 0.5, ½, 5×10^{-1}. A probability of something occurring once in one-hundred trials can be represented as 10^{-2}. The probability applied to rotor failures will be stated as the probability of failure for a turbine in one year of operation. A probability of 10^{-2} per turbine per year can then be understood that on average there will be one rotor failure in a year for every 100 turbines.

Reporting on turbine failures is very limited, most likely due to the sensitivity of the industry. There are few accounts of turbine failure in the literature. There are statistics in the public domain that will be discussed below.

Types of rotor failures are as follows:

- Root-connection full-blade failure
- Partial-blade failure from lightning damage
- Failure at outboard aerodynamic device
- Failure from tower strike
- Partial-blade failure due to defect
- Partial-blade failure from extreme load buckling

Some of the causes of rotor failures:

- Unforeseen environmental events outside the design envelope
- Failure of turbine control/safety system
- Human error
- Incorrect design for ultimate loads
- Incorrect design for fatigue loads
- Poor manufacturing quality

Not surprisingly, most failures are a combination of these factors, which points to the complexity of the technology. The probabilities of some events are highly correlated with each other. For example, loss of grid power is highly correlated with high wind events. The potential then exists for a control system malfunction due to loss of power to coincide with a high loading event. Thus the turbine designer must plan for both events occurring simultaneously.

3.3.1. *Rotor Failures in the Literature*

One of the earliest documented rotor failure events comes from one of the first applications of utility-scale wind energy (Putnam 1948). It is also one of the few accounts with a published distance. The Smith Putnam 1.25 MW turbine suffered a rotor failure in its test campaign resulting in a blade throw of 750 ft (230 m), or 3.7 times the overall height. The failure was attributed to lack of knowledge of the design loads for the turbine. The blade throw was probably exacerbated by siting on a slope (approximately ten degrees). The blade was of steel construction, with a weight of eight tons (mass of 7260 kg). That is at least 50% heavier than modern construction. A heavier blade could fly farther due to a reduced drag-to-weight ratio (Eggers, Holley et al. 2001).

The next period of literature deals with the analysis of large-scale turbines under development in the 1970s and early 1980s. Although the possibility of failure was discussed, no mention of the probability was placed forward for the Department of Energy (DOE) MOD series turbines such as the General Electric MOD-1 (General Electric 1979) and the Boeing MOD-2 (Lynette and Poore 1979). The Solar Energy Research Institute (SERI) conducted a preliminary study of wind turbine component reliability (Edesess and McConnell 1979). Using an analysis of the individual failure rate estimates and inspection intervals of the rotor and braking systems, the authors predicted a failure rate for the wind turbine rotor at 1.2×10^{-2} per turbine per year.

A strong early wind program in Sweden prompted studies of the subject (Eggwertz, Carlsson et al. 1981) where the first attempts at analyzing the rotor fragment risk were made. The first guess at the probability of failure was made at 1 in 100,000 (10^{-5}) failures per turbine per year.

The evolution of the wind industry back to smaller turbines brought large scale manufacturing and experience was gained with equipment failures. In a 1989 paper (De Vries 1989) conducted a blind survey of manufacturers that reported on 133 turbine failures in the industry. De Vries also placed probabilities at 2×10^{-2} rotor failures per turbine per year for the Netherlands, 3 to 5×10^{-3} for Denmark and 3×10^{-3} for the United States. This is two to three orders of magnitude higher than that predicted by Eggwertz, but closer to the SERI analysis.

Failures are occasionally reported in Windpower Monthly. They have reported a rotor overspeed failure in Denmark (Møller 1987) and full-blade failures in Spain (Luke 1995). A report in the technical literature comes from Germanischer Lloyd (Nath and Rogge 1991), one of the certification bodies for wind energy. The paper describes two medium-size turbine rotor failures. The rotor diameter and tower height were not reported. One failure was attributed to insufficient shutdown braking force resulting in overspeed, and blades were thrown to 150 and 175 meters. The other failure was attributed to poor manufacturing quality and blade fragments were thrown 200 meters. Updates to certification requirements were made as a result of the failure investigations. These certification requirements call for redundancy in safety shutdown systems and quality control in the blade manufacturing process. De Vries had also earlier suggested stricter certification requirements to reduce the rotor failure rate.

One wind turbine manufacturer has made a public testimonial of their rotor failure rate. A managing engineer at Vestas, in testimony for the Kittitas Valley Wind Power Project in Washington State (Jorgensen 2003), declared that there had been only 1 blade failure in 10,000 units for 12 years. The failure reported occurred in 1992 on a V39-500 kW machine when a blade was thrown 50–75 meters. If an average of six years of total operation for the entire fleet is assumed, the failure rate would be estimated at 1.6×10^{-5} rotor failures per turbine per year.

3.3.2. Alameda County Turbine Failure Data

Under Article 15 of the Alameda County Windfarm Standard Conditions (Alameda County 1998a), a windfarm operator must notify the County Building Official of any tower collapse, blade throw, fire, or injury to worker. Recent files of failure data from the county building department were compiled by the CWEC in order to determine failure rates. County representatives claim that not all operators have been diligent in their reporting, but one operator of Kenetech 56-100 machines has been. These turbines are 100 kW machines with 56 ft (17 m) diameter rotors. The majority were manufactured in the 1980s. The failure reports only indicate the failure type. There is no mention of rotor fragment distance (if fragments were thrown from the turbine), or the conditions at time of failure. The failures could have been discovered as the result of an inspection before any part had separated from the turbine. The failure data covered the year 2000 to fall of 2003. The number of Kenetech 56-100 machines in operation by this operator was obtained from the California Wind Performance Reporting System (http://wprs.ucdavis.edu/).

For the time period of the reports, the rotor failure rate was 5.4×10^{-3} failures per turbine per year. This value coincides well with that reported by De Vries (1989). As a comparison the failure rate for the tower was 6.9×10^{-4} failures per turbine per year, an order of magnitude less probable than the rotor failure rate.

3.3.3. WindStats Turbine Failure Data

WindStats is a technical publication for the wind industry published quarterly in Denmark. Failure data are available for wind turbines located in Denmark and Germany. The Denmark data have been available since 1993; the Germany data since 1996. Like the Alameda County data, the data only indicate failure type. There is no mention of rotor fragment distance (if it occurred at all), or the conditions at the time of failure, are mentioned. CWEC compiled data through the spring 2004 issue.

For Denmark, the failure rate for rotors was 3.4×10^{-3} failures per turbine per year. Again, this is within the values reported by De Vries (1989) in the late 1980s. The tower failures for the same period are 1.0×10^{-4}. As with the Alameda data, the tower failure probability is an order of magnitude lower than the rotor failures. For Germany, the data are reported as "rotor" failures, which for the reporting period were 1.5×10^{-2} failures per turbine per year. This is an order of magnitude higher than the Denmark data, but on the same order of the Netherlands in De Vries. There are no apparent trends in the data indicating changes in failure rates over time.

3.3.4. Dutch NOVEM Report

During the writing of this report the Netherlands Agency for Energy and the Environment (NOVEM) was writing a handbook on wind turbine siting due to the risk posed by wind turbines. The overall report is summarized in English by Braam and Rademakers (2004) from the Energy Research Centre of the Netherlands, ECN, and the report was published in Dutch in 2005 (Braam, van Mulekom et al. 2005). The CWEC received approval from the authors to translate Appendix A of the handbook and it is included in Appendix A of this document.

The appendix from the handbook reviews data from two large databases of wind turbines in Denmark and Germany. The database covers turbine operation from the 1980s until 2001. The authors analyzed the data and recommended values of risk for the following failure events:

- Failure at nominal operating rpm 4.2×10^{-4}
- Failure at mechanical breaking (~1.25 time nominal rpm) 4.2×10^{-4}
- Failure at mechanical breaking (~2.0 time nominal rpm) 5.0×10^{-6}

The authors compared these results to earlier values developed by European agencies in the earlier 1990s, with the overall blade failure rate declining three times. It is expected that with the maturity of the industry blade failures will continue to decrease.

Documented blade failures and distances were also reported in the handbook. The maximum distance reported for an entire blade was 150 m, for a blade fragment the maximum distance reported was 500 m.

3.4. Rotor Fragment Analyses

This section discusses the estimates of rotor fragment risk as determined by six researchers. The impetus behind these investigations was to study the hazard potential of the rotor failure. While rotor failures can occur with the machine operating or stationary, these studies were limited to the operating case.

3.4.1. Background of Rotor Fragment Models

Parked Turbines

Wind turbines are parked if the wind speed is out of the operating range, or if there is fault detected while the wind speed is within the operating limits. The typical high wind shutdown for a wind turbine is 25 meters/second, m/s. The turbine is usually designed to withstand a peak gust outlined by the International Electrotechnical Commission (IEC). Peak gusts for various wind classes are shown in Table 3. The peak gust is defined as a three-second average gust that has a fifty percent probability of occurring in fifty years, more succinctly known as "50-year wind." The IEC wind classes are also distinguished by the annual average wind speed. All wind speeds are designated at hub height.

Table 3. IEC peak gusts

IEC Class	I	II	III
50-year wind	70 m/s	59.5 m/s	52.5 m/s
Annual Average	10 m/s	8.5 m/s	7.5 m/s

If a rotor has failed in a parked condition, there is no initial velocity of any fragment coming off. Any movement away from the turbine is governed by gravity and the aerodynamic force on the fragment. None of the analyses studied the failure of the parked turbine, and it is assumed that failure during operation will result in a higher probability of the blade or the blade fragment flying farther.

Ballistics Models

Analysis of rotor failure uses methods of classical dynamics in order to describe the problem. Figure 4 is a representation of a rotor failure. If there is a rotor failure, either a fragment or the entire blade, the motion of the fragment is governed by specific forces. If the failure has taken place while the turbine is operating, the fragment has an initial velocity due to rotation, while in flight the motion is constrained by gravity and aerodynamic forces. The initial velocity of the rotor fragment is a function of the tip velocity, determined by Equation 1:

$$\text{Equation 1} \qquad V_{tip} = \Omega R$$

where:

$\Omega =$ Rotor rotational speed, and

$R =$ Rotor radius

Normal operating tip speeds of the turbines studied in the literature varied from 40 m/s to 100 m/s. Modern wind turbines fall within this range. The tip speed is chosen to meet the performance requirements for the turbine and also to minimize acoustic emissions. The lower the tip speed, the lower the loads and noise from the blades for a given blade design. This can be compared to the low/high switch setting for a fan.

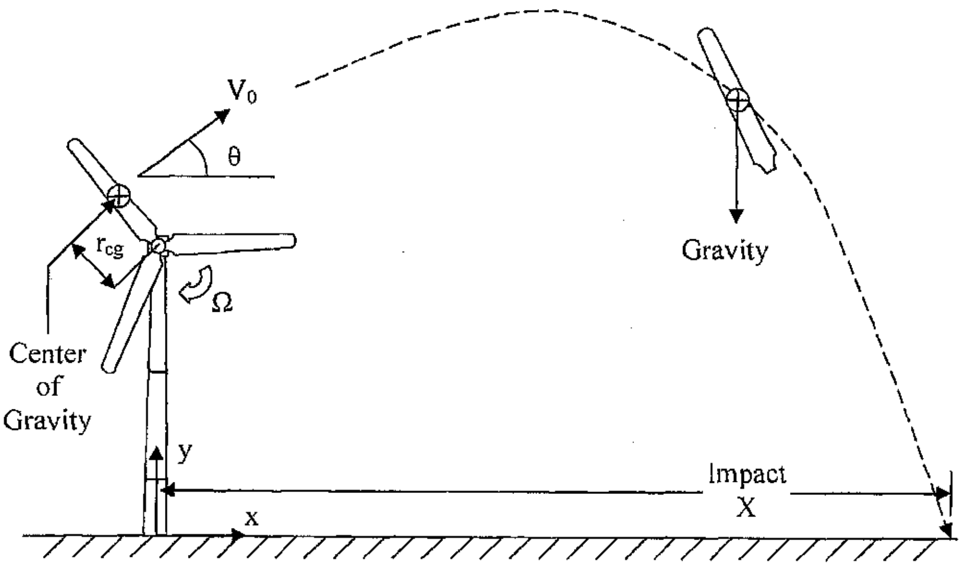

Figure 4. Rotor fragment schematic

If there is a failure of the rotor and a fragment is released, the initial velocity at separation is given by Equation 2:

$$\text{Equation 2} \qquad V_0 = \Omega r_{cg}$$

where:

$V_0 =$ Initial velocity of fragment at center of gravity

$r_{cg} =$ Radial position of the fragment center of gravity

At the time of separation, the blade or fragment has the same angular velocity (or spin) as the rotor.

A rudimentary model of ballistics is the path of a fragment in a vacuum. The only force acting on the fragment is gravity. This model is found in most elementary dynamics textbooks, such as Schaum's (Nelson, Best et al. 1998). The total ground range achieved by the fragment, with release height and impact height equal, is given by Equation 3.

Equation 3 $$X = \frac{V_0^2}{g}\sin 2\theta$$

where:

$X =$ Horizontal total ground range of a fragment in a vacuum

$g =$ Gravitational acceleration

$\theta =$ Release angle between the velocity vector and horizontal

The release angle is directly related to the blade azimuth, which is the position of the rotor at a particular time.

In a vacuum the aerodynamic forces are not modeled, the fragment is not affected by the ambient winds. The maximum range in a vacuum is achieved when the release angle is 45°. With this value of the release angle, Equation 3 becomes Equation 4.

Equation 4 $$X_{\max} = \frac{V_0^2}{g}$$

where:

$X_{\max} =$ Maximum horizontal range of a rotor fragment in a vacuum

The values of range from this simple model are not realistic because the atmosphere is not a vacuum. However, this simple model shows the importance of the release velocity because it is a squared term. For example, a 10% increase in release velocity increases the maximum range by 21%. This model also shows the dependence on the release angle. In any probability study, this would be a random parameter, because it is assumed that a rotor failure would not be dependent on the azimuthal angle.

Other models increase on the complexity of the vacuum model. The most common approach is to assume that the aerodynamic force is proportional to the square of the instantaneous velocity. The aerodynamic force is separated into lift and drag, and the constants of proportionality are called coefficients of lift and drag (C_L and C_D). Both the crosswind and downwind distances are determined. The solutions for the fragment range from these models (so-called two-degrees-of-freedom or 2 DOF models) cannot be solved directly and require numerical methods.

The next level of complexity assumes that C_L and C_D are dependent on the orientation of the fragment, and the fragment is allowed to rotate and translate (3 DOF or 6 DOF models).

Rotor Overspeed

One particularly hazardous failure scenario is turbine overspeed. The increased velocity in overspeed will over stress the rotor blade, and, in the event of a failure, increase the range of the fragment. The rotor is usually designed with a safety factor of 1.5. If the rotor loads are approximately proportional to the rotor speed (Eggers, Holley et al. 2001), the rotor could possibly fail at 150% of nominal rotor speed. To prevent this possibility, most wind turbines are equipped with redundant safety systems to shutdown the rotor. A turbine with industry certification (e.g. Germanischer Lloyd 1993), must have a safety system completely independent of the control system. The safety system must also have two mutually independent braking systems. Usually the blades pitch to release the aerodynamic torque while a brake is applied to the shaft. In the event of a failure in one system, the other system must be able to hold the rotor speed below maximum. An emergency shutdown is typically designed to occur if the rotor speed exceeds 110% of nominal. Even with redundant safety systems, rotor overspeed still occurs in industry, sometimes by human error when the safety systems have been defeated during maintenance.

Impact Probabilities

The analyses next turn to the probability that a fragment will land on a certain target or in a particular area in the range of the turbine assuming a rotor failure. The studies follow various approaches to determine this probability; this will be discussed below. The probability of impact is then multiplied by the probability of rotor failure, discussed in the previous section. The final result is the probability that a target fixed at a certain range from the turbine will be hit in one year. If targets are not fixed, such as cars on a roadway, then the probability must be multiplied again by the probability that the target will be in position. Mobile targets are not discussed in the analyses.

A simplified impact probability can be derived from Equation 3. Since this relationship is only valid for a ground release, only release angles of 0 to 180° (see Figure 4) result in movement away from the release point. Release angles of 180 to 360° result in impact at the base. The random release angle is assumed to have uniform distribution from 0° to 360°. Using methods of probability, the probability that a fragment will fall within an annulus that is less than the maximum range is given by Equation 5.

Equation 5 $$P\{X_1 \le X \le X_2 \le X_{max}\} = \frac{2}{\pi}\left[\arcsin\frac{X_2}{X_{max}} - \arcsin\frac{X_1}{X_{max}}\right]$$

where:

$X_1 =$ inner radius of annulus.

$X_2 =$ outer radius of annulus.

This relationship is plotted in Figure 5 for a normalized annular width of 0.05. Note that the relatively high probability of the fragment landing directly under the tower is not shown. The nature of the equation results in an increasing probability of impact in the outermost annuli, due to a wide range of release angles that provide nearly the maximum range. However, the annular area increases with increasing radius.

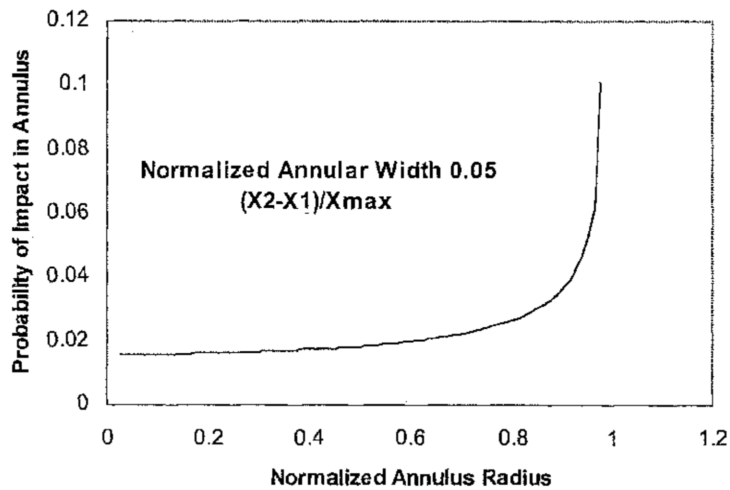

Figure 5. Probability of impact within an annular region

We next assume that the target is an annular sector, as in Figure 6.

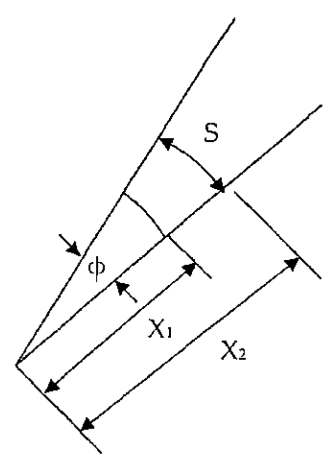

Figure 6. Target annular sector

In order to make the sector size roughly equal throughout the ballistic range, we set the outer arc length (S) equal to the annular width, given by Equation 6:

$$\text{Equation 6} \qquad S \cong X_2 - X_1$$

The arc length is also given by

$$\text{Equation 7} \qquad S = X_2 \times \varphi$$

where:

$\varphi =$ Sector angle in radians (assumed to be small)

Equating Equation 6 and Equation 7 and solving for the sector angle we obtain:

$$\text{Equation 8} \qquad \varphi = \frac{X_2 - X_1}{X_2}$$

The probability of impact in this annular sector, assuming equal probability in all directions, is given by:

$$\text{Equation 9} \qquad P\{X_1, X_2, \varphi\} = \frac{\varphi}{\pi^2}\left[\arcsin\frac{X_2}{X_{\max}} - \arcsin\frac{X_1}{X_{\max}}\right]$$

This relationship is plotted in Figure 7. This simplified model shows a peak in probability near the tower base, and then a relatively constant probability until the probability rises again near the maximum range. This behavior is similar to more complex models incorporating aerodynamics. The peak at maximum range places a constraint on the overall hazard and acceptable setback distances.

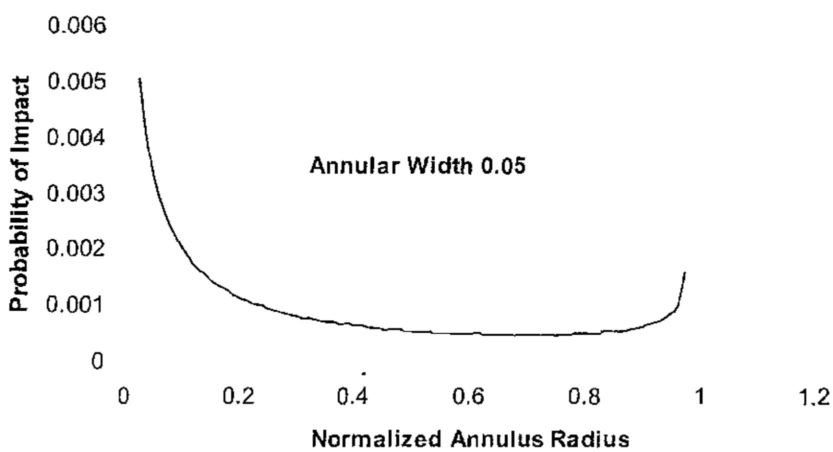

Figure 7. Probability of impact within annular sector

Multiple Turbines

If there is more than one turbine in the area, such as in a wind plant, then the individual probabilities must be added for a particular area. This is mentioned briefly in Macqueen (1983). The probabilities add according to the Law of Total Probability; for two turbines this is represented inEquation 10.

Equation 10 $$P(A+B)=P(A)+P(B)-P(A,B)$$

where:

$P(A+B)=$	Probability of A or B or both occurring
$P(A)=$	Probability of A occurring
$P(B)=$	Probability of B occurring.
$P(A,B)=$	Probability of both A and B occurring (Equation 11)

Equation 11 $$P(A,B)=P(A)P(B/A)=P(B)P(A/B)$$

where:

$P(B/A)=$	Conditional probability B occurring given A has occurred
$P(A/B)=$	Conditional probability of A occurring given B has occurred

If the events are independent, which would be the case in a random failure, the conditional probabilities are from Equation 12 and Equation 13.

Equation 12 $$P(B/A)=P(B)$$

Equation 13 $$P(A/B)=P(A)$$

The overall probabilities become Equation 14.

Equation 14 $$P(A+B)=P(A)+P(B)-P(A)P(B)$$

As an example, consider a region that has a 10^{-4} probability of impact from a Turbine "A" and a 10^{-5} probability of impact from Turbine "B". From Equation 14, the overall probability of impact is:

$$P(A+B)=10^{-4}+10^{-5}-(10^{-4}\times10^{-5})$$
$$P(A+B)=1.1\times10^{-4}$$

These formulae can be expanded for multiple turbines.

Overall Probability

The overall probability can then be compared to other risks. De Vries (1989) mentions a government policy in the Netherlands of one-in-a-million (10^{-6}) per year risk level for new industrial activities. This is on the same order of present-day industry quality programs, such as "Six-Sigma," with a failure rate objective of three-in-a-million. Previously we discussed rotor failure probabilities on the order of one-in-a-thousand (10^{-3}) to one- in-a-hundred (10^{-2}). If we assume a conservative value of one-in-a-hundred (10^{-2}), this results in a required probability of impact of less than one-in-ten-thousand (10^{-4}) per year.

3.4.2. Rotor Fragment Analyses in the Literature

Eggwertz, Sweden 1981

This is the first documentation of a rotor fragment analysis, and is a comprehensive report on turbine structural safety for the Swedish industry. At the time, megawatt-size turbines were being considered for power production in Sweden. The analysis referenced previous work in Sweden on the possibility of fragment gliding due to spin; however the extension of the fragment flight was considered negligible. For the examination of risk areas, the drag coefficient in the analysis was fixed at 0.5 for lateral and downwind directions, and the lift coefficient was assumed to be zero.

For the probability analysis the blade and azimuth locations were divided into equal spanwise sections and equal weighting was applied to failure at these sections. This allowed for a semi-random probability of failure of the blade at a particular section and at a particular azimuth. A total of 144 fragment releases were modeled. A discussion was made of the probability of rotor failure, mentioned in the Rotor Failure section, but no criteria were applied in the final analysis.

The discussion of the physics and probability of impact is very detailed. The risk area included considerations of sliding and rotation of the rotor fragment. The fragment was assumed to translate on the ground and come to a complete stop due to friction. The area surrounding the turbine was divided into 10-m rings and the fragment impact area within the ring was divided by the total ring area. The probability calculated assumes equal probability of launch for all wind directions. The result was the risk level that a target within a ring will be hit.

The overall analysis was conducted for a 39 m radius machine at an 80 m hub height operating at 25 rpm in a 7 m/s wind speed. This was considered to be the most likely operating condition. Assuming that a failure had occurred, the probability was high at the tower base and then relatively even at 10^{-3} until 200 m. The analysis showed the probability of impact from any fragment dropped off dramatically (below 10^{-5}) at 220 m. This throw distance is 1.8 times the overall turbine height. The throw distance for a probability of 10^{-4} is only slightly less than this value. The dramatic drop off in the probability at 220 m was used as a basis for the safety area around the turbine; however, the calculations were made at nominal operating conditions and at a single wind speed. Failures in an overspeed conditions would increase this area.

Montgomerie, Sweden 1982

Montgomerie (Montgomerie 1982) expanded on Eggwertz's work by modeling the fragment with a full six-degrees of freedom. The aerodynamic model is not explained but is referenced from an unpublished thesis in Sweden. Similar work would later be developed by Sørensen (1984a).

Montgomerie presents results for an example turbine similar to Eggwertz's. The break at the rotor and the azimuth at break are treated with equal probability. However, the new model includes a wind speed and wind direction distribution from the wind turbine site. The normally circular hazard contour is only made slightly oval with the wind direction distribution. The maximum throw distance for the example exceeds 1600 m and the distance for 10^{-4} probability is 1500 m. These values are much greater than Eggwertz's results; however, there is no explanation for the discrepancy between them. The results are also relatively higher than results presented by other researchers.

Macqueen, United Kingdom 1983

This work was conducted in the United Kingdom for the Central Electricity Generating Board. As in Sweden, the United Kingdom was considering generating electricity with megawatt-size wind turbines. Macqueen starts by bounding the problem with an analysis of the maximum launch velocity of a rotor fragment being limited by the approach of the speed of sound. An estimate of the maximum velocity is 310 m/s in an extreme overspeed condition for a typical turbine. The fragment distance would not exceed 10 km using classical ballistics results with no aerodynamic drag. It is unreasonable to expect setback criteria of this distance; the turbine rotor would probably fail at a much lower velocity, plus the aerodynamic drag acting on the fragment would greatly reduce the distance. However this provides an upper extreme limit.

The analysis followed the same lines as Eggwertz with analysis of gliding and tumbling and classical ballistics with average lift and drag coefficients. The tumbling analysis was to determine the conditions for stable, gliding flight of a fragment. Macqueen reasoned that the flight time of a fragment was several times longer than one tumbling period and therefore stable flight could not be expected. However gliding was considered as a rare case if the fragment did not leave with sufficient rotational energy. For the tumbling case, Macqueen reasoned a C_L of 0.0 and a C_D of 1.0. For gliding, lift was chosen as C_l = 0.8 and C_D= 0.4. Macqueen estimated the probability of gliding occurring in a potential failure at 10^{-2} to 10^{-3}.

Macqueen also included a discussion of a three-dimensional model of fragment flight, and concluded that the model did not show the fragment achieving a stable gliding condition. Macqueen concludes that the effect of lift in the three-dimensional case increases the range of flight by no more than 10%.

A series of runs at equally spaced azimuthal positions were used to develop the probability distributions. The possibility of sliding after impact was not addressed in the current work. He then separated the analysis into two failure events, one at a 10%

overspeed at average winds, the other at the maximum possible release velocity with an extreme gust. The turbine studied was of similar geometry to the MOD-2, with 91 m diameter rotor and 61 m hub height.

The probability of impact is weighted by area (per square meter), and assumes equal distributions in all directions. Probability distributions showed peaks near the tower and at the maximum range, similar to the results of the simplified model in Figure 7. The probability of impact was then a function of the target and fragment size. Macqueen reasoned that the rotor fragments would be large compared to target, making the probability independent of target size; however this would not be the case with a busy roadway, with many targets over a large area.

For overall probabilities Macqueen used the Eggwertz probability of 10^{-5} for rotor failures. Macqueen also compared the probabilities to a statistic of risk of death by lightning strike in the United Kingdom at 10^{-7} per year. For the turbine studied, a large 2.5 MW unit, the risk of being hit by a rotor fragment within 210 m (approximately two times overall height) is equivalent to being struck by lightning. However, these results were based on the rotor failure probability of 10^{-5} and the assumption of a target size less than the overall fragment area.

Sørensen, Denmark 1984

This investigation was part of the wind power program of the Ministry of Energy and the Electric Utilities in Denmark. The conference paper (Sørensen 1984b) was a summary of the full report in Danish. Detailed sensitivity studies are found in the Wind Engineering paper (Sørensen 1984a). The analysis is unique in that the aerodynamics of the fragment under ballistic motion was fully modeled. Sørensen used synthesized data from a NACA 0012 wing to simulate the fragment under various alignments. The blade fragment was broken into segments and the aerodynamic forces were determined independent of each other. The total force was then a summation of the individual forces. This approach is similar to current state-of-the-art modeling of wind turbine rotors in the industry. Three turbines of increasing size were studied.

The modeling showed that the fragment tumbling motion decayed as it reached the maximum height with the heavy end directed down as the fragment fell back to earth. This behavior was also described by Eggwertz in scaled model studies. The model behavior places into question the pure tumbling and constant aerodynamic coefficients of the other models. Comparison with these models showed that the average drag coefficient for the lateral throw would have to be varied from 0.15 to 0.4 to achieve similar results to the full aerodynamic model. These coefficients are lower than what has been considered by the other researchers. For the downwind range, the constant coefficient models predicted a much lower distance. Therefore, constant coefficient models would tend to predict shorter overall throw distances compared to Sørensen's method.

The *Wind Engineering* paper went through several sensitivity studies of the modeling parameters. A summary of these studies is presented in Table 4.

Table 4. Sensitivity studies by Sørensen in *Wind Engineering* paper

Subject	Description	Results
Airfoil Data	Analysis conducted on four airfoil data sets	7% spread in maximum range
Aerodynamic Unsteadiness	Dynamic aerodynamic loads modeled	12% reduction in maximum range with unsteady model
Autorotation	Model tendency of fragment to glide like helicopter rotor	Substantial reduction in range
Center of Gravity Location	Vary chordwise center of gravity position on fragment	Negligible effect for typical 25-35% chord line placement
Blade Pitch Angle	Blade pitch angle at moment of release	Large influence; pitch of maximum thrust had maximum range
Wind Velocity	Ambient wind velocity at moment of release	Large influence, partially due to dependence on pitch angle effect

The impact probabilities reported in the conference paper (Sørensen 1984b) assumed the target as a one-meter sphere. Sliding of the wreckage was assumed, with 25 meters of slide assumed for a throw greater than 75 m range. As stated before in the Macqueen (1983) discussion, these probabilities would have to be adjusted for targets larger than the blade fragment, such as a busy roadway, or a dwelling. The probability analysis followed the same approach as Eggwertz (1981) by dividing the region around the turbine into ring segments. Uniform wind direction was assumed.

Probabilities were only presented for the Project "K" turbine for a full 30-m blade throw and 10-m blade fragment throw. This turbine is of 1.5 to 2.0 MW size with a 60 m hub height. Release angle and wind speed were varied and multiple throws were calculated. The probabilities were presented as a function of tip speed. Results are shown in Figure 8, comparing the range with 10^{-4} probability (the "risk" range) to the maximum range.

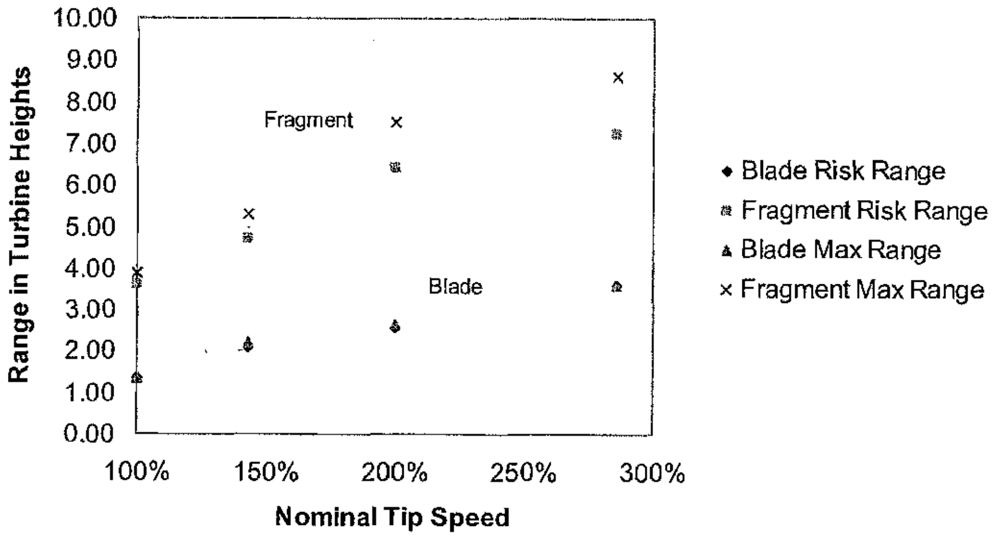

Figure 8. Throw distances in Sørensen conference paper with 1×10^{-4} probability risk range

The maximum ranges do not increase exponentially as would be predicted for a vacuum in Equation 4. This is the result of including the aerodynamic forces. Also, there is negligible difference for the full blade maximum range and range with 10^{-4} probability. This is not true for the fragment.

Turner, United Kingdom 1986 and 1989

Turner's (1986) work was a further expansion of MacQueen's work. He starts by developing a model of the probability similar to that in Section 0. He uses this model to form conclusions of the overall statistics of the more advanced problem. He used a Monte Carlo method to run simulations of fragment throws with the simple model, and then performed a chi-squared test with the exact solution of the simple problem to show the validity of the Monte Carlo method. He also developed a method to determine confidence levels after a certain number of throws so that an appropriate number of throws can be determined.

Turner assumed a geometric distribution for the probability of the rotor break point. It was assumed that inboard portions of the blade were twice as likely to break as outboard portions. Equal distribution was assumed for the azimuth position of break. For impact, he developed a bouncing model that he considered conservative based on data from artillery tests. He used a cutoff angle of 20° above which bouncing was not permitted. He also used Eggwertz model for sliding after impact.

Turner later expanded on his work to include a six-degree of freedom model of the fragment (Turner 1989). His model dynamics were similar to (Montgomerie 1982). The aerodynamic model used two-dimensional airfoil data with no adjustment for off-axis flow. A small drag value was added for spanwise flow. He presented results of Monte-Carlo simulations for several model conditions.

Eggers, United States 2001

This is the most recent analysis (Eggers, Holley et al. 2001) generated for the National Wind Technology Center in Colorado. The analysis used classical ballistic theory and assumed constant values of aerodynamic force coefficients. A discussion and analysis is made of the possibility of gliding flight assuming the blade achieves a stable gliding angle; it is assumed negligible. The low probability of this is reasoned due to the complex geometry of the blades, with varying chord, airfoil section, and twist. The mean values of drag ($C_D = 0.5$) and normal force coefficients are considered constant during flight. Half and full-blade fragments are analyzed.

An example turbine was studied with a 15.2 m rotor radius operating at 50 rpm in 11.2 to 22.4 m/s winds. A probability distribution, assuming equal weighting for all directions, was determined analytically and solved numerically. This method was unique in that several trials of throws were not necessary to obtain the distributions. Also assumed was that the failure was the result of an overspeed, and that the range of the overspeed failure was a Gaussian distribution between 1.25 and 1.75 times the nominal speed. Eggers, like Macqueen (1983), confirms peaks in the probability distribution near the tower and at maximum range. Two tower heights were also studied, showing higher probability at the tower base for the shorter tower. Probability values cannot be determined from the paper due to the limited resolution of figures.

3.4.3. Comparisons of Rotor Fragment Analyses

Studies of example turbines were performed in all the analyses discussed previously. A comparison is shown below in Figure 9. The maximum attainable lateral throw distance, normalized by overall turbine height, for a failure at nominal operating conditions is shown for the various analyses. The results show the drop in the normalized maximum throw distance with increasing turbine size.

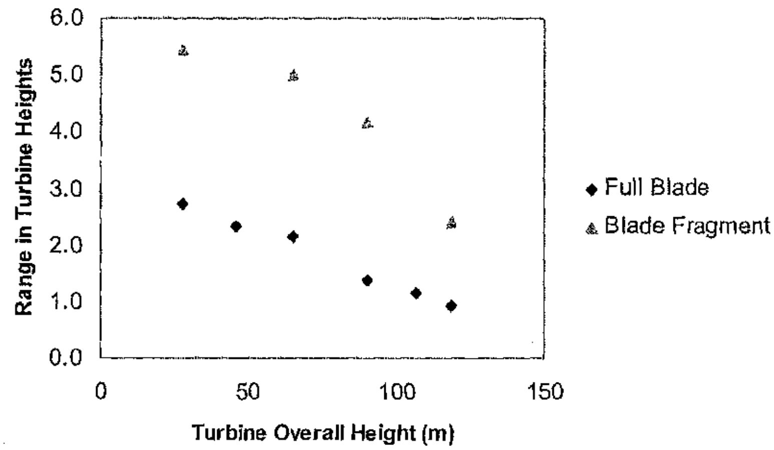

Figure 9. Comparison of rotor fragment analyses for maximum range at nominal operating conditions

4.0 Conclusions and Recommendations

4.1. Conclusions

This study was performed on setbacks for permitting of wind energy. Counties with past and future development of wind energy have setbacks based on overall turbine height. A simple example was presented showing the negative economic impact of setbacks based on size for modern turbines. The application and size of the setbacks varied widely across the counties. However, a common setback is three-times the overall turbine height from a property line.

Most setbacks were established early in the development of the wind industry and were outcomes of ad hoc groups of government and industry. Other counties followed suit based on the example of the early developments. There is some evidence for Riverside County that the "three-times" rule may have been an outcome of expected spacing to reduce waked operation losses. There is no evidence that setbacks were based on formal analysis of the rotor fragment risk.

CWEC also studied the probability of wind turbine rotor failure. Reporting of wind turbine failures are scarce in the literature, but available data from Alameda County and Europe show rotor failures from approximately one-in-one-hundred (10^{-2}) to one-in-one-thousand (10^{-3}) per turbine per year. The most comprehensive study from the Netherlands reported failures for European turbines of approximately one-in-one thousand (10^{-3}) per turbine per year.

Six studies examined modeling of the rotor fragment risk in detail. Several researchers analyzed but discounted the possibility of gliding flight, and instead used simplified aerodynamic models. Sørensen (1984a) used a three dimensional analysis of the rotor fragment flight and showed the limitations of the simplified models. The literature does not offer any guidance for applying setback distances that would be useful for wind energy planning.

Two observations can be made from a comparison of the analyses with failure at the nominal operating condition. The first is that as the overall turbine height increases, the range normalized by overall height decreases. This is primarily because the maximum range is dependent on turbine tip speed. As discussed previously, the tip speed has remained nominally unchanged as turbine size has increased. The other conclusion is that blade fragments fly farther than full blades. This is because the initial velocity at failure tends to be higher for the fragment than the entire blade. This result indicates that setbacks based on overall turbine height may be reduced for larger turbines.

4.2. Recommendations

The setback literature reviewed in this report does not provide an analytical rationale for determining wind turbine setbacks. However, after reviewing the literature for analysis of the rotor fragment hazard, CWEC proposes the following items to develop guidelines for setbacks.

4.2.1. Rotor Failure Rate and Operating Conditions at Failure

The rotor failure probabilities presented by Rademakers and Braam in Appendix A represent the most comprehensive study. The values presented in Section 3.3.4 should be used for analysis of the overall hazard. These values are organized by rotor speed, which can be used to set the release velocity at failure. However, the wind conditions at failure are not known. Simulations can be performed at several wind speeds, and either the worst case could be used, or the results can be weighted by a standard wind speed distribution.

Turbine Sizes

A mixture of turbine sizes should be studied to determine if setbacks should be a standard distance or a function of the turbine size. Turbine sizes currently marketed are 660 kW to 5 MW. Smaller turbines should be studied for stand-alone applications and review of existing hazards.

4.2.2. Position of Blade Break

Since the position of the failure cannot be predicted with certainty, the approach of Eggwertz (1981) to divide the blade into sections should be used. In addition to randomizing the break position, turbines with blade components such as aerodynamic devices, blade dampers, and lightning protection should be studied as fragments.

4.2.3. Aerodynamic Model

The methods of Sørensen (1984a) should be applied for the aerodynamic model. This model was the most comprehensive and showed the limitations of constant aerodynamic coefficient models. The model is well documented and can be updated to modern programming languages. There was an effort to update this program to MATLAB© at the Technical University of Denmark (DTU); however the status of this work is unknown.

Further studies could be conducted to incorporate shear and turbulence into the model. With these effects included, the rotor fragment might exhibit constant lift coefficient and drag coefficient behavior which might warrant use of simpler models.

The model should be built as a tool that can be used by the industry for use on any turbine to study specific cases, such as permitting waivers.

4.2.4. Impact Modeling

The methods of (Turner 1986) and Eggwertz (1981), or Sørensen (1984a) should be used to model the physics at impact. The methods include bouncing at impact and the effects of rotation and translation after impact.

4.2.5. Slope Effects

Slope effects were not included in the reviewed analyses. Because of the common placement of turbines on ridgelines, as in the Altamont and the Tehachapi wind resource areas, modifications to the setback distance should be studied. Modifications should be stated in simple language, similar to the language in the Alameda ordinance.

4.2.6. Validation Effort

None of the analyses have been validated with actual failures. Validation with an actual failure can be made with the following information:

- Turbine tower height
- Rotor diameter
- Position of failure on rotor
- Azimuth of failure (would be very hard to obtain)
- Rotor speed
- Pitch of blades
- Geometric details of the fragment (planform, airfoils, weight, center of gravity, twist distribution)
- Wind speed, direction, and local air density
- Distance and bearing of blade or fragment from tower base

Another effort would be to deliberately cause a rotor failure and obtain the above information. This test could be conducted on a turbine at the end of its useful life in a clear field. Explosive bolts or a ring charge could be used to separate the blade or fragment from the turbine. The azimuth at break must be carefully determined.

5.0 Benefits to California

Researchers should use the information as background for developing models of the rotor fragment hazard. California planning agencies should then use this new rotor fragment hazard information, together with the information in this report as a tool for modifying or establishing wind turbine setbacks.

A better understanding of the risks involved with wind energy will permit the development of appropriate methods to manage that risk, thereby increasing the acceptance of wind energy developments by local governments and the general public.

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7.0 Glossary

Specific terms and acronyms used throughout this paper are defined as follows:

Acronym	**Definition**
C_D	Coefficient of drag
C_L	Coefficient of lift
CWEC	California Wind Energy Collaborative
DOE	U.S. Department of Energy
DOF	degrees of freedom
DTU	Technical University of Denmark
EIR	Environmental Impact Report
IEC	International Electrotechnical Commission
kW	Kilowatt (1000 Watts)
m	Meters
m/s	Meters per second
MW	Megawatt (1,000,000 Watts)
NREL	National Renewable Energy Laboratory
RPM	Revolutions per minute
SERI	Solar Energy Research Institute (predecessor of NREL)
WECS	Wind Energy Conversion System

Attachment I

ANALYSIS OF RISK-INVOLVED INCIDENTS OF WIND TURBINES

Version 1.1, January 2005

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1. INTRODUCTION

As part of the project "Handboek Risicozonering Windturbines (Guide for Risk-Based Zoning of Wind Turbines)," research was conducted on incidents involving wind turbines that may pose a risk to their surroundings. This information is used to quantify the failure events, as well as for the development of a method, described in the Guide, to calculate the risks. These risks include blade failure, tower failure, or any other parts of the wind turbine falling off. In order to determine these risks, it is necessary to understand the possible failure events, and the frequency of these events. Validation of the calculation method is impossible by means of experimentation, but in order to gain sufficient trust in the method it is necessary to have information on what part of the blade has fallen off, its size, and the distance it traveled after separation from the turbine.

To determine the failure frequency of blades, towers, and other parts of a particular wind turbine, the ISET (Institut für Solare Energieversorgungstechnik) in Germany and the EMD (Energie- og Miljødata) in Denmark have provided information [1,2]. Both institutes have a database containing energy production, incident, and maintenance information for most of the wind turbines in Germany and Denmark, respectively. Incidents and occurrences of importance are selected based on the raw data that is extracted from the ISET and IMG databases, in order to obtain insight into possible failure events. This information is also used to determine the frequency of failure events per year, as well as to provide information about the uncertainties. In this appendix the extracted data from the ISET and EMD databases are combined and then applied to calculate failure frequencies.

A supplementary study was conducted based on the throw distance, dimensions of thrown parts, etc. Based on information from the internet, magazines, and detailed information in ISET and EMD reports, a summary of incidents and the related throw distances for different types of turbines was made. The results of this research are included in this appendix.

When reading this report and applying the information in it, it is important to keep in mind the following:

- The data, particularly the number of incidents, are never complete. Not all incidents are reported or known to the ISET, EMD, or ECN. To prevent this from leading to false results, the population of wind turbines for which statistics are calculated is specifically chosen so that all incidents involving these turbines are known.
- It is not always possible to determine the way an accident developed. Sometimes it is clearly reported that a blade (or two blades) has broken off and landed 100 m from the turbine. Sometimes it is only reported that a blade has been damaged and replaced, without any reports of pieces that may have broken off and been thrown from the

turbine. In cases where the extracted data were incomplete, a suitable conservative interpretation of the data was applied.

Based on the information, five separate categories have been determined that are of importance for the risk analysis.

1. Whole turbine blades or very large blade pieces breaking off and being thrown.
2. Brake tips and other blade pieces such as blade surface panels, composite material, bolts, etc. being thrown from the turbine.
3. Tower collapsing.
4. Large parts, such as the nacelle, the whole rotor, or other main components, falling down.
5. Small parts, such as the anemometer or bolts, falling down from the nacelle or the hub.

The reasons for this classification are as follows.

1. A blade that has broken off can be thrown relatively far and has a large mass. It can cause relatively heavy damage to another object.
2. A brake tip or a small part of a blade can be thrown very far. Because it has a small mass, the chance of doing damage to another object is smaller than that of an entire blade.
3. The collapse of a tower usually means great risk to anything in close proximity of the turbine. The entire turbine has an extremely large mass and can therefore cause heavy damage to anything close to the turbine.
4. Similarly to the tower collapse, the fall of a large component such as a nacelle can cause heavy damage to anything close to the turbine.
5. Small parts that fall down cannot cause heavy damage. The risk area for this situation is limited to just a few meters from the tower.

Each category requires a different approach to the risk analysis.

The shedding of ice is not listed here explicitly. The calculation of vulnerable distance and risks for ice can be based on those for category 2 "brake tips and small parts of blades." The frequency of ice being thrown from a blade is very location dependent and therefore the importance of this phenomenon cannot be determined generally for a turbine. Furthermore, the AMvB [3] stipulates that wind turbines with ice on their blades are forbidden to start up.

In this report the following topics are addressed consecutively:

- Results of the analysis of the EMD database.
- Results of the analysis of the ISET database.
- Calculation of the frequency of failure for the categories listed above.
- Results of the analyses concerning the development of a calculation method for throw distances.
- A summary of the failure frequencies and a recommendation on the application of these values in risk analyses.

2. ANALYSIS OF DANISH FAILURE DATA

2.1 Introduction

Energie- og Miljødata (EMD) has a database that contains approximately 6000 turbines in Denmark. The energy production and failure data are registered for over half of these turbines. The owners of the turbines can voluntarily submit a monthly report to the Danish Association of Turbine Owners. This association performs an initial analysis of the information and then codes it. The data is then sent to EMD. EMD feeds the information into their database. In total, EMD has selected and reported 210 risk involved incidents [1].

The main goal of the analysis of the EMD-provided information is the selection of incidents and the calculation of failure frequencies for the five categories (blades, tips, tower, nacelle and rotor, or small parts). In determining the number of relevant incidents and determining the size of the population of turbines, attention is paid to the following.

- The size of the total population of turbines is not always known. Not all turbine owners submit monthly information. This can mean that there were no incidents, or that the incidents were not reported. In particular, energy production numbers of turbines that belong to electric utilities are submitted monthly, but incidents are seldom or never submitted. Of the remaining turbines, incident reports are regularly submitted with the energy production numbers. EMD has followed a conservative approach, and only included those turbines for which incidents are regularly reported. Most turbines belonging to electric utilities are therefore left out of the analyses. It is very probable that most turbines larger than 1 MW belong to the electric utilities. This is exactly the type of turbine that is most important for future risk analyses.
- Blade fracture is relevant to all turbines; a flyaway tip is only relevant to stall regulated turbines with blade tips. Therefore, the size of the total population can be different for each analysis.
- Most incidents are poorly documented, and the actual number of risk-involved incidents cannot be determined for certain. EMD uses codes to indicate which component failed, the reason for failure, and whether parts were thrown from the turbine. From the codes it is difficult to determine the size of the thrown object, the distance thrown, and the order of events. In some cases this information is included in the comments. Between 1993 and 2000 the code was expanded. Between 1984 and 1992, the code was severely restricted. It was seldom even noted whether a compromised turbine had done damage to the surrounding area. This made it possible for a turbine that had a complete failure and lost many parts (see Fig. 2.1) to be reported exactly like a turbine that had a complete failure and posed no risk to the surrounding area (see Fig. 2.2).

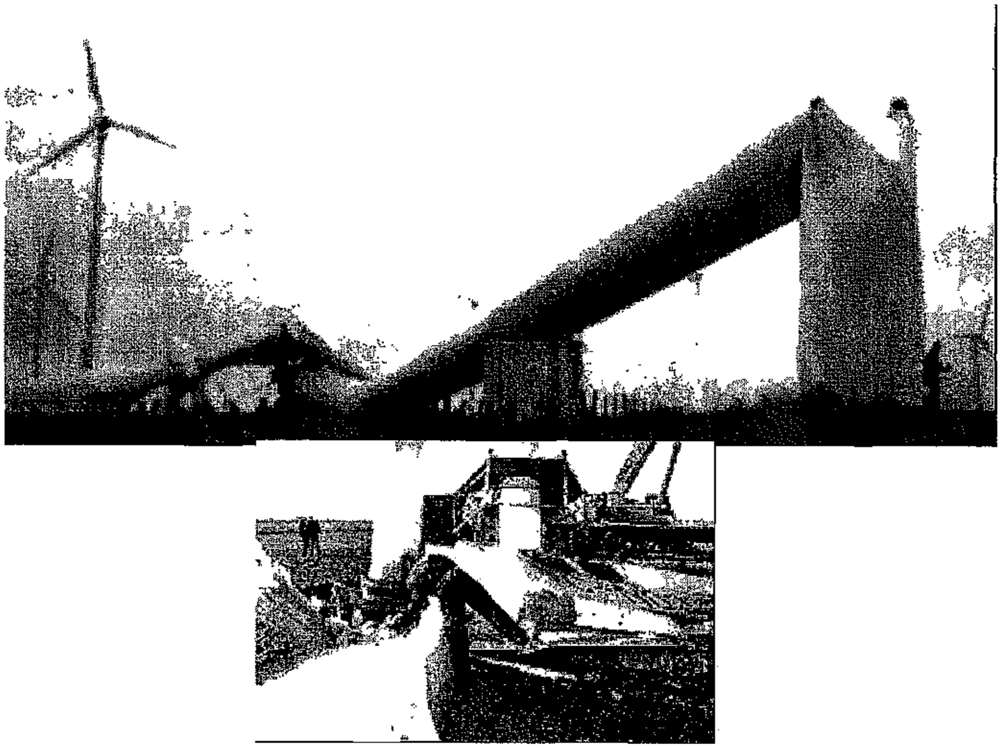


Fig. 2.1: Two examples of incidents that pose possible danger to the surrounding area.

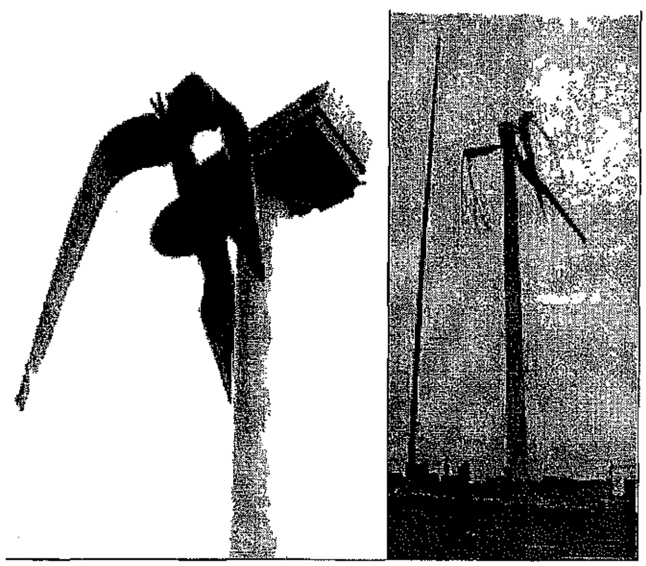


Fig. 2.2: Two examples of turbines that failed, but caused no danger to their surroundings.

2.2 Turbine Population

The turbine population from 1984 through 2000, as provided by EMD, is separated into the different types. The results are presented in Fig. 2.3. At the end of the year 2000 the total turbine population reached about 2900 turbines. The total number of operating years reached almost 30,000. By far the most turbines are stall-regulated turbines.

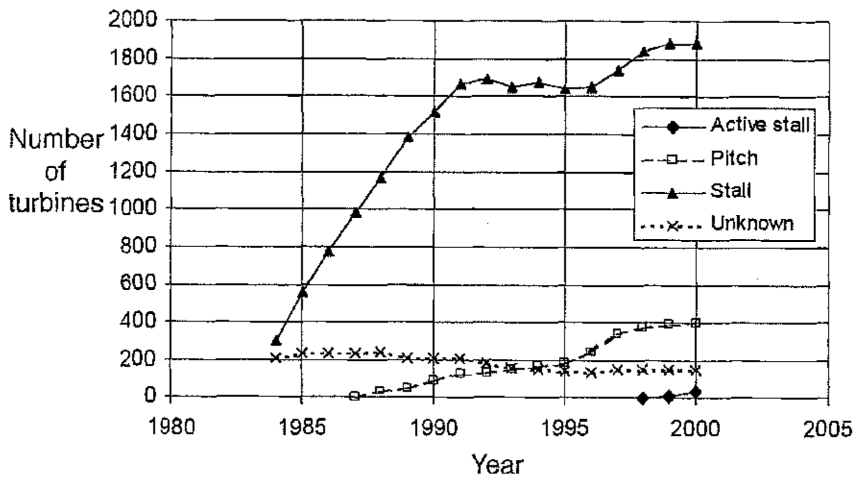


Fig. 2.3: Number of wind turbines in the EMD database, separated by type.

When the turbines are separated into groups based on rated output, the distribution as shown in Table 2.1 is established.

Table 2.1: Number of operating years, separated into groups based on rated output

Rated Output [kW]	Operating Years	Percentage
0 - 50	3229	11.0%
51 - 300	24368	82.8%
301 - 750	1769	6.0%
751 - 1300	47	0.2%
1301 -	0	0.0%
Total	29413	100.0%

2.3 Failures and Incidents

As is briefly discussed in paragraph 2.1, not all incidents are reported with enough detail to make unambiguous conclusions. EMD has created the following four categories to indicate how dangerous an incident is:

3. Definitely dangerous, unambiguously reported
2. May be dangerous, but not for certain
1. Not dangerous, unambiguously reported
0. Necessary information missing

In many cases it appeared difficult to indicate exactly whether a turbine had indeed lost parts as in Fig. 2.1, or was just heavily damaged as in Fig. 2.2. The final results from the selection of risk involved incidents are given in Table 2.2. The total can be seen in Table 2.3. This table includes the total number of operating years for each type. This number is obtained by summing the number of turbines in operation per year over all the years.

Table 2.2: Number of risk involved incidents per year for each regulation type. For each type, number of turbines in operation at that point is given per year.

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Active stall															3	10	30
Blades																	
Tips																	
Turbine, nacelle, large parts																	
Small parts																	1
Pitch				4	35	53	88	126	134	153	170	183	239	339	373	389	399
Blades																	
Tips																	
Turbine, nacelle large parts																	
Small parts																1	
Stall	300	557	772	984	1167	1386	1517	1664	1689	1648	1675	1642	1651	1743	1839	1865	1887
Blades							2	3		2	1	1		1	1		1
Tips									1						1	1	
Turbine, nacelle large parts			1							1						1	
Small parts											5	2	4	1	2	3	2
Unknown	210	230	234	237	245	209	208	207	181	155	152	144	136	150	153	154	150
Blades			1		1												
Tips																	
Turbine, nacelle, large parts				1			1		2								
Small parts																	
Total # turbines	510	787	1006	1225	1447	1648	1813	1997	2004	1956	1997	1969	2026	2232	2368	2438	2466
Total # failures with dropped parts	0	0	2	1	1	0	3	3	3	3	6	3	4	2	4	6	4

Table 2.3: Total of all risk involved incidents, total for all operating years, and the number of operating years for each type of turbine.

	1984-1992	1993-2000	Total
Active Stall	**0**	**43**	**43**
Blades			
Tips			
Whole Turbine			
Small Parts		1	1
Pitch	**440**	**2245**	**2685**
Blades			
Tips			
Whole Turbine			
Small Parts		1	1
Stall	**10036**	**13970**	**24006**
Blades	5	7	12
Tips	1	2	3
Whole Turbine	1	2	3
Small Parts		19	19
Unknown	**1961**	**1194**	**3155**
Blades	2		2
Tips			
Whole Turbine	4		4
Small Parts			
Turbine Years	**12437**	**17452**	**29889**
Total Incidents	**13**	**32**	**45**
Total Suspected Incidents	55	51	106

In the time period between the years 1993 and 2000, in total there were 11 "category 3 incidents" reported, and 66 "category 2 incidents." Based on the information provided by EMD, and after reading the commentary, there appeared to be 51 suspicious incidents; of the 77 total incidents, 26 could be eliminated. Of the 51 suspicious incidents, 32 were proven risky and were included in the analysis. Between 1984 and 1992 there were 55 suspicious incidents, and 13 ended up being included in the analysis.

From the detailed analysis of the incidents, it seems that some cases involved multiple parts breaking off and being thrown. With blades, for example, it is possible for one, two, or three blades to be thrown. In the seven incidents involving blade throw between 1993 and 2000, a total of ten blades were thrown. There were no incidents reported that involved more than one object when it came to the tips and small parts. Clearly when the incident involved the tower or nacelle, only one object can be affected. That is why there is a multiplication factor of 10/7 used in calculating risk for the blades. The total number of incidents and the corresponding population of turbines are tabulated in Table 2.4.

In EMD's report, only failures of the whole turbine were reported; no distinction was made between the categories "nacelle and rotor" and tower failures. When the part listed was the "turbine," it was not immediately clear whether it was the tower or the nacelle that was affected. Later analyses of the raw data, according to tables 2.2 and 2.3, showed that at least 2, maybe even 3, of the 7 incidents involved the whole tower collapsing. That is why in table 2.4 there are half incidents.

Table 2.4: Overview of incidents in the total wind turbine population

Part	84-92	93-00	84-00	Factor	Total	Turbine Years	Notes
Blades	7	7	14	1.4	20	29889	Total number of turbines
Tips	1	2	3	1.0	3	24006	Total number of stall turbines
Nacelle	3.5	1	4.5	1.0	4.5	29889	Total number of turbines
Tower	1.5	1	2.5	1.0	2.5	29889	Total number of turbines
Small Parts		21	21	1.0	21	17452	Total number of turbines between 1993 and 2000
TOTAL	**13**	**32**	**45**				

As can be deduced from the previous paragraphs, determining the number of incidents within the scope of the entire turbine population is done with much uncertainty. The population used by EMD involves mostly three-bladed, stall regulated turbines, with a rated output of up to 750 kW. This population is made up of about 2900 turbines. Future turbines for which the risk analysis is being done will most likely be pitch regulated turbines with an output greater than 1 MW. It is these types of turbines for which EMD has little information. It is not clear if there were indeed no incidents, or if they merely were not reported.

2.4 Trends

Simultaneously the correlation between the age of a turbine and its frequency of failure was researched. For this the 32 critical incidents between 1993 and 2000 were divided into four time periods (0-5 years, 5-10 years, etc.). The number of incidents in each time period is divided by the number of turbines that fall into that category. (Note that determining the population of turbines in each category could not be done with great accuracy. The number of turbines between 0 and 5 years old was determined by subtracting the number of turbines in operation in 1995 from the number of turbines in operation in 2000. It is unclear whether there were turbines taken out of operation or replaced). Most failures were caused by turbines between 5 and 10 years old.

The relationship between the rated-power category of the turbines and their failure frequency was also researched. The number of incidents in each rated-power category is divided by the number of years in operation for each category. No trend is found.

3. ANALYSIS OF GERMAN FAILURE DATA

3.1 Introduction

ISET has made an inventory of "critical losses" that have occurred in Germany over the past 10 years. ISET has defined a "critical loss" in the following way.

A critical loss is a sudden and lasting change in a wind turbine that can potentially or definitely cause damage to the surrounding area. The cause of the change can be due to external sources (e.g. lightning and storm), or internal sources (fatigue).

It is therefore not conclusive that the recorded cases did cause damage to the surrounding area. This inventory is in principle based on the WMEP database (Wissenschaftliches Meß- und Evaluieringsprogramm), which is managed by ISET. Additional information was obtained from technical publications and the internet.

Information from approximately 1500 turbines in Germany has been collected in a systematic manner in the WMEP database since 1989. The results of these 1500 turbines provide a representative overview for the approximately 10,000 total turbines that have been installed in Germany. The database contains over 48,000 entries. In order to facilitate analysis of the database, the above definition for a critical loss is used as a starting point.

Based on this definition, a number of search criteria have been devised for the database. The most important criteria used are:

1. The shutdown of a turbine has to be the result of a failure (preventive maintenance and other planned activities are thereby eliminated);
2. Eligible failure modes are:
   - Storm
   - Lightning
   - Defective component
   - Defective assembly or mounting
   - Other causes;
3. A repair or a replacement is required for one of the following main components:
   - Rotor hub

- Blade
- Nacelle
- Tower

Repairs or replacements of gear boxes or generators are not included, because a failure of these components rarely causes potential danger to the surrounding area.

The automatic search of the database with the aforementioned criteria resulted in 152 matches. These matches are subsequently scrutinized one at a time by ISET, resulting in a further reduction of the number of incidents. This finally resulted in 43 cases that could actually be reported as involving serious damage.

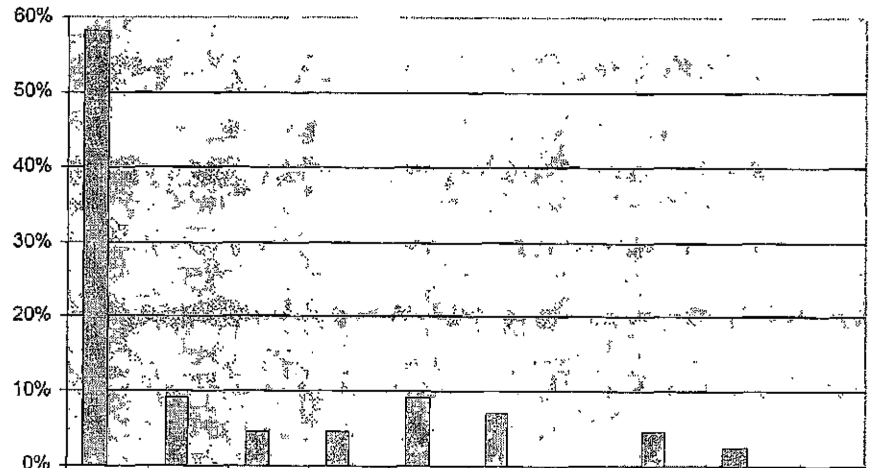
These 43 cases involve the time period from 1991 until July 2001.

3.2 Turbine Population

The total number of operating years of all 1566 wind turbines included in the database at the end of July 2001 was about 13,000 years. The 43 serious damage incidents correspond to 0.33 critical incidents per 100 operation years.

3.3 Failures and Incidents

The 43 cases of turbine damage from the WMEP database are arranged by type of damage. The results are presented in Figure 3.1.



	Blade damage	Burned down	Blade break	Nacelle fall	Other failures	Rotor break	Tower collapse	Over-speed	Total loss	Total
	58%	9%	5%	5%	9%	7%	0%	5%	2%	100%
Number	25	4	2	2	4	3	0	2	1	43

Fig. 3.1: Type of damage for 43 cases involving serious damage.

Blade fracture, rotor failure, nacelle fall, and tower collapse are all of importance to risk analyses, because it is these phenomena that can cause damage to people or objects in the nearby surroundings. The other types of damage result only in economic damages.

With regards to blade fracture, there has been one report of a case where one blade broke off the turbine. For the second case, no information is given on the number of fractured blades. For further analysis, a conservative conclusion was made that all three blades had fractured. So, in total, there were four broken blades in the two cases of blade fracture.

Three cases of rotor failure were reported. With this type of failure there are a few possibilities:

1. The rotor failure causes the blades to break off and to be thrown from the turbine.
2. The rotor breaks off and falls from the turbine. The parts fall close to the turbine and the effects are similar to those of a fallen nacelle.

One case was reported that involved blades striking the tower, and then breaking off. As a result, the number of cases of blade fracture becomes seven. In the other two cases it was reported that damage was found, but not whether blades were broken or a rotor fell. For these two cases it is assumed that it was the rotor that fell. It should be noted that there is no mention of brake tips falling, or of small parts falling from the nacelle or hub.

The total number of critical turbine damage cases that are relevant to the risk analysis is shown in Table 3.1. The research done by ISET focused on critical cases, therefore there is no information on small parts. Nowhere is there mention of brake tip failure.

Table 3.1: Number of critical turbine damage cases with the potential to cause danger to the surrounding area

Part	Number	Turbine Years
Blade separation	7	13000
Fallen nacelle and/or rotor	4	13000
Tower failure	0	13000

3.4 Trends

From the analysis conducted by ISET, the following trend develops. Lightning seemed to cause a great percentage (34%) of the heavy damage to turbine blades. However, as the blades include better lightning protection systems, the number of heavy damage cases decreases significantly. Now lightning causes only limited damage to the blade surface, near the receptors which during preventive maintenance can be repaired.

4. FAILURE FREQUENCIES

In Chapters 2 and Chapter 3 overviews are given for the total number of incidents per turbine part. The failure frequencies are calculated based on all reported incidents, from the EMD database as well as the ISET database. Table 4.1 gives an overview of the total number of incidents, and the number of turbine-years for which the incidents have relevance.

Table 4.1 also gives the calculated failure frequencies. The expected failure frequency value for each part is calculated by dividing the total number of incidents by the number of relevant turbine-years. It appears that the number of incidents is small compared to the number of turbine-years, so the calculated expected value has a non-negligible uncertainty that can be quantified by the probability density function of the expected value. The occurrence of a particular incident can be modeled with a Poisson process. In a Poisson process there is an invariable chance of an incident occurring in time. For *n* incidents in *T* turbine-years, the probability density function for the failure frequency per turbine-year, $f(\lambda)$, is given by the Gamma function [4], or

$$f(\lambda;\alpha,\beta)=\frac{\beta^{-\alpha}\lambda^{\alpha-1}\exp\left(\frac{-\lambda}{\beta}\right)}{\Gamma(\alpha)}$$

where

$$\alpha = n$$

$$\beta = 1/T$$

Next to the expected value in Table 4.1 is also listed the 95 % upper limit for the failure frequency.

Table 4.1: Failure frequencies per part.

Part	Total EMD and ISET		Failure Frequency [1/turbine-year]	
	Number	Turbine years	Expected Value	95% upper limit
Blades [1])	27	42889	$6.3*10^{-4}$	$8.4*10^{-4}$
Tips	3	24006	$1.2*10^{-4}$	$2.6*10^{-4}$
Nacelle	8.5	42889	$2.0*10^{-4}$	$3.2*10^{-4}$
Tower	2.5	42889	$5.8*10^{-5}$	$1.3*10^{-4}$
Small Parts	21	17452	$1.2*10^{-3}$	$1.7*10^{-3}$

[1]) Failure frequency is based on total number of turbine-years, so this indicates the chance of blade failure per turbine per year.

5. ANALYSIS OF INCIDENTS AND THROW DISTANCES

In addition to determining the failure frequencies of blades, tips, turbines, and small parts, attention was also paid to accident scenarios. To calculate the risk turbines pose to their surroundings, it is important to know what throw distances are probable and how large the separated parts are. Therefore, an analysis was done of incidents and accidents that are published in detail, for which the following sources are consulted:

- http://wilfriedheck.tripod.com/unf.htm
- http://querulant.com/querulant/wind
- http://home.wxs.nl/%Ewindshnieuws.htm
- http://home.wxs.nl/~hzwarber/wind/feiten/veilig.htm
- Energie- en Milieusp. 4-95
- Windnieuws ODE 94/1
- Windnieuws ODE 94/2
- Windnieuws ODE Febr. 95
- Windnieuws ODE April 95
- Windnieuws ODE Jan. 96
- Windnieuws ODE Juni 96
- Windnieuws ODE Sept. 96
- Duurzame Energie Dec. 95
- Duurzame Energie Febr. 95

The results of the analyses are presented in Figures 5.1 through 5.4. In these figures, one for each type of incident, the reported throw distance is presented (x-axis) as a function of the rated power (y-axis). The curves in each graph relate the approximate rotor diameter associated with corresponding rated power level. The curves are added to put the throw distances in perspective.

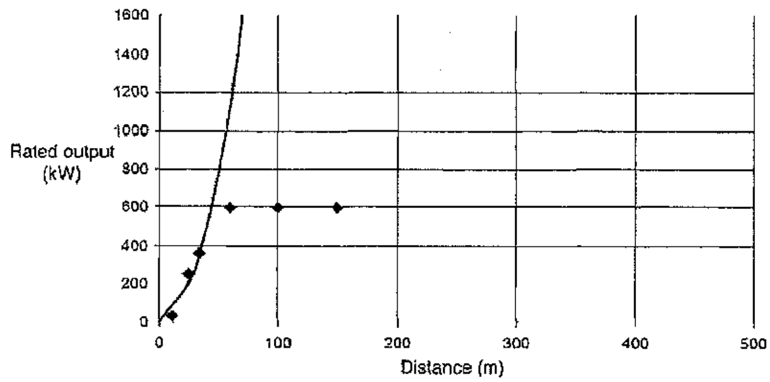


Fig. 5.1: **Throw distance of entire blades as a function of the rater power output, the drawn line gives the rotor diameter.**

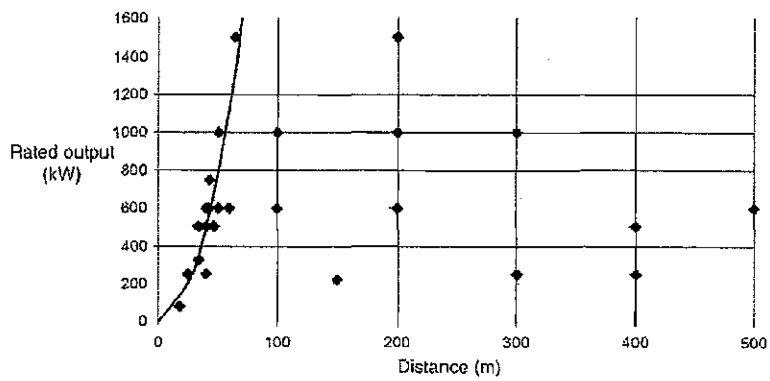


Fig. 5.2: **Throw distance of tips and small blade pieces as a function of the rated power output, the drawn line gives the rotor diameter.**

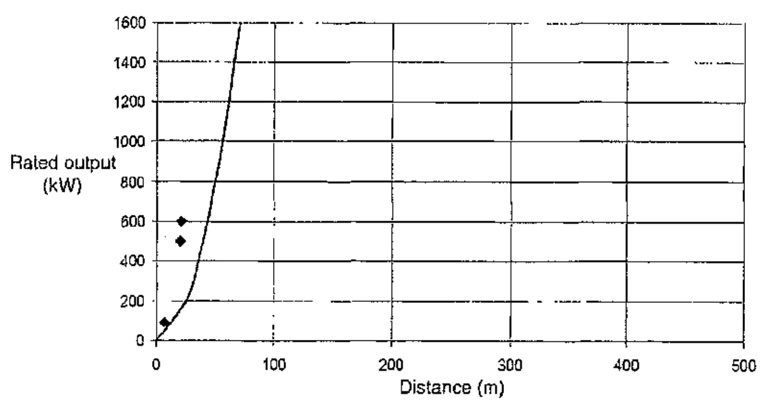


Fig. 5.3: **Throw distance due to fall of nacelles and rotors, as a function of the rated power output, the drawn line gives the rotor diameter.**

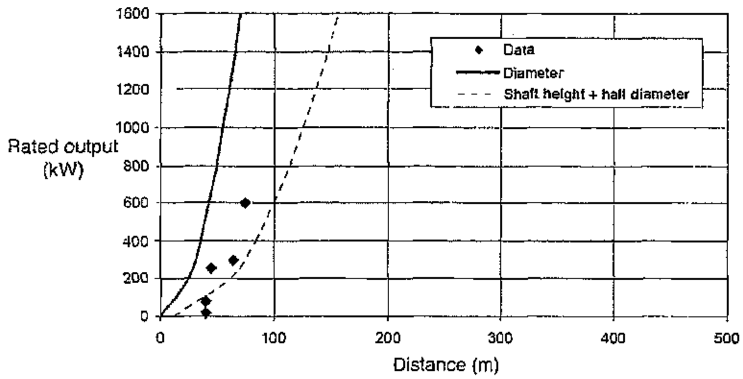


Fig. 5.4: Throw distance due to tower collapse as a function of the rated power output, the drawn line gives the rotor diameter. The dotted line gives the shaft height plus rotor radius (half diameter).

The following can be concluded from Figures 5.1 through 5.4.

- Small blade parts and tips can fly very far. The maximum distance reported is 500 m.
- The maximum throw distance of an entire blade found during this analysis is about 150 m. Distances of 400 and 600 meters for entire blades were also reported in publications. Nevertheless, attempts to confirm these numbers through contacting the owner or the publisher were unsuccessful.
- When a rotor or nacelle falls down, the risk zone is approximately equal to half a rotor diameter.
- When an entire tower fails, the risk zone is equal to the height of the tower plus half a rotor diameter.

6. CONCLUSIONS

6.1 Recommended Risk Analysis Values

ECN has analyzed the reported incident information for a large population of wind turbines in Denmark and Germany and determined the frequencies of:

- Blade fracture;
- Tips and other small parts breaking off;
- Tower failure at the tower root;
- Rotor or nacelle falling down;
- Small parts falling from the rotor or nacelle.

The chance of blade fracture is further separated into:

- Failure at nominal operating rpm (revolutions per minute);
- Failure during mechanical braking;
- Failure due to overspeed.

The ECN also did an in-depth study of the possible throw distances due to turbine failure. The results of this analysis are summarized in Table 6.1.

Table 6.1: Failure frequencies and maximum reported throw distances

Part	Failure frequency per turbine per year			Maximum throw distance [m] (reported and confirmed)
	Expected Value	95% upper limit	Recommended Risk Analysis Value [1/yr]	
Entire blade	$6.3*10^{-4}$	$8.4*10^{-4}$	$8.4*10^{-4}$	150
Nominal rpm			***$4.2*10^{-4}$***	
Mechanical braking			***$4.2*10^{-4}$***	
Overspeed			***$5.0*10^{-6}$***	
Tip or piece of blade	$1.2*10^{-4}$	$2.6*10^{-4}$	**$2.6*10^{-4}$**	500
Tower	$5.8*10^{-5}$	$1.3*10^{-4}$	**$1.3*10^{-4}$**	Shaft height + half diameter
Nacelle and/or rotor	$2.0*10^{-4}$	$3.2*10^{-4}$	**$3.2*10^{-4}$**	Half diameter
Small parts from nacelle	$1.2*10^{-3}$	$1.7*10^{-3}$	**$1.7*10^{-3}$**	Half diameter

6.2 Closing Remarks

Until now ECN, NRG, and KEMA and other organizations have conducted various risk analyses. The failure frequencies used for these analyses were derived from a study of Danish failure frequencies like those published between 1990 and 1992 in WindStats with the expected values for the failure frequencies of blade fracture per turbine split up into:

- Failure at nominal operating rpm — $1.3*10^{-3}$ per year
- Failure during mechanical braking (~1.25 times nominal rpm) — $1.3*10^{-3}$ per year
- Failure by overspeed (~2 times nominal rpm) — $5.0*10^{-6}$ per year

The total chance of blade fracture per turbine was $2.6*10^{-3}$ per year. The analysis of the new failure information shows that this chance is decreased by a factor of 3.1 to $8.4*10^{-4}$. The recommended risk analysis value is 3.1 times smaller than the one used in the past.

Failure during overspeed is not reported in either ISET's or EMD's data. The ISET data did reveal that two incidents led to a long-lasting overspeed situation. The chance of this happening is therefore 2/13,000 = $1.5*10^{-4}$. The blades stayed in one piece in these situations. Until now the chance of overspeed was determined by multiplying the chance of electric grid failure (5 times per year), the chance of failure of the first brake system (10^{-3} per claim), the chance of failure of the second brake system (10^{-3} per claim), and the chance of blade fracture in this situation (=1). Here it is recommended to retain the old calculation value for blade fracture during overspeed, as $5.0*10^{-6}$ per year.

Information about the tower failures was until now never derived from failure frequency databases. Until now the assumption was made that the chance of a tower failure had to be at least ten times smaller than that of a blade failure because it goes nearly unreported. The calculation value of $1.0*10^{-4}$ was used. The new calculation value based on the 95% upper limit is 1.3 times larger than the value that was used in the past.

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Permitting Setbacks for Wind Turbines in California and the Blade Throw Hazard

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1 Summary

The California Wind Energy Collaborative has been tasked to look at barriers to new wind energy development in the state. Due to the visibility of wind energy and its community impact, planning commissions in the state have developed setback standards to reduce the hazard of blade failures resulting in projectiles. These standards are usually based on overall turbine height. New developments with larger, modern wind turbines can be "squeezed out" of parcels thus reducing the economic viability. Current setback standards and their development are reviewed. The blade failure probability is discussed and public domain statistics are reviewed. The available documentation shows blade failure probability in the 1-in-100 to 1-in-1000 per turbine per year range. There is no indication of improvement of this statistic with new technology. The analysis of the blade throw event is discussed in simplified terms. The range of the throw is highly dependent on the release velocity, which is a function of the turbine tip speed. The tip speed of wind turbines do not tend to increase with turbine size, thus offering possible relief to setback standards. Four independent analyses of the blade throw hazards were reviewed. The analyses do not particularly provide guidance for setbacks. Recommendations are made to use models from previous analyses for developing setbacks with an acceptable hazard probability.

2 Glossary

Specific terms and acronyms used throughout this paper are defined as follows:

Acronym	Definition
C_D	Coefficient of Drag
C_L	Coefficient of Lift
CWEC	California Wind Energy Collaborative
DOE	U.S. Department of Energy
EIR	Environmental Impact Report
IEC	International Electrotechnical Commission
kW	Kilowatt (1000 Watts)
m	Meters
m/s	Meters per second
MW	Megawatt (1,000,000 Watts)
NREL	National Renewable Energy Laboratory
RPM	Revolutions per minute
SERI	Solar Energy Research Institute (predecessor of NREL)
WECS	Wind Energy Conversion System

3 Introduction

California has played a pivotal role in the creation and evolution of the wind power industry. Wind power is unique in the visibility and exposure to the public as compared to other forms of power generation. By necessity, communities have become involved in planning for the development of wind power in their jurisdiction. Both the regulation and technology of wind power evolved together in the last two decades.

Particular attention was made to protect the public from hazards. With the advent of a new technology, the probability of failure is high because the physics are not well understood. The engineering of the technology must also be balanced with economics, and the balance is very tenuous at the beginning of a new venture. Equipment and business failures plagued the industry in the last two decades, and legacy equipment still fails at a high rate today.

One hazard possibility of wind turbines is the failure of the blade resulting in projectiles. Concerns over public exposure to this risk led the counties to develop setbacks from adjacent properties and structures. The development of county ordinances took place independently of each other; however in most cases the fledgling wind power industry was involved in the development (McClendon and Duncan 1985). In general, the setbacks were based on the heights of the turbines.

Utility scale turbines installed in California have evolved from 50 kW machines of 25 m overall height to 1.8 MW machines of 100 m overall height. The nature of that evolution, in general, is that manufacturers stop production of smaller turbines due to improved economics of the new larger turbines. With increased overall height, the setback is increased, and modern turbines can be "squeezed out" of developments.

The California Wind Energy Collaborative (http://cwec.ucdavis.edu/), through its "Windplant Optimization" task, has been directed to prepare this white paper on permitting issues in regards to the blade throw hazard. The concern over restrictions on development was the impetus to study current ordinances and the blade throw hazard. Two possibilities offer the potential for relief in this area. Modern wind turbines might offer higher reliability, thus lowering the risk of blade failure. Second, in the event of a blade failure, the hazard area is governed by the blade tip speed. This tip speed has not changed, and in some cases is reduced for modern turbines. Therefore, more appropriate setbacks might be a fixed distance, and not a function of the turbine size. These possibilities, along with background research, are discussed in this report.

4 California Zoning Ordinances for Wind Energy

One objective of this white paper was to report on current permitting issues with regards to setback issues. Research was conducted to document the current setback requirements and determine how they were developed. The research was narrowed to counties with a history of wind energy development and with future projects in the planning stages.

Wind Turbine setbacks are codified for other reasons besides safety. Scenic corridors might be established so that views are not adversely impacted by new structures. Acoustic emissions from turbines might limit siting. Maximum sound pressure levels might be established at property lines or dwellings, constraining the placement of turbines.

As discussed above, setbacks can be established to minimize risk of component failure on property and personnel. The setbacks are usually a multiple of the total turbine height, from tower base to upper extreme point of the rotor (see Figure 1). Generally the setbacks can vary from 1.25 to 3 times the overall machine height. Larger setbacks are sometimes required for special areas. In contrast to these standards, counties in California with more rural development, such as Merced and San Joaquin, use building setbacks and do not distinguish wind turbines separately.

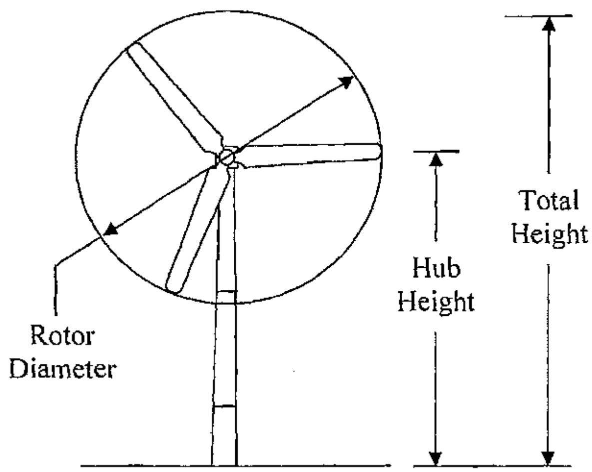

Figure 1. Wind Turbine Dimensions

4.1 Example Wind Farm and the Problem with Setbacks

As an illustration of the potential of setbacks limiting modern wind energy development, consider the following hypothetical situation. A developer has a one thousand by one thousand meter (one square kilometer or 247 acre) parcel of land available in a county with three times machine total height setback. The site has a strong prevailing wind direction, and the machines must be spaced in consideration of wake effects of three diameters crosswind and ten diameters downwind. Two machines are considered:

1. Vestas V-47
    - 660-kW full rating
    - 47 meter rotor diameter
    - 50 meter tower height
2. General Electric GE 1.5s

- 1500-kW full rating
- 70.5 meter rotor diameter
- 65 meter tower height

The layouts are shown in Figure 2 and Figure 3, with shaded zones representing the setback areas.

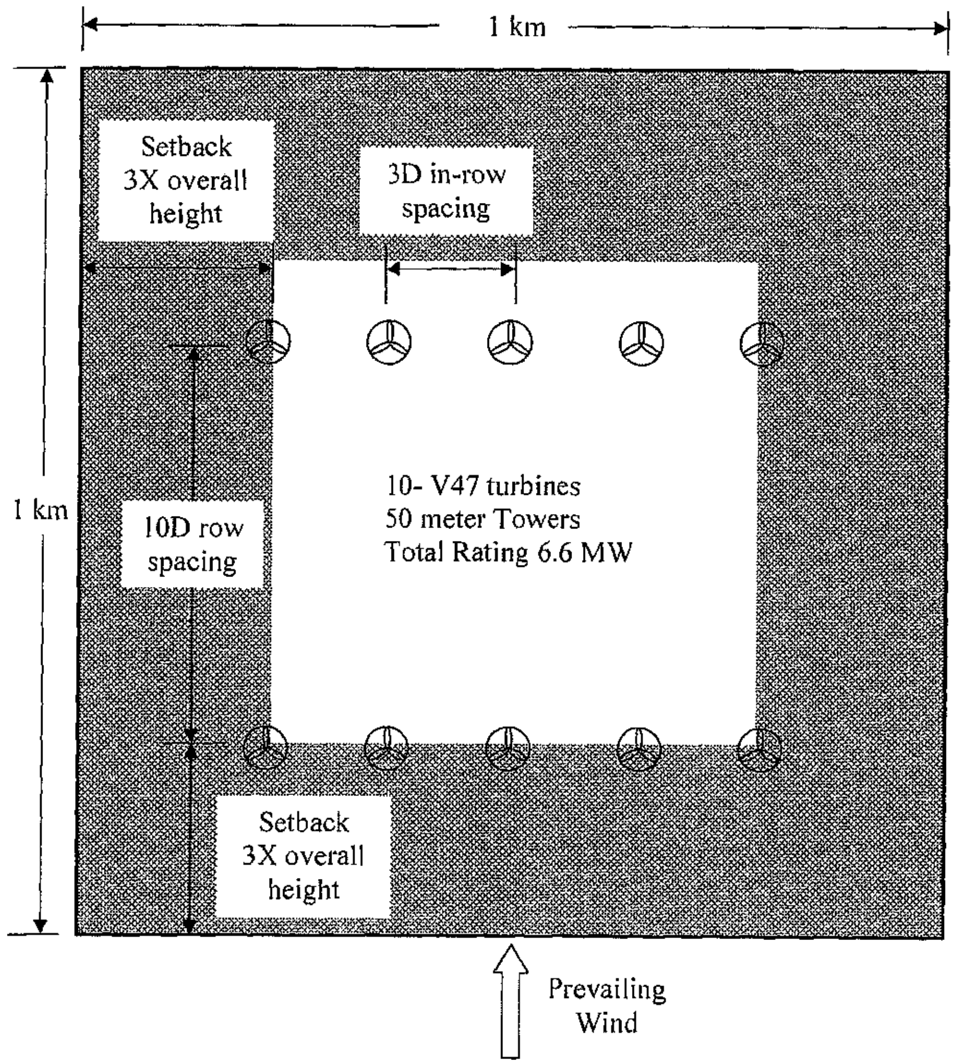

Figure 2. Layout for V-47 Wind Turbines Based on Setback Requirement of Three Times Total Turbine Height

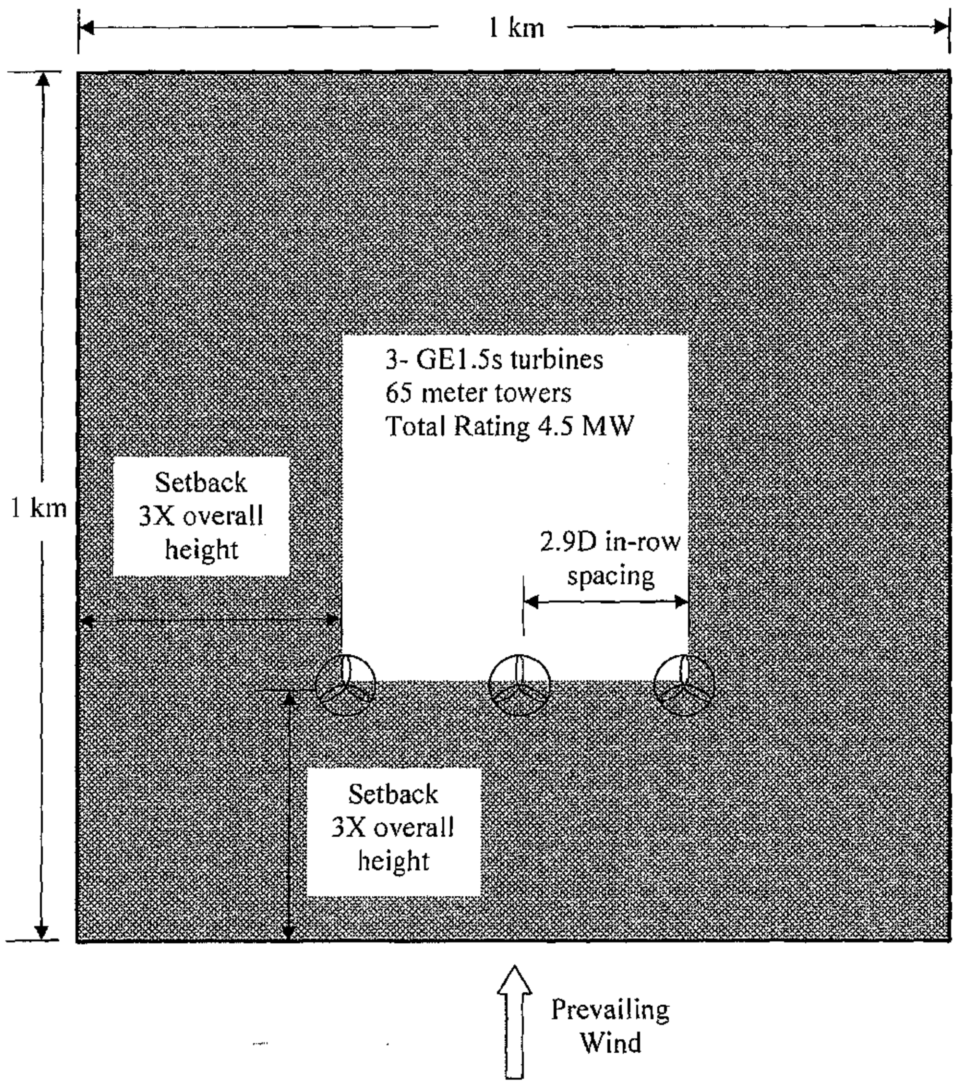

Figure 3. Layout for GE 1.5s Machines Based on Setback Requirements of Three Times Total Turbine Height

For the V47 machine, the spacing requirements and setbacks allow for ten machines with total rating of 6.6 MW. In contrast, the requirements allow only three GE 1.5 turbines with total rating of 4.5 MW. The crosswind spacing in this case had to be reduced slightly. Downwind spacing requirements would force a second row of turbines off the parcel. The setback requirements for this example result in lower energy production with the application of larger, modern machines. The options available to a developer are further constrained with the current trend of manufacturers producing larger machines.

4.2 Current Wind Energy Ordinances

The majority of the county ordinances can be obtained from the Internet. Many counties have their codes residing on Ordlink (http://ordlink.com/), a LexisNexis product. The author strongly suggests checking the current information available on the web sites. Checking the requirements would especially be important during the lifetime of a development project. Information on current ordinances and safety setback requirements is summarized in Table 1.

Table 1. Setback References in California County Ordinances

	Internet Site	Ordinance	Setback Reference
Alameda	code for wind energy not available on internet	Draft Environmental Impact Report, Repowering a Portion of the Altamont Pass Wind Resource Area, Appendix A, Alameda County Windfarm Standard Conditions	Paragraph 15. Safety Setback
Contra Costa	http://www.co.contra-costa.ca.us/	County Code, Title 8 Zoning, Ch. 88-3 Wind Energy Conversion Systems	88-3.602 Setback Requirements
Kern	http://ordlink.com/codes/kerncoun/	Title 19 Zoning, Chapter 19.64 WIND ENERGY (WE) COMBINING DISTRICT	19.64.140 Development standards and conditions
Merced	http://web.co.merced.ca.us/planning/zoningord.html	Zoning Code (Ordinance) Ch. 18.02, Agricultural Zones	Table 5 Agricultural Zones Development Standards
Riverside	http://www.tlma.co.riverside.ca.us/planning/ord348.html	Ordinance 348, Section 18.41, Commercial Wind Energy Conversion Systems Permits	18.41.d(1) Safety Setbacks
Solano	code for wind energy not available on internet	Wind Turbine Siting Plan and Environmental Impact Report 1987	Page 17 Safety Setbacks

4.3 Wind Turbine Setback Comparison

Table 2 below lists setbacks for several of the counties organized by feature that the turbine must be displaced from, such as a property line. The distances are stated in multiples of overall turbine height (see Figure 1). If a fixed distance is included with the multiple, then the maximum of the two values must be used for the setback.

Table 2. Safety Setback Comparison

NOTE: For reference only- check counties for current zoning requirements.

	Property Line	Dwelling	Roads	Reductions in Setbacks
Alameda County	3x/300 ft (91 m), more on slope	3x/500 ft (152 m), more on slope	3x/500 ft (152 m), 6x/500 ft from I-580, more on sloped terrain	maximum 50% reduction from building site or dwelling unit but minimum 1.25x, road setback to no less than 300 ft (91 m)
Contra Costa County	3x/500 ft (152 m)	1000 ft (305 m)	None	exceptions not spelled in ordinance can be filed with county
Kern County	4x/500 ft (152 m) <40 acres or not wind energy zone, 1.5x >40 acres	4x/1000 ft (305 m) off-site	1.5x	With agreement from adjacent owners to no less than 1.5x
Riverside County	1.1x to adjacent Wind Energy Zones	3x/500 ft (152 m) to lot line with dwelling	1.25x for lightly traveled, 1.5x/500 ft (152 m) for highly traveled.	None
Solano County	3x/1000 ft (304 m) adjacent to residential zoning, 3x from other zonings	3x/1000 ft (304 m)	3x	Setback waived with agreement from owners of adjacent parcels with wind turbines

There is quite a mixture of requirements amongst the counties. Riverside County maintains the minimum setback distances to properties with adjacent wind energy zoning. Also note that Alameda County has adjustments for sloping terrain. If the ground elevation of the turbine is two or more times the height of the turbine above the feature, the setback distance increases from three times to four times. All with exception of Riverside County allow for reduction of the setback distance with special consideration. An example of reduced setback can be found in the Altamont Repowering EIR (Alameda County 1998b), where a developer submitted a blade throw analysis as substantiation for the reduction.

Merced County, as stated before, with some wind energy development in the Pacheco Pass area, utilizes standard building setbacks for wind turbines in agricultural districts.

4.4 County Wind Energy Ordinances in the Literature

With exception to Solano County, the ordinances are not explanatory documents; no background information is provided. The most comprehensive paper on the subject of wind energy permitting in California comes from McClendon (1985). Although this paper was written in 1985, it captures the essence of the process at the time and generally not much has changed in the interim. Another paper by Throgmorton (1987) focuses on Riverside County development exclusively. Further clues to the development of standards can be found in Environmental Impact Reports written for the counties on specific developments. The counties will be discussed separately below.

References in the literature to safety setbacks are scarce. One can be found in Taylor (1991). Taylor proposed setbacks for a 30-meter diameter rotor machine, but no tower height is mentioned. The proposed setbacks were 120-170 meters from a habitation or village, 50 meters from a lightly traveled road, and 100 meters from a heavily traveled road. Another mention of setbacks for safety can be found in a Windpower Monthly article regarding a rotor failure in Denmark (Møller 1987). A setback of 90 meters plus 2.7 times the rotor diameter was proposed. No guidance can be obtained from the Wind Energy Permitting Handbook available from the National Wind Coordinating Committee (NWCC 2002). In all the above references, there is no discussion of the technical basis for the setbacks.

4.4.1 Alameda County Ordinance

Alameda County, encompassing most of the Altamont pass, was one of the first regions in the world to have large-scale wind energy development. The Altamont Pass area has until recently been isolated from population centers, lowering the possibility of conflict with the community. The McClendon paper (1985) reports concerns over safety and reliability of wind turbines resulted in an ad-hoc public/industry group to develop new standards. The setbacks as they stand today can be found in Resolution Number Z-5361 of the Zoning Administrator of Alameda County from 5 September 1984. There is no known technical description on how the setbacks were developed.

4.4.2 Contra Costa County Ordinance

Contra Costa encompasses the northern portion of the Altamont pass. The zoning language is much less specific than Alameda County, but the setbacks are similar.

4.4.3 Kern County Ordinance

According to county personnel and from McClendon (1985), the standards for Kern County were developed with an ad-hoc committee of wind energy people and other interests, as in the case with Alameda County. Kern has stricter setbacks for properties not zoned for wind energy development, but is less restrictive for roads (see Table 2).

4.4.4 Riverside County Ordinance

Riverside County can always be viewed as an area of intense development. Regulations were established after an extensive EIR by Wagstaff and Brady (Riverside County California, United States Bureau of Land Management, et al. 1982). Clues to the majority of the setback distances can be found in the report. Although there is no technical basis for the original setback of three times the total height of the turbine, one can infer that this distance arose from the discussion of wake effects. It was expected that in-row spacing for wake effects would be six diameters, and adjacent wind energy parcels would require a spacing of at least half this distance. The report also mentions an estimate of the throw distance for the MOD-0A, an early Westinghouse machine. The stated value of 500 ft (152 m) translates to three times overall height for this turbine. Evolution of the ordinance resulted in reduction of some of the setbacks, which now seem to offer a buffer for the possibility of tower collapse.

4.4.5 Solano County Ordinance

Solano County also developed wind turbine requirements with industry involvement in 1985. The outcome of this work was the Solano County Wind Turbine Siting Plan (Solano County 1987), which remains as the guide for permitting in the county. The plan supercedes the current language in the zoning ordinance that has setbacks of 1.25 times the overall turbine height. This plan was also developed by the authors of the Riverside County EIR, and proposes a "three times" setback. The estimated blade throw of the MOD-0A is again mentioned. There is a comparison of the setbacks with the potential blade throw of the MOD-2 turbine. The blade throw of this turbine in a vacuum was estimated at 1300 feet (396 m, 3.7 times overall turbine height) for a broken tip and 700 feet (213 m, 2 times overall turbine height) for the whole blade. There is no technical discussion for these values and they are not tied into the proposed spacing. Also amongst the county literature is the Montezuma Hills EIR (Solano County and Earth Metrics 1989), where a three times diameter safety setback was proposed, with no consideration for turbine height. Neither reference provides a technical basis for the setback distance.

5 Blade Failure Probabilities

We now turn to the probability of a blade failure occurring. Probabilities will be discussed in terms of ratios. For example, a coin toss with heads has a one in two probability, represented equally as 0.5, ½, 5×10^{-1}. A probability of something occurring once in one-hundred trials can be represented as 10^{-2}. The probability applied to blade failures will be stated as the probability of failure for a turbine in one year of operation. A probability of 10^{-2} can then be understood that on average there will be one blade failure in a year for every 100 turbines.

Reporting on turbine failures is very limited. most likely due to the sensitivity of the industry; however there are a few accounts in the literature. Also, there are statistics in the public domain of blade failures in Alameda County and from the WindStats newsletter for Denmark and Germany.

Types of blade failures are as follows:

- Root connection full blade failure
- Partial blade failure from lightning damage
- Failure at outboard aerodynamic device
- Failure from tower strike
- Partial blade failure due to defect

- Partial blade failure from extreme load buckling

Some of the causes of blade failures:
- Unforeseen environmental events outside the design envelope
- Failure of turbine control/safety system
- Human error
- Incorrect design for ultimate loads
- Incorrect design for fatigue loads
- Poor manufacturing quality

Not surprisingly, most failures are a combination of these factors, which points to the complexity of the technology. And, the probabilities of some events are highly correlated with each other. For example, loss of grid power is highly correlated with high wind events. The potential then exists for a control system malfunction due to loss of power to coincide with a high loading event. Thus the turbine designer must plan for both events occurring simultaneously.

5.1 Blade Failures in the Literature

One of the earliest documented blade failure events comes from one of the first applications of utility-scale wind energy (Putnam 1948). It is also one of the few accounts with a published distance. The Smith Putnam 1.25 MW turbine suffered a blade failure in its test campaign resulting in a blade throw of 750 ft (230 m), or 3.7 times the overall height. The failure was attributed to lack of knowledge of the design loads for the turbine. The blade throw was probably exacerbated by siting on a slope (approximately ten degrees). The blade was of steel construction, with a weight of eight tons (7260 kg). That is at least 50% heavier than modern construction. A heavier blade could fly farther due to a reduced drag-to-weight ratio (Eggers, Holley et al. 2001).

The next period of literature deals with the analysis of large-scale turbines under development in the 1970s and early 1980s. Although the possibility of failure was discussed, no mention of the probability was placed forward for the Department of Energy (DOE) MOD series turbines such as the General Electric MOD-1 (General Electric 1979) and Boeing MOD-2 (Lynette and Poore 1979). The Solar Energy Research Institute (SERI) conducted a preliminary study of wind turbine component reliability (Edesess and McConnell 1979). Using an analysis of the individual failure rate estimates and inspection intervals of the rotor and braking systems, the authors predicted a failure rate for the wind turbine rotor at 1.2×10^{-2} per year.

A strong early wind program in Sweden prompted studies of the subject (Eggwertz, Carlsson et al. 1981) where the first attempts at analyzing the blade throw hazard was attempted. The blade throw analysis is discussed below. The first guess at the probability of failure was made, at one in 100,000 (10^{-5}) failures per turbine per year.

The evolution of the wind industry back to smaller turbines brought large scale manufacturing and experience was gained with failures of equipment. In a 1989 paper, De Vries (1989) conducted a blind survey of manufacturers that reported on 133 turbine failures in the industry. De Vries also placed probabilities at 2×10^{-2} rotor failures per turbine per year for the Netherlands, 3 to 5×10^{-3} for Denmark and 3×10^{-3} for the United States. This is two to three orders of magnitude higher than predicted by Eggwertz, but came closer to the SERI analysis.

Reports of failures can be found occasionally in Windpower Monthly; for example a rotor overspeed failure in Denmark (Møller 1987) and full-blade failures in Spain (Luke 1995). A report in the technical literature comes from Germanischer Lloyd (Nath and Rogge 1991), one of the certification bodies for wind energy. The paper describes two medium-size turbine blade failures. The rotor diameter and tower height were not reported. One failure was attributed to insufficient shutdown braking force resulting in overspeed, and blades were thrown to 150 and 175 meters. The other failure was attributed to poor manufacturing quality and blade fragments were thrown 200 meters. Updates to certification requirements were made as a result of the failure investigations. These certification requirements call for redundancy in safety shutdown systems and quality control in the blade manufacturing process. De Vries had also earlier suggested stricter certification requirements to reduce the blade failure rate.

One wind turbine manufacturer has made a public testimonial of their blade failure rate. A managing engineer at Vestas, in testimony for the Kittitas Valley Wind Power Project in Washington State (Jorgensen 2003), declared that there had been only one blade failure in ten-thousand units for twelve years. The failure reported occurred in 1992 on a V39-500 kW machine and a blade was thrown 50-75 meters. If we assume an average of six years of total operation for the entire fleet, the failure rate would be estimated at 1.6×10^{-5} blade failures per turbine per year.

5.2 Alameda County Turbine Failure Data

Under Article 15 of the Alameda County Windfarm Standard Conditions (Alameda County 1998a), a windfarm operator must notify the County Building Official of any tower collapse, blade throw, fire, or injury to worker. Recent files of failure data from the county building department were compiled by the CWEC in order to determine failure rates. County representatives claim that not all operators have been diligent in their reporting, but one operator of Kenetech 56-100 machines has been. These turbines are 100 kW machines with 56 ft (17 m) diameter rotors. The majority were manufactured in the 1980s. The failure reports only indicate the failure type; no mention of blade throw distance (if it occurred at all), or the conditions at time of failure, is mentioned. The failures could have been discovered as the result of an inspection and the blade had not yet separated from the rotor. The failure data covered the year 2000 to fall of 2003. The number of Kenetech 56-100 machines in operation by this operator was obtained from the California Wind Performance Reporting System (http://wprs.ucdavis.edu/).

For the time period of the reports, the blade failure rate was 5.4×10^{-3} failures per turbine per year. This value coincides well with that reported by De Vries (1989). As a comparison the failure rate for the tower was 6.9×10^{-4} failures per turbine per year, an order of magnitude less probable than the blade failure rate.

5.3 WindStats Turbine Failure Data

WindStats is a technical publication for the wind industry published quarterly in Denmark. Failure data is available for wind turbines reported in Denmark and Germany. The Denmark data has been available since 1993; the Germany data from 1996. Like the Alameda County data, the data only indicates failure type; no mention of blade throw distance (if it occurred at all), or the conditions at the time of failure, is mentioned. Data up to the Spring 2004 issue was compiled.

For Denmark, the failure rate for blades was 3.4×10^{-3} failures per turbine per year. Again, this is within the values reported by De Vries (1989) in the late 1980s. The tower failures for the same period are 1.0×10^{-4}. As with the Alameda data, the tower failure probability is an order of magnitude lower than the blade failures. For Germany, the data is reported as "rotor" failures, which for the reporting period was 1.5×10^{-2} failures per turbine per year. This is an order of magnitude higher than the Denmark data, but on the same order of the Netherlands in De Vries. There are no apparent trends in the data indicating changes in failure rates over time.

5.4 Remarks on Blade Failure Probabilities

The limited available statistics show that the blade failure probability is on the order of 10^{-3} to 10^{-2} failures per turbine per year, and there seems to be no evidence showing improvement with technology. With industry experience the estimate of Eggwertz (1981) of 10^{-5} failures turned out to be optimistic. The failure rate of Vestas blades estimated at 1.6×10^{-5}, is impressive and if the industry as a whole could attain this rate the discussion of safety setbacks would be made much simpler. However, this statistic should be independently verified before being used as an example for the industry.

A report by the Energy Research and Development Administration (ERDA 1977) mentions the possibility of designing fail-safe cable retention systems to prevent blade throws, similar to the safety cable systems for race car wheels. Modern turbines have large cables for lightning protection, perhaps these can be used for this purpose also.

6 Blade Throw Analyses

Analysis of potential blade throws were studied by four researchers and details of their work will be discussed below. The impetus behind these researches was to study the hazard potential of the blade failure. Blade failures can occur with the machine operating or stationary. however the operating case was only studied in the literature.

6.1 Background of Blade Throw Models

6.1.1 Parked Turbines

Wind turbines are parked if the wind speed is out of the operating range, or if there is fault detected while the wind speed is within the operating limits. The typical high wind shutdown for a wind turbine is 25 m/s. The turbine is usually designed to withstand a peak gust outlined by the International Electrotechnical Commission (IEC). Peak gusts for various wind classes are shown in Table 3. The peak gust is defined as a three-second average gust that has a fifty percent probability of occurring in fifty years, more succinctly known as "50-year wind." The IEC wind classes are also distinguished by the annual average wind speed. All wind speeds are designated at hub height.

Table 3. IEC Peak Gusts

IEC Class	I	II	III
50-year wind	70 m/s	59.5 m/s	52.5 m/s
Annual Average	10 m/s	8.5 m/s	7.5 m/s

If a blade has failed in a parked condition there is no initial velocity of the projectile. Any movement away from the turbine will be constrained by gravity and the aerodynamic force of the ambient wind. None of the analyses studied the failure of the parked turbine, and it can be assumed that failure during operation will result in a higher probability of the blade or a portion of the blade flying farther.

6.1.2 Ballistics Models

Analysis of blade failure uses methods of classical dynamics in order to describe the problem. Figure 4 is a representation of a blade failure. If there is a blade failure, either a portion or the entire blade, the motion of the projectile is governed by specific forces. If the failure has taken place while the turbine is operating, the blade has an initial velocity due to rotation, while in flight the motion is constrained by gravity and aerodynamic forces. The initial velocity of the blade fragment is a function of the tip velocity, determined by Equation 1:

Equation 1 $$V_{tip} = \Omega R$$

where:

Ω = rotor rotational speed, and
R = rotor radius.

Normal operating tip speeds of the turbines studied in the literature varied from 40 m/s to 100 m/s. Modern wind turbines fall within this range. The tip speed is chosen to meet the performance requirements for the turbine and also to minimize acoustic emissions. The lower the tip speed, the lower the loads and noise from the blades for a given blade design. This can be compared to the low/high switch setting for a fan.

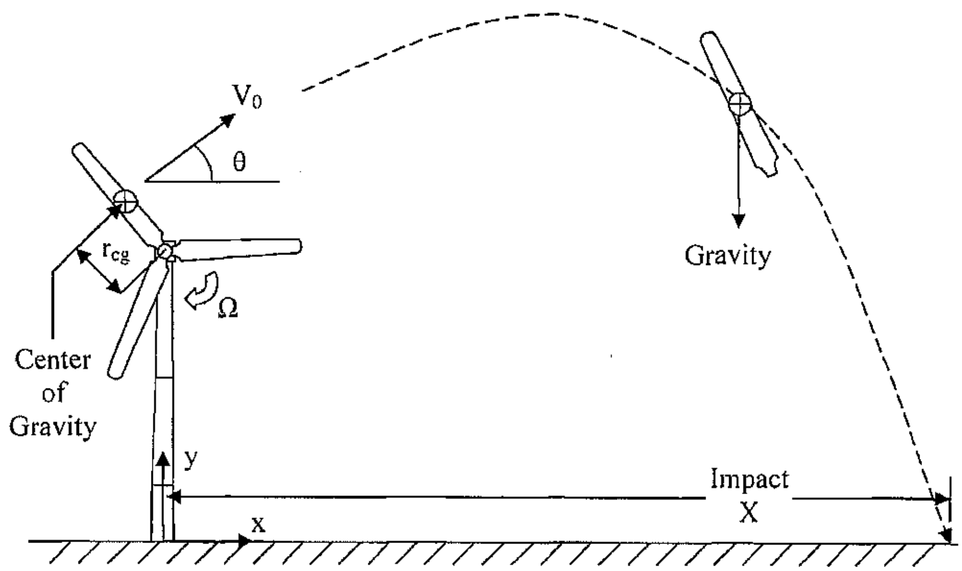

Figure 4. Blade Throw Schematic

If there is a failure of the blade, the initial velocity at separation will be given by Equation 2:

Equation 2 $$V_0 = \Omega r_{cg}$$

where:

$V_0 =$ Initial velocity of fragment at center of gravity.
$r_{cg} =$ Radial position of the fragment center of gravity.

Because of this relation, the initial velocity of a blade fragment tends to be higher than that of an entire blade because the fragment has a greater radial position. Also at the time of separation, the blade or fragment has the same angular velocity (or spin) as the rotor.

A rudimentary model of ballistics is the path of a projectile in a vacuum. The only force acting on the projectile is gravity. The total ground range achieved by the projectile, with release height and impact height equal, is given by Equation 3.

Equation 3 $$X = \frac{V_0^2}{g}\sin 2\theta$$

where:

$X =$ horizontal total ground range of a projectile in a vacuum
$g =$ gravitational acceleration

$\theta =$ release angle between the velocity vector and horizontal.

The release angle is directly related to the blade azimuth, which is the position of the rotor at a particular time.

Because the aerodynamic forces are not modeled, the projectile is not affected by the ambient winds, and does not travel downwind. The maximum range in a vacuum is achieved when the release angle is 45°. With this value of the release angle, Equation 3 becomes Equation 4.

Equation 4 $$X_{max} = \frac{V_0^2}{g}$$

where:

$X_{max} =$ maximum horizontal range of a projectile in a vacuum.

The values of range from this simple model are not realistic because the atmosphere is not a vacuum. This simple model however, shows the importance of the release velocity because it is a squared term. For example, a 10% increase in release velocity increases the maximum range by 21%. This model also shows the dependence on the release angle. In any probability study this would have to be a random parameter, because it is assumed that a rotor failure would not be dependent on the azimuthal angle.

More complex models, to be discussed below, increase on the complexity of the vacuum model. The most common approach is to assume that the aerodynamic force is proportional to the square of the instantaneous velocity. The aerodynamic force is separated into lift and drag, and the constants of proportionality are called coefficients of lift and drag (C_L and C_D). Both the crosswind and downwind distances are determined. The solutions for the projectile range from these models cannot be solved directly and require numerical methods. The next level of complexity assumes that C_L and C_D are dependent on the orientation of the projectile, and the blade is modeled as a rotating and translating wing.

6.1.3 Rotor Overspeed

One particularly hazardous failure scenario is turbine overspeed. The increased velocity in overspeed will over stress the rotor blade. and, in the event of a failure. increase the range of the projectile. The rotor is usually designed with a safety factor of 1.5. If the rotor loads are approximately proportional to the rotor speed (Eggers, Holley et al. 2001), the rotor could possibly fail at 150% of nominal rotor speed. To prevent this possibility. most wind turbines are equipped with redundant safety systems to shutdown the rotor. A turbine with industry certification (e.g. Germanischer Lloyd 1993), must have a safety system completely independent of the control system. The safety system must also have two mutually independent braking systems. Usually the blades pitch to release the aerodynamic torque and a brake is applied to the shaft. In the event of a failure in one system, the other system must be able to hold the rotor speed below maximum. An emergency shutdown is typically designed to occur if the rotor speed exceeds 110% of nominal. Even with redundant safety systems, rotor overspeed still occurs in industry, sometimes by human error when the safety systems have been defeated during maintenance.

6.1.4 Impact Probabilities

The analyses next turn to the probability that a projectile will hit a certain target or a particular area in the range of the turbine assuming a blade failure. The authors have various approaches to determine this probability; this will be discussed below. The probability of impact is then multiplied by the probability of blade failure, discussed in the previous section. The final result is the probability that a target fixed at a certain range from the turbine will be hit in one year. If targets are not fixed, such as cars on a roadway, then the probability must be multiplied again by the probability that the target will be in position. Mobile targets are not discussed in the analyses.

A simplified impact probability can be derived from Equation 3. Since this relationship is only valid for a ground release, only release angles of 0 to 180° (see Figure 4) result in movement away from the release point. Release angles of 180 to 360° result in impact at the base. The random release angle is assumed to have uniform distribution from 0 to 360°. Using methods of probability, the probability that a fragment will fall within an annulus that is less than the maximum range is given by Equation 5.

Equation 5

$$P\{X_1 \le X \le X_2 \le X_{max}\} = \frac{2}{\pi}\left[\arcsin\frac{X_2}{X_{max}} - \arcsin\frac{X_1}{X_{max}}\right]$$

where:

X_1 = inner radius of annulus.

X_2 = outer radius of annulus.

This relationship is plotted in Figure 5. Note that the relatively high probability directly under the tower is not shown. The nature of the equation results in an increasing probability of impact in the outermost annuli, due to a wide range of release angles that provide nearly the maximum range. However, the annular area increases with increasing radius.

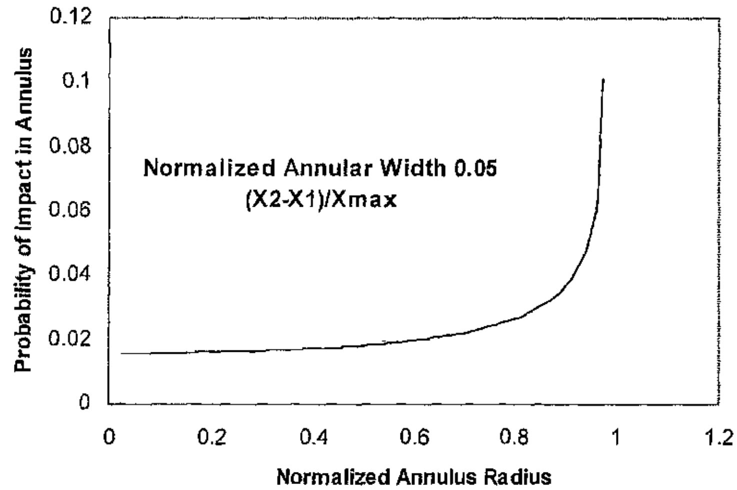

Figure 5. Probability of Impact Within an Annular Region

We next assume that the target is an annular sector, as in Figure 6. In order to make the sector size roughly equal throughout the ballistic range, we set the outer arc length (S) equal to the annular width, given by Equation 6:

Equation 6 $S \equiv X_2 - X_1$

The arc length is also given by

Equation 7 $S = X_2 \times \varphi$

where:

$\varphi =$ Sector angle in radians

Equating Equation 6 and Equation 7 and solving for the sector angle we obtain:

Equation 8 $\varphi = \dfrac{X_2 - X_1}{X_2}$

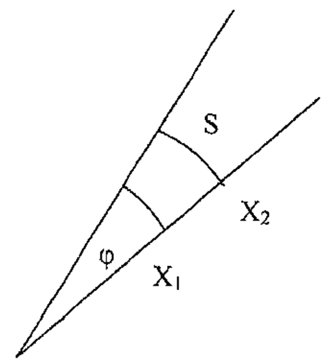

Figure 6. Target Annular Sector

The probability of impact in this annular sector, assuming equal probability in all directions, is given by:

Equation 9 $$P\{X_1, X_2, \varphi\} = \frac{\varphi}{\pi^2}\left[\arcsin\frac{X_2}{X_{max}} - \arcsin\frac{X_1}{X_{max}}\right]$$

This relationship is plotted in Figure 7. This simplified model shows a peak in probability near the tower base, and then a relatively constant probability until the probability rises again near the maximum range. This behavior is similar to more complex models incorporating aerodynamics. The peak at maximum range places a constraint on the overall hazard and acceptable setback distances.

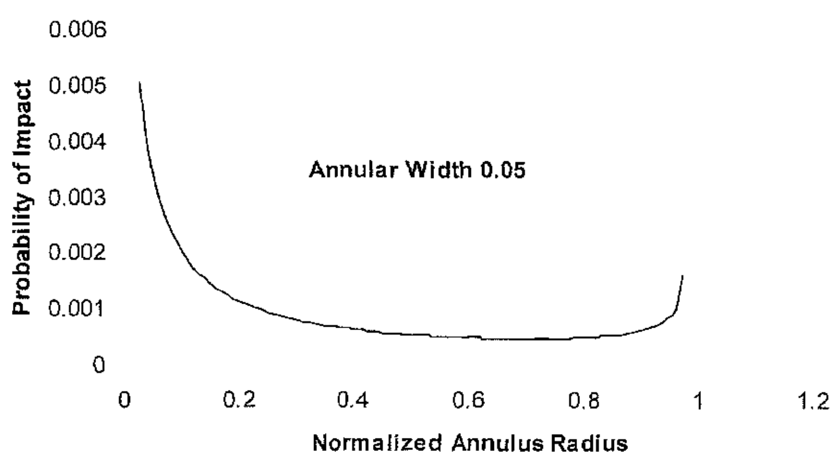

Figure 7. Probability of Impact in Annular Sector

6.1.5 Multiple Turbines

If there is more than one turbine in the area, such as in a wind plant, then the individual probabilities must be added for a particular area. This is mentioned briefly in Macqueen (1983). The probabilities add according to the Law of Total Probability; for two turbines this is represented in Equation 10.

Equation 10 $P(A+B)=P(A)+P(B)-P(A,B)$

where:

$P(A+B)=$	Probability of A or B or both occurring
$P(A)=$	Probability of A occurring
$P(B)=$	Probability of B occurring.
$P(A,B)=$	Probability of both A and B occurring (Equation 11).

Equation 11 $P(A,B)=P(A)P(B/A)=P(B)P(A/B)$

where:

$P(B/A)=$	Conditional probability B occurring given A has occurred
$P(A/B)=$	Conditional probability of A occurring given B has occurred

If the events are independent, which would be the case in a random failure, the conditional probabilities are from Equation 12 and Equation 13.

Equation 12 $P(B/A)=P(B)$

Equation 13 $P(A/B)=P(A)$

The overall probabilities become Equation 14.

Equation 14 $P(A+B)=P(A)+P(B)-P(A)P(B)$

As an example, consider a region that has a 10-4 probability of impact from a Turbine "A" and a 10-5 probability of impact from Turbine "B". From Equation 14, the overall probability of impact is:

$$P(A+B)=10^{-4}+10^{-5}-(10^{-4}\times10^{-5})$$
$$P(A+B)=1.1\times10^{-4}$$

These formulae can be expanded for multiple turbines.

6.1.6 Overall Probability

The overall probability can then be compared to other risks. De Vries (1989) mentions a government policy in the Netherlands of one-in-a-million (10^{-6}) per year risk level for new industrial activities. This is on the same order of present-day industry quality programs, such as "Six-Sigma," with a failure rate objective of three-in-a-million. Previously we discussed blade failure probabilities on the order of one-in-a-thousand (10^{-3}) to one- in-a-hundred (10^{-2}). If we assume a conservative value of one-in-a-hundred (10^{-2}), this results in a required probability of impact of less than one-in-ten-thousand (10^{-4}) per year.

6.2 Blade Throw Analyses in the Literature

6.2.1 Eggwertz, Sweden 1981

This is the first documentation of a blade throw analysis, and is a comprehensive report on turbine structural safety for the Swedish industry. At the time, megawatt-size turbines were being considered for power production in Sweden. The analysis referenced previous work in Sweden on the possibility of blade gliding due to spin; however the extension of the blade flight was considered negligible. For the examination of risk areas, the drag coefficient in the analysis was fixed at 0.5 for lateral and downwind directions, and the lift coefficient was assumed to be zero.

For the probability analysis the blade and azimuth locations were divided into equal spanwise sections and equal weighting was applied to failure at these sections. This allowed for a semi-random probability of failure of the blade at a particular section and at a particular azimuth. A total of 144 throws were modeled. A discussion was made of the probability of blade failure, mentioned in the Blade Failure section, but no criteria were applied in the final analysis.

The discussion of the physics and probability of impact is very detailed. The danger area included considerations of sliding and rotation of the blade fragment. The fragment was assumed to translate on the ground and come to a complete stop due to friction. The area surrounding the turbine was divided into 10-m rings and the fragment impact area within the ring was divided by the total ring area. The probability calculated assumes equal probability of launch for all wind directions. The result was the risk level that a target within a ring will be hit.

The overall analysis was conducted for a 39 meter radius machine at an 80 meter hub height operating at 25 rpm in a 7 m/s wind speed. This was considered to be the most likely operating condition. Assuming that a failure had occurred, the probability was high at the tower base and then relatively even at 10^{-3} until 200 meters. The analysis showed the probability of impact from any fragment dropped off dramatically (below 10^{-5}) at 220 meters. This throw distance is 1.8 times the overall turbine height. The throw distance for a probability of 10^{-4} is only slightly less than this value. The dramatic drop off in the probability at 220 meters was used as a basis for the safety area around the turbine; however, the calculations were made at nominal operating conditions and at a single wind speed. Failures in an overspeed conditions would increase this area.

The next published work (Macqueen, Ainsilie et al. 1983) expanded on Eggwertz's work to include failure possibilities besides those at nominal operating conditions.

6.2.2 Macqueen, United Kingdom 1983

This work was conducted in the United Kingdom for the Central Electricity Generating Board. As in Sweden, the United Kingdom was considering generating electricity with megawatt-size wind turbines. Macqueen starts by bounding the problem with an analysis of the maximum launch velocity of a blade fragment being limited by the approach of the speed of sound. An estimate of the maximum velocity is 310 m/s in an extreme overspeed condition for a typical turbine. The projectile distance would not exceed 10 km using classical ballistics results with no aerodynamic drag. It is unreasonable to expect setback criteria of this distance; the turbine rotor would probably fail at a much lower velocity. However this provides an upper extreme limit.

The analysis followed the same lines as Eggwertz with analysis of gliding and tumbling and classical ballistics with average lift and drag coefficients. The tumbling analysis was to determine the conditions for stable, gliding flight of a fragment. Macqueen reasoned that the flight time of a fragment was several times longer than one tumbling period and therefore stable flight could not be expected. However gliding was considered as a rare case if the blade did not leave with sufficient rotational energy. For the tumbling case, Macqueen reasoned a C_L of 0.0 and a C_D of 1.0. For gliding, lift was chosen as $C_L= 0.8$ and $C_D= 0.4$. Macqueen estimated the probability of gliding occurring in a potential failure at 10^{-2} to 10^{-3}.

Macqueen also included a discussion of a three-dimensional model of blade flight, and concluded that the model did not show the blade achieving a stable gliding condition. Macqueen concludes that the effect of lift in the three dimensional case increases the range of flight by no more than 10%.

A series of runs at equally spaced azimuthal positions were used to develop the probability distributions. The possibility of sliding after impact was not addressed in the current work. He then separated the analysis into two failure events, one at a 10% overspeed at average winds, the other at the maximum possible release velocity with an extreme gust. The turbine studied was of similar geometry to the MOD-2, with 91 m diameter rotor and 61 m hub height.

The probability of impact is weighted by area (per square meter), and assumes equal distributions in all directions. Probability distributions showed peaks near the tower and at the maximum range, similar to the simplified model in Figure 7. The probability of impact was then a function of the target and fragment size. Macqueen reasoned that the blade fragments would be large compared to target, making the probability independent of target size; however this would not be the case with a busy roadway, with many targets over a large area.

For overall probabilities Macqueen used the Eggwertz probability of 10^{-5} for rotor failures. Macqueen also compared the probabilities to a statistic of risk of death by lightning strike in the United Kingdom at 10^{-7} per year. For the turbine studied, a large 2.5 MW unit, the risk of being hit by a blade fragment within 210 m (approximately two times overall height) is equivalent to being struck by lightning. However, these results were based on the blade failure probability of 10^{-5} and the assumption of a target size less than the overall blade area.

6.2.3 Sørensen, Denmark 1984

This investigation was part of the wind power program of the Ministry of Energy and the Electric Utilities in Denmark. The conference paper (Sørensen 1984b) was a summary of the full report in Danish. Detailed sensitivity studies are found in the Wind Engineering Journal paper (Sørensen 1984a). The analysis is unique in that the aerodynamics of the blade under ballistic motion was fully modeled. Sørensen used synthesized data from a NACA 0012 wing to simulate the blade under various alignments. The blade fragment was broken into segments and the aerodynamic forces were determined independent of each other. The total force was then a summation of the individual forces. This approach is similar to current state-of-the-art modeling of wind turbine rotors in the industry. Three turbines of increasing size were studied.

The modeling showed that the blade tumbling motion decayed as the blade reached the maximum height with the heavy end directed down as the blade fell back to earth. This behavior was also described by Eggwertz in scaled model studies. The model behavior places into question the pure tumbling and constant aerodynamic coefficients of the other models. Comparison with these models showed that the average drag coefficient for the lateral throw would have to be varied from 0.15 to 0.4 to achieve similar results to the full aerodynamic model. These coefficients are lower than what was usually considered by the other researchers. For the downwind range, the constant coefficient models predicted a much lower distance. Therefore, constant coefficient models would tend to predict shorter overall throw distances compared to Sørensen's method.

The wind engineering paper went through several sensitivity studies of the modeling parameters. A summary of these studies is presented in Table 4.

Table 4. Sensitivity Studies by Sørensen in Wind Engineering Paper

Subject	*Description*	*Results*
Airfoil Data	Analysis conducted on four airfoil data sets	7% spread in maximum range
Aerodynamic Unsteadiness	Dynamic aerodynamic loads modeled	12% reduction in maximum range with unsteady model
Autorotation	Model tendency of blade to glide like helicopter rotor	Substantial reduction in range
Center of Gravity Location	Vary chordwise center of gravity position on blade	Negligible effect for typical 25-35% chord line placement

Subject	*Description*	*Results*
Blade Pitch Angle	Blade pitch angle at moment of release	Large influence; pitch of maximum thrust had maximum range
Wind Velocity	Ambient wind velocity at moment of release	Large influence, partially due to dependence on pitch angle effect

The impact probabilities reported in the conference paper assumed the target as a one-meter sphere. Sliding of the wreckage was assumed, with 25 meters of slide assumed for a throw greater than 75 m range. As stated before in the Macqueen (1983) discussion, these probabilities would have to be adjusted for targets larger than the blade fragment, such as a busy roadway, or a dwelling. The probability analysis followed the same approach as Eggwertz (1981) by dividing the region around the turbine into ring segments. Uniform wind direction was assumed.

Probabilities were only presented for the Project "K" turbine for a full 30-m blade throw and 10-m blade fragment throw. This turbine is of 1.5 to 2.0 MW size with a 60 m hub height. Release angle and wind speed were varied and multiple throws were calculated. The probabilities were presented as a function of tip speed. Results are shown in Figure 8, comparing the range with 10^{-4} probability (the "hazard" range) to the maximum range.

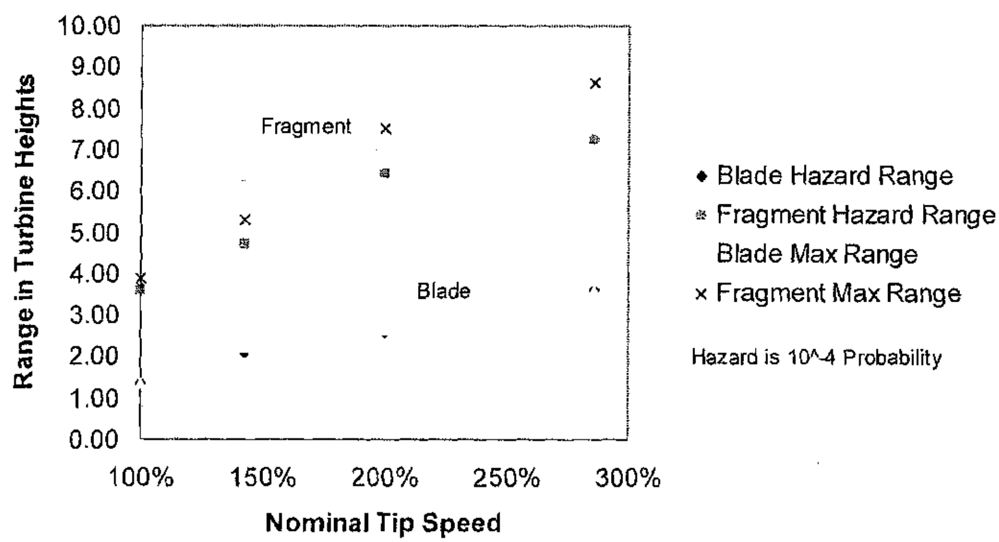

Figure 8. Throw Distances in Sørensen Conference Paper with 10^{-4} Probability Hazard Range

The maximum ranges do not increase exponentially as would be predicted for a vacuum in Equation 4. This is the result of including the aerodynamic forces. Also, there is negligible difference for the full blade maximum range and range with 10^{-4} probability. This is not true for the fragment.

6.2.4 Eggers, United States 2001

This is the most recent analysis (Eggers, Holley et al. 2001) generated for the National Wind Technology Center in Colorado. The analysis used classical ballistic theory and assumed constant values of aerodynamic force coefficients. A discussion and analysis is made of the possibility of gliding flight assuming the blade achieves a stable gliding angle; it is assumed negligible. The low probability of this is reasoned due to the complex geometry of the blades, with varying chord, airfoil section, and twist. The mean values of drag ($C_D = 0.5$) and normal force coefficients are considered constant during flight. Half and full-blade projectiles are analyzed.

An example turbine was studied with a 15.2 meter rotor radius operating at 50 rpm in 11.2 to 22.4 m/s winds. A probability distribution, assuming equal weighting for all directions, was determined analytically and solved numerically. This method was unique in that several trials of throws were not necessary to obtain the distributions. Also assumed was that the failure was the result of an overspeed, and that the range of the overspeed failure was a Gaussian distribution between 1.25 and 1.75 times the nominal speed. Eggers, like Macqueen (1983), confirms peaks in the probability distribution near the tower and at maximum range. Two tower heights were also studied, showing higher probability at the tower base for the shorter tower. Probability values cannot be determined from the paper due to the limited resolution of figures.

6.3 Comparisons of Blade Throw Analysis

Studies of example turbines were performed in all the analyses discussed previously. A comparison is shown below in Figure 9. The maximum attainable lateral throw distance, normalized by overall turbine height, for a failure at nominal operating conditions is shown for the various analyses.

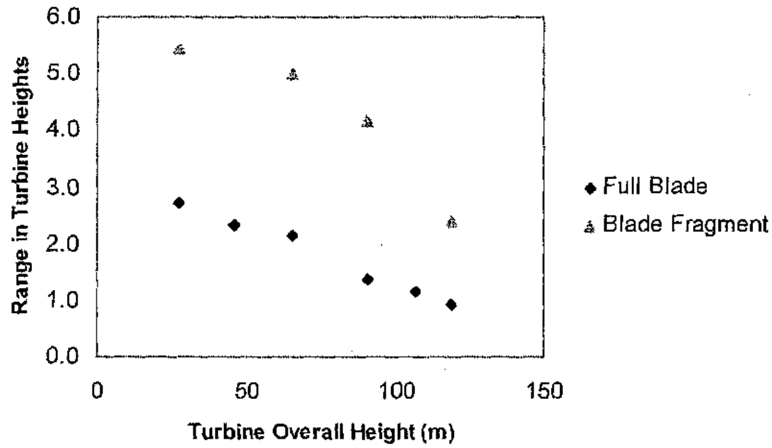

Figure 9. Comparison of Blade Throw Analyses for Maximum Range at Nominal Operating Conditions

Two observations can be made from a comparison of the analyses with failure at the nominal operating condition. The first is that as the overall turbine height increases, the range normalized by overall height decreases. This is primarily because the maximum range is dependent on turbine tip speed. As discussed previously, the tip speed has remained nearly the same as turbine size has increased. The other conclusion is that blade fragments fly farther than full blades. As stated previously, this is because the initial velocity at failure tends to be higher for the fragment than the entire blade.

7 Recommendations for Further Study

The literature reviewed in this report does not specifically provide guidance for wind turbine setbacks. The following items of further study are proposed in order to obtain guidelines for setbacks.

7.1 Blade Failure Rate

Unless there exists a more thorough database of blade failures, the value discussed in the Blade Failure section of 10^{-2} per turbine per year should be used for the blade failure probability. A lower probability might not significantly affect the results due to the peak in the impact probability near maximum range.

7.2 Turbine Sizes

A mixture of turbine sizes should be studied to determine if setbacks should be a standard distance or a function of the turbine size. Turbine sizes currently marketed are 660 kW to 5 MW. Smaller turbines should be studied for stand-alone applications and review of existing hazards.

7.3 Position of Blade Break

Since the position of the failure cannot be predicted with certainty, the approach of Eggwertz (1981) to divide the blade into sections should be used. In addition to randomizing the break position, turbines with aerodynamic devices, blade dampers, and lightning protection components on the blades should be studied as fragments.

7.4 Operating Conditions at Failure

Since the throw distance is highly dependent on release velocity and ambient conditions, a probabilistic method should be developed to vary these parameters. Modern turbines with redundant braking systems should not develop an overspeed condition; however the possibility, albeit unknown, still exits. Perhaps the method of Eggers (2001) of varying the failure tip speed from 1.25 to 1.75 times nominal tip speed should be used.

7.5 Aerodynamic Model

The methods of Sørensen (1984a) should be applied for the aerodynamic model. There was an effort to update his program to MATLAB at the Danish Technological University; however the status of this work is unknown.

Further studies could be conducted to incorporate shear and turbulence into the model. With these effects included, the blade throw might exhibit constant C_L and C_D behavior which might warrant use of simpler models.

The model should be built as a tool that can be used by the industry for use on any turbine to study specific cases such as permitting waivers.

7.6 Impact Modeling

The methods of Eggwertz (1981) or Sorensen (1984a) should be used to model the physics at impact. Both have methods for including the effects of rotation and translation after impact.

7.7 Slope Effects

Slope effects were not included in the reviewed analyses. Because of the common placement of turbines on ridgelines, as in the Altamont and the Tehachapi wind resource areas, the modification to the setback distance should be studied.

7.8 Validation Effort

None of the analyses have been validated with actual failures. Validation with an actual failure can be made with the following information:

- Turbine tower height
- Position of failure on rotor
- Azimuth of failure (would be very hard to obtain)
- Rotor speed
- Pitch of blades

- Geometric details of the fragment (planform, airfoils, weight, cg, twist distribution)
- Wind speed, direction, and local air density
- Distance and bearing of blade or fragment from tower base

Another effort would be to deliberately cause a blade failure and obtain the above information. This test could be conducted on a turbine at the end of its useful life in a clear field. Explosive bolts or a ring charge could be used to separate the blade or fragment from the turbine. The azimuth at break must be carefully determined.

8 Conclusions

A study was performed on setbacks for permitting of wind energy. Counties with past and future development of wind energy have setbacks based on overall turbine height. The application and size of the setbacks varied widely across the counties. Most setbacks were established early in the development of the wind industry and were outcomes of ad hoc groups of government and industry.

Reporting of wind turbine failures are scarce in the literature, but available data from Alameda County and from Europe show blade failures from one-in-one-hundred (10^{-2}) to one-in-one-thousand (10^{-3}) per turbine per year.

Four researchers looked at modeling the blade throw risk in detail. Several authors analyzed but discounted the possibility of gliding flight, and instead used simplified models of the aerodynamics. Sørensen (1984a) used a three dimensional analysis of the blade fragment flight and showed the limitations of the simplified models. The literature, however, does not offer any guidance for applying setback distances that would be useful for wind energy planning. Items for further study are proposed in order to determine consistent standards.

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March 24, 2009
Europe, Health, Human rights, Noise, Ordinances, Property values, Regulations, Safety, Siting

European Setbacks (minimum distance between wind turbines and habitations)

European Platform Against Windfarms

Information provided by EPAW [1] members and summarized by Mark Duchamp

Note from the NWW editor: These are not necessarily good examples. For information about noise and health impacts that require a setback from homes of at least 2 kilometers (1-1/4 mile), see the NWW Noise & Health page [2].

BELGIUM
350 metres (1,148 feet) in theory (stated in draft legislation, but never voted). In practice the developers avoid problems by making it no closer than 500 m (1,640 ft).

CZECH REPUBLIC
There are no regulations on setbacks from wind turbine. In practice: 400 m to 800 m (1,312-2,625 ft).

DENMARK
Windmills must be situated at a minimum distance of 4 × their height away from habitation. If the windmill is erected closer than 6 × its height, an estimation is carried out free of charge regarding the depreciation of the property value. If the loss is more than 1%, full compensation of the loss in property value is paid out. If the property is situated farther away than 6 × the height of the windmill, 4,000 DKK is payable to have an evaluation of the loss in value carried out. If it is estimated that the depreciation is more than 1%, the loss in value of the property is paid out and the 4,000 DKK reimbursed. If it is estimated that there is no loss in value of the property, the 4,000 DKK is forfeited. Owners of windmills have to pay the compensation.

ENGLAND, WALES
No regulations. I suppose the courts would enforce the laws on noise levels, but the experts invariably seem to show up on days with little wind, and of course never at night. In a court case, the previous owners of a house were condemned to compensate the buyers because they had not disclosed the windfarm project affecting the house: "District Judge Buckley decided that this amounted to 'material misrepresentation' and ordered the Holdings to pay compensation of 20 per cent of the market value of the house in 1997, £12,500, plus interest, because of damage to visual amenity, noise pollution and the 'irritating flickering' caused by the sun going down behind the moving blades of the turbines 550 metres [1,804 ft] from the house." John Etherington says: "There have been permissions as close as 350 m [1,148 ft] I think."

FRANCE
On a case-by-case basis, only limited by noise legislation. The French Academy of Medicine recommends 1,500 m (4,921 ft). This is not respected, however. In practice, 500 m (1,640 ft) seems to be the minimum observed.

GERMANY
Different setbacks apply according to the noise level protection of the area :

- "quiet regions" [35 dB(A)]: 1,000-1,500 m (3,281-4,921 ft)
- "middle regions" [(40 dB(A)]: 600-1,000 m (1,969-3,281 ft)
- "standard region" [(45 dB(A)]: 300-600 m (984-1,969 ft)

All makes and models of wind turbines are not equally noisy, hence the lack of a precise distance. Some states have standards of their own.

ITALY
Setbacks are determined by regional authorities. Some regions have defined setbacks, others don't. Calabria and Molise: 5 × the height of the turbines (not specified if mast or total height). Basilicata: 2 km from urbanized areas. Campania: 10 × the turbine height from urbanized areas. Molise: 20 × the turbine height from urbanized areas.

NETHERLANDS
In practice, they use 4 × the height of the mast of the wind turbine. This is not a legal setback. The legal setback is linked to a maximum noise level [40 dB(A)]. New limits are proposed and in discussion at this time and a possible change of setbacks is expected to become law in the middle of this year (2009).

NORTHERN IRELAND
The "Best Practice Guidance to Planning Policy Statement 18 'Renewable Energy'" (August 2009) states: "As a matter of best practice for wind farm development, the Department [of the Environment] will generally apply a separation distance of 10 times rotor diameter to occupied property (with a minimum distance of not less than 500m)."

ROMANIA
The setback is 3 × the height of the mast, and this distance may be shortened with the approval of local communities but not shorter than height of the tower + length of blades + 3 meters. So far, this appears to be the European record on the nuisance scale.

SCOTLAND
On a case-by-case basis within 2 km of the edge of cities, towns, and villages (SSP6 legislation). Some people skim this and interpret it as a 2 km setback. It is nothing of the sort. The policy was adopted after the vast majority of wind proposals were submitted so does not apply to them. Another caveat: note that "cities, towns, and villages" in practice suggests probably a minimum of 3,000 or more homes. Isolated country houses, in any event, are excluded from this. Some examples:

- Bankend Rigg (awaiting approval): just over 1,000 m (3,281 ft)
- Chapelton (awaiting approval): 750 m (2,461 ft)
- Dungavel (awaiting approval): 1,000 m (3,281 ft)
- Whitelee (built): about 1,000 m (3,281 ft)
- Gathercauld Ceres (awaiting approval): 572 m (1,877 ft)
- Auchtermuchty (approved): 650 m (2,133 ft)

Addendum, April 18, 2009: The Stop Highland Windfarms Campaign wrote to Jim Mather, Minister for Enterprise, Energy and Tourism, for clarification. In reply, the Directorate for the Built Environment wrote: "The 2km separation distance is intended to recognise that, in relation to local communities, visual impacts are likely to be a prominent feature and this should be taken into account when identifying the most suitable search areas. However, impacts will clearly vary considerably depending on the scale of projects and the proposed location. That is why SPP6 confirms that, in all instances, proposals should not be permitted if they would have a significant long term detrimental impact on the amenity of people living nearby. This principle applies to houses within and outwith 2km of the proposed development and regardless of whether they are single dwellings or part of a settlement." Click here for a copy of the correspondence in full, by courtesy of the Caithness Windfarm Information Forum. [3]

SPAIN
National: noise legislation applies. Regional: windpower policies sometimes specify a setback. Examples:

- Valencia: 1,000 m (3,281 ft) from any piece of land that may be built upon.
- Andalucia: 500 m (1,640 ft)

SWEDEN
The only limit is the noise level [40 dB(A)]. In practice, 500 m (1,640 ft) seems to be the setback applied, but there are exceptions (350 m [1,148 ft] in one case). I am told there are regulations for shadows.

SWITZERLAND
Documentation from Suisse Eole (quango promoting windfarms) mentions 300 m (984 ft) from the tip of turbine blades of a 70 m (230 ft) turbine. But each canton is still working on a clear setback policy.

See also: "Safe setbacks: How far should wind turbines be from homes?" [4]

URLs in this post:
[1] EPAW: http://www.epaw.org
[2] see the NWW Noise & Health page: http://www.wind-watch.org/ww-noise-health.php
[3] Click here for a copy of the correspondence in full, by courtesy of the Caithness Windfarm Information Forum.: http://www.caithnesswindfarms.co.uk/SPP6%20Q%20and%20A.pdf

[4] "Safe setbacks: How far should wind turbines be from homes?": http://kirbymtn.blogspot.com/2008/07/safe-setbacks-how-far-should-wind.html

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WIND POWER DEVELOPMENT MORATORIUM ORDINANCE

FOR THE TOWN OF SEDGWICK

The TOWN OF SEDGWICK (Maine) adopts a Wind Power Development Moratorium Ordinance as follows:

FOR THE PURPOSES of this moratorium ordinance, "wind power development" means any wind energy facility consisting of one or more wind turbines, the purpose of which is to primarily generate electricity to supply to off-site customers, and includes substations, cable/wires, and other structures accessory to such facility.

WHEREAS, areas of the Town of Sedgwick are suddenly under threat of increased development pressure from Wind Power Developments; and

WHEREAS, this development pressure was unanticipated and has not been adequately provided for in the Town's current Ordinances; and

WHEREAS, there is a strong likelihood that all areas of the Town will continue to be subjected to this development pressure due to the amount of undeveloped land, the nonexistence of any regulations or restrictions on locations of Wind Power Developments, and the high demand for such Wind Power Developments; and

WHEREAS, development of such Wind Power Developments could pose serious threats to the public health, safety, and welfare of the residents of Sedgwick through the over-development of parts of Town with such Wind Power Developments without adequate provisions for issues of safety, land-use compatibility, and visual access to view corridors; and

WHEREAS, the Town will need at least 180 days to develop and implement a Wind Turbine Ordinance, and the necessary amendments to zoning and land-use ordinances and regulations to accommodate these Wind Power Development pressures; and

WHEREAS, in the Judgment of the Town, these facts create an emergency within the meaning of 30-A M.R.S.A. 4356 (1) (B) and require the following Wind Power Development Moratorium Ordinance as immediately necessary for the preservation of the public health, safety, and welfare;

NOW, THEREFORE, the Town of Sedgwick hereby ordains that a Wind Power Development Moratorium Ordinance is hereby imposed, effective immediately, and applicable to the maximum extent permitted by law and subject to the severability clause below, to all proceedings, applications, and petitions not pending (within the meaning of M.R.S.A. Sec. 302) as of November 2, 2010, and on any new construction or use, requiring approval under the terms of the Town's zoning and land-use ordinances and regulations for such Town until the effective date of the necessary amendments to the zoning and land-use ordinances and regulations or until May 2, 2011;

BE IT FURTHER ORDAINED, that the Planning Board, Board of Appeals, the C.E.O., all Town agencies, and all Town employees shall neither accept nor approve applications, plans, permits, licenses, and/or fees for any construction or uses governed by this Wind Power Development Moratorium Ordinance for such Wind Power Developments for said period of time;

BE IT FURTHER ORDAINED, that those provisions of the Town's land-use ordinances and regulations which are inconsistent or conflicting with the provisions of this Wind Power Development Moratorium Ordinance, including, without limitation, the requirements for site-plan review by the Planning Board, subdivision and/or special-exception review by the Planning Board, and height-variance appeals by the Board of Appeals, are hereby repealed to the extent that they are applicable for the duration of the Wind Power Development Moratorium Ordinance hereby ordained, but not otherwise;

BE IT FURTHER ORDAINED, that to the extent any provision of the Wind Power Development Moratorium Ordinance is deemed invalid by a court of competent jurisdiction, the balance of the Wind Power Development Moratorium Ordinance shall remain valid.

BE IT FURTHER ORDAINED, that a Sedgwick Wind Turbine Ordinance will require a public hearing by the Planning Board and the Board of Selectmen, and must be voted upon at a Town Meeting or Special Town Meeting.

EMERGENCY CLAUSE:

In view of the emergency cited in the preamble, this Wind Power Development Moratorium Ordinance shall take effect immediately upon passage by the Town, and shall apply, to the maximum extent permitted by the law but subject to the severance clause above, to all proceedings, applications, and petitions not pending as of November 2, 2010, and shall stand repealed as of May 2, 2011.

Given under our hands at Sedgwick, Maine, on this 16th day of September, 2010.

/s/ Nelson Grindal

/s/ Colby Pert

/s/ Victor Smith

Wind Turbine - Materials and Manufacturing
Fact Sheet

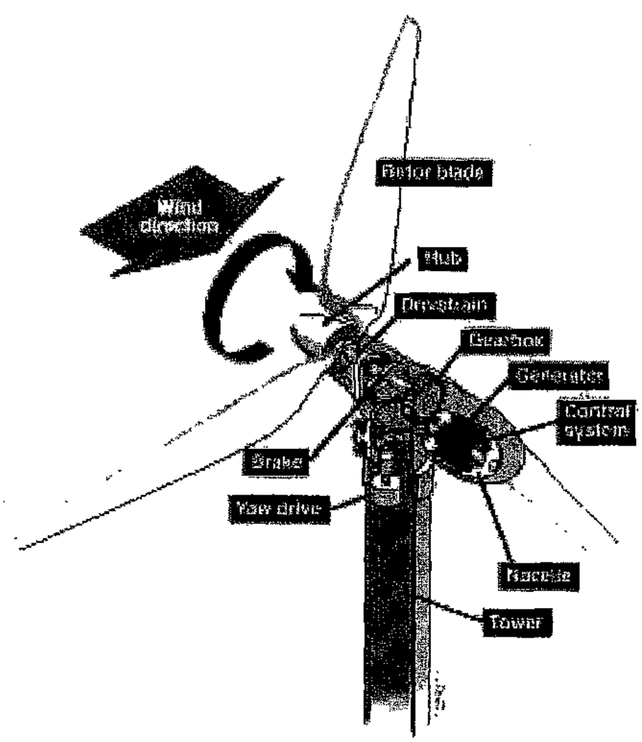
Prepared for the Office of Industrial Technologies, US Department of Energy
By Princeton Energy Resources International, LLC.
Dan Ancona and Jim McVeigh

Recognition of the value of wind energy as a low cost, clean source for electricity is creating major new business opportunities for manufacturing and materials innovation. Worldwide growth in wind generation since 1994 has been 30% or higher annually. The cost of energy from large wind power plants has declined to less than $0.05/kWh at good wind sites. By the end of 2000, the global capacity had passed 17,600 megawatts (MW) [See reference 1], and in the United States alone, more than 1,800 MW of new installations should be completed this year [2, 3].

The combined sales of large wind power plants and small turbines for distributed generation is now $4-5 billion annually worldwide and growing. Small turbines (less than 100 kW each) are being produced for the growing distributed generation and off-grid markets. Grid-connected wind power plants typically employ hundreds of 1 to 2 MW turbines today and larger, 3 to 5 MW machines, with 100-meter (m) (110 yards - longer than a football field) or greater rotors are being developed. The wind turbine manufacturing business has grown from a "cottage industry," with hand-built subsystems, to sales warranting large-scale production operations.

Parts of a Wind Turbine

Wind turbines come in many sizes and configurations and are built from wide range of materials. In simple terms, a wind turbine consists of a **rotor** that has wing shaped **blades** attached to a **hub**; a **nacelle** that houses a drivetrain consisting of a **gearbox,** connecting shafts, support bearings, the **generator**, plus other machinery; a **tower**; and ground-mounted electrical equipment.



Wind Turbine Nomenclature

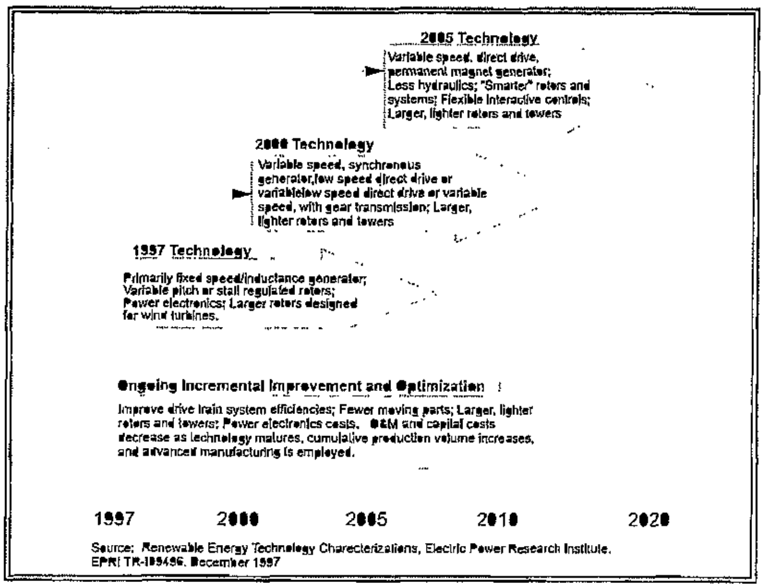
The wing shaped blades on the rotor actually harvest the energy in the wind stream. The rotor converts the kinetic energy in the wind to rotational energy transmitted through the drivetrain to the generator. Generated electricity can be connected directly to the load or feed to the utility grid [4].

The weight and cost of the turbine is the key to making wind energy competitive with other power sources, because research programs have significantly improved the efficiency of the rotor and maximized the energy capture of the machine. The real opportunity today is through better, low cost materials and though high volume production, while ensuring the reliability is maintained. The typical weight and cost of the primary turbine components today are shown in Table 1. In addition there are foundations and conventional ground-mounted systems, including transformers, switching and other power equipment.

Table 1. Turbine Component Weight and Cost

Component	% of Machine Weight	% of Machine Cost [5]
Rotor	37177	20-30
Nacelle and machinery, less	25-40	25
Gearbox and drivetrain	37025	37178
Generator systems	36927	37025
Weight on Top of Tower	35-50	N/A
Tower	30-65	37188

There appear to be several areas where technological progress and cost reduction are needed. Turbine subsystem costs are generally evenly split between rotor, nacelle, drivetrain power systems, and the tower. There is no single component that dominates turbine cost. The rotor is the highest cost item on most machines and must be the most reliable. Towers are normally the heaviest component and could benefit from weight reduction, but lightening the rotor or tower-top weight has a multiplier effect throughout the system including the foundation.



Wind Turbine Technology Evolution

Expected Technology Evolution

The components of turbines are changing as the technology improves and evolves. There is a trend toward lighter weight systems. Light weight, low cost materials are especially important in blades and towers for several reasons. First the weight of the blades and rotor is multiplied through out the machine.

The tower weight is key because it is typically 60% of the weight of the turbine above the foundation, due to the fact that sophisticated light-weight, high-strength materials are often too costly to justify their use.

Another technology shift is occurring in the drive train. In some cases the gearbox is being eliminated by employing variable speed generators and solid state electronic converters that produce utility quality alternating current (AC) power. This trend began in small machines and is now being incorporated in turbine sizes from 100 kW to 3 MW. Other trends in wind turbine technology are discussed in detail in the Renewable Energy Technology Characterizations published by the Electric Power Research Institute (EPRI) [5] with DOE support.

Market and Turbine Component Materials Data

Table 2. Turbine Models Used in Current and Future Materials Usage Estimates

Turbine Make	Rated Power (kW)
Southwest Windpower	0.4, 1.0
Bergey	1.5, 10
Atlantic Orient Corp.	50
Northern Power Systems	100
Enercon	500, 850
Micon	600, 900
Bonus	600, 1000
Vestas	660, 850, 1650, 2000
Nordex	1000
Mitsubishi	600, 1000

To estimate the quantities and types of materials used in wind turbines, a database was compiled from a variety of industrial, DOE laboratory and existing PERI sources. Much of the wind turbine and component characteristics and weight data came from the DOE, Wind Partnerships for Advanced Technologies (WindPACT) program database through NREL and their subcontractors, as well as directly from turbine manufacturers, their web sites and marketing materials. Twenty-eight types and models of turbines were analyzed in this report, ranging from small models for direct current (DC) battery charging (e.g. the 0.4 kW Southwest Windpower turbine), to large grid connected alternating current (AC) machines currently commercially available (e.g. the Enron 1.5 MW) and being employed in 100-200 MW wind power plants. Very large multi-megawatt machines being designed for future wind farm applications, both on- and off-shore (e.g. the 5 MW NREL concept turbine), were also included in expected future markets after 2005. The specific models, type and size, that were assumed for each manufacturer as the basis for estimating current and future market share in our model is shown in Table 2. The actual unit production and sales data incorporated in the market share database is considered proprietary by the manufacturers. This data was used in estimating weights of materials shown in Table 3.

Future Market Projections

The surge in growth in wind turbine installations in the United States and around the world is expected to continue and actually accelerate. In a study conducted by the World Energy Council (WEC) projected worldwide wind capacity of 13 gigawatts (GW) by 2000 (actual installed capacity was 13.6 GW by the end of 1999), increasing to 72 GW by 2010 and 180 GW by 2020. WEC also considered an "environmentally driven scenario" that has much faster growth if national policies were adjusted. That scenario projected 470 GW of wind power by 2020.

In the United States, the American Wind Energy Association (AWEA) supports the DOE projections for wind power.

- Provide at least 5% of the nation's electricity by 2020 with 10 GW online by 2010 and 80 GW by 2020.
- Double the number of states with more than 20 MW installed to 16 by 2005 and to 24 by 2010.
- Provide 5% of the electricity used by the federal government (the largest single consumer of electricity) by 2010 with 1,000 MW online.

The members of the European Wind Energy Association (EWEA) have increased their estimates for wind installations in that region. Since 1993, the market for new turbines has grown at over 40 % per year. During 1999 was a record year with over 3000 MW installed in that year, resulting in a total installed capacity of 9,500 MW. This is well above the EWEA's old target for 2000 of 8000 MW. With support from the European Commission, studies show and the wind industry believes that the target of 40 GW will also be passed sooner, so the target for 2010 has been raised to 50 GW, of which 5 GW are expected to be offshore capacity. Similarly, a new target of 150 GW was agreed to by EWEA for 2020, of which 50 GW will be offshore.

The future markets for wind turbines in the United States and Europe are large but the biggest potential is expected to be in Asia, Latin America, the Former Soviet Union and Africa. These are the markets where demand for electricity is growing the fastest and the need for sustainable development with reliance on domestic energy resources are the greatest [6]. Growth in these markets could surpass both Europe and the U.S. by 2020.

Materials Usage in Current Wind Turbines

A wide range of materials are used in wind turbines. There are substantial differences between small and large machines and there are projected changes in designs that will accommodate the introduction of new material technologies and manufacturing methods. The estimated materials use in small and large turbines is shown in Table 3. To arrive at a total, the material usage is weighted by the estimated market share of the various manufacturers and machines types.

Table 3. Percentage of Materials Used in Current Wind Turbine Component

Large Turbines and *(Small Turbines*[1]*)*

Component/ Material (% by weight)	**Permanent Magnetic Materials**	**Pre-stressed Concrete**	**Steel**	**Aluminum**	**Copper**	**Glass Reinforced Plastic** [4]	**Wood Epoxy** [4]	**Carbon Filament Reinforced Plastic** [4]
Rotor								
Hub			*(95)* - 100	*(5)*				
Blades			5			95	*(95)*	*(95)*
Nacelle [2]	*(17)*		*(65)* - 80	3 - 4	14	1 - *(2)*		
Gearbox [3]			98 -*(100)*	*(0)* - 2	*(<1)* - 2			
Generator	*(50)*		*(20)* - 65		*(30)* - 35			
Frame, Machinery & Shell			85 - *(74)*	9 - *(50)*	4 - *(12)*	3 - *(5)*		
Tower		2	98	*(2)*				

Notes:
1. Small turbines with rated power less than 100 kW- (listed in italics where different)
2. Assumes nacelle is 1/3 gearbox, 1/3 generator and 1/3 frame & machinery
3. Approximately half of the small turbine market (measured in MW) is direct drive with no gearbox
4. Rotor blades are either glass reinforced plastic, wood-epoxy or injection molded plastic with carbon fibers

The trends in design and manufacturing differ between small and large turbines. Small machines tend to use lighter weight castings in an effort to reduce costs. Many parts are die cast aluminum in small turbines, while in large machines steel castings or forgings are needed to meet strength and structural fatigue requirements. The size of steel castings for large turbines, especially the blade hub units, is one of the manufacturing challenges.

Material fatigue properties are an important consideration in wind turbine design and materials selection. During the expected 30 year life of a wind turbine, many of the components will need to be able to endure 4×10^8 fatigue stress cycles. This high cycle fatigue resistance is even more severe than aircraft, automotive engines, bridges and most other man-made structures.

Future Component Development Trends

There are new component developments underway now that will significantly change the materials usage patterns. Generally there are trends toward lighter weight materials, as long as the life-cycle cost is low. Specific development trends in turbine components are discussed below:

Rotors — Most rotor blades in use today are built from glassfiber-reinforced-plastic (GRP). Other materials that have been tried include steel, various composites and carbon-filament-reinforced-plastic (CFRP). As the rotor size increases on larger machines, the trend will be toward high strength, fatigue resistant materials. As the turbine designs continually evolve, composites involving steel, GRP, CFRP and possibly other materials will likely come into use.

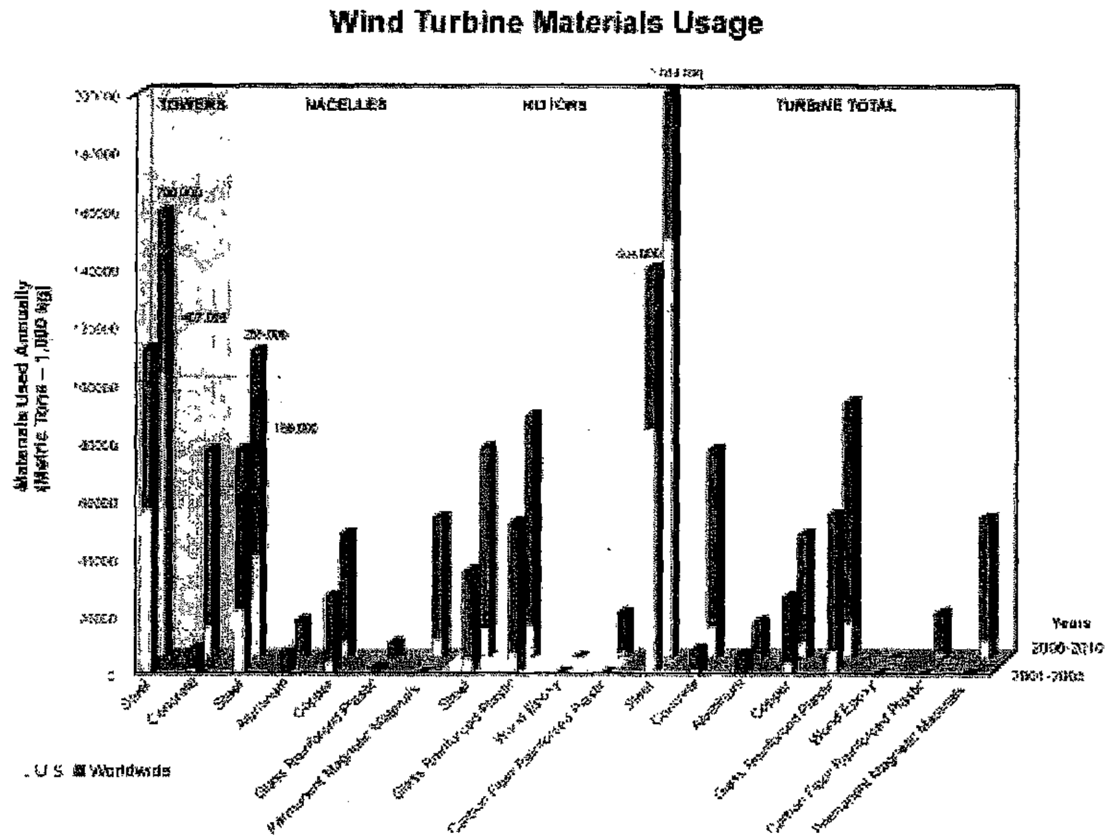
Gearboxes — The step-up gearbox used on large turbines today is expected to be replaced in many future machines. Most small turbine designed for battery charging use a variable speed, permanent magnet, variable frequency generator connected to a rectifier. As high power solid state electronics are improved, larger and larger machines are likely to use AC-DC-AC cycloconverters. This is the case on turbines being developed by Northern Power Systems (100 kW), the ABB (3 MW), and in some commercial machines. This trend will increase the use of magnetic materials in future turbines. Large epicyclic gear boxes used in large ships, may continue to be the drive system for some large turbines.

Nacelles — The nacelle contains an array of complex machinery including, yaw drives, blade pitch change mechanisms, drive brakes, shafts, bearings, oil pumps and coolers, controllers and more. These are areas where simplification and innovation can pay off.

Towers — Low cost materials are especially important in towers, since towers can represent as much as 65% of the weight of the turbine. Prestressed concrete is a material that is starting to be used in greater amounts in European turbines, especially in off-shore or near-shore applications. Concrete in towers has the potential to lower cost, but may involve nearly as much steel in the reinforcing bars as a conventional steel tower.

Material Usage Trends Through 2010

The component development trends described above are reflected in the following material use projections. The overall annual material usage trends are shown in the following figure for two periods, from now though 2005 and for 2006 though 2010. Introduction of much of the new technology discussed above is expected to be incorporated in commercial machines during the later period. Materials used in machines installed in the U.S. are included as part of the global totals.



The following observations are based on the results of the material usage analysis:

- Turbine material usage is and will continue to be dominated by steel, but opportunities exist for introducing aluminum or other light weight composites, provided strength and fatigue requirements can be met.
- Small turbine production volume is increasing rapidly which can be accommodated by manufacturing mechanization and innovation that will lower costs.
- Elimination of the gearbox by using variable speed generators will increase through use of permanent magnetic generators on larger turbines increasing the need for magnetic materials.
- New high power electronics will help reduce the need for gearboxes and also decrease losses occurred during transmission of wind power to distant load centers.
- Simplification of the nacelle machinery may not only reduce costs, but also increase reliability.
- Blades are primarily made of GRP, which is expected to continue. While use of CFRP may help to reduce weight and cost some, low cost and reliability are the primary drivers.
- Increasing the use of offshore applications may partially offset this trend in favor of the use of composites.
- Prestressed concrete towers are likely to be used more, but will need a substantial amount of steel for reinforcement.

- Wood epoxy, used in early blade production, is not expected to be a material of choice despite excellent fatigue properties.
- Wind turbine component and materials manufacturing are major and expanding business opportunities for at least the next 10 years.
- The largest market for wind turbine systems and materials in the future will be outside North America and Europe, but this market will be slower in development.

References:

1) International Energy Agency, Implementing Agreement for Co-operation in the Research and Development of Wind Turbine Systems, *Annual Report 2000*, May 2001.

2) American Wind Energy Association, *Global Wind Energy Market Report: Wind Energy Growth Was Steady in 2000, Outlook for 2001 Is Bright.* AWEA web site: http://www.awea.org/faq/Global05-2001.PDF.

3) American Wind Energy Association. 2001. Wind Project Database: Wind Energy Projects Throughout the United States. AWEA web site: http://www.awea.org/projects/index.html.

4) Department of Energy, *Wind Power Today,* DOE/GO-102001-1325, May 2001.

5) Electric Power Research Institute and DOE, *Renewable Energy Technology Characterizations,* EPRI TR-109496, December 1997.

6) Legerton M L, Adamantiades A G, Ancona DF, *Wind Power Plants,* World Energy Council Conference, Houston, TX, Working Group Paper 3.3, 15 September 1998.

Projects Committee of the
Connecticut Clean Energy Fund Board

Thursday, November 12, 2009

A regular meeting of the **Projects Committee (the "Committee") of the Renewable Energy Investments Board hereinafter referred to as the "Connecticut Clean Energy Fund Board"** was held on November 12, 2009, at the office of the Connecticut Clean Energy Fund, 200 Corporate Place, Rocky Hill, CT.

1. **Call to Order**: Noting the presence of a quorum, Mr. Peters, Chairman of the Committee, called the meeting to order at 10:02 a.m. Committee members present: Alan Greene (by phone), Kevin Hennessy (by phone), and Jerry Peters (by phone). Absent: Robert Maddox and John Olsen.

Staff and Adjunct Staff Attending: Christin Cifaldi, Lise Dondy (by phone), Dale Hedman, Dave Ljungquist, Shelly Mondo, Rick Ross, and Matthew Stone.

2. **Approval of Meeting Minutes:**

Mr. Peters asked the Committee members to consider the minutes from the October 15, 2009 meeting.

> **Upon a motion made by Mr. Hennessy, seconded by Mr. Peters, the Committee members voted in favor of adopting the minutes from the October 15, 2009 meeting as presented (Mr. Greene abstained from the vote).**

3. **Pre-Development Loans Phase 2—BNE Wind Colebrook and BNE Wind Prospect**

Mr. Hedman stated that the Projects Committee in July 2008 approved pre-development program funding for Phase 1 of two BNE Energy Inc. wind projects as follows: 1) Wind Prospect in the amount of $102,375; and 2) Wind Colebrook in the amount of $119,625. He discussed the milestones required and achieved for the pre-development funding for both projects. Based on the progress made in Phase I, CCEF staff recommends predevelopment funding for Phase 2 of both projects.

Mr. Hedman discussed the background of the process that ultimately led to the predevelopment funding and the two-step phasing of the projects. He reviewed some of the parameters of Phase 1. Mr. Hedman mentioned that some concern was expressed with obtaining support from the two communities prior to funding, and CCEF was provided with letters of support from the Mayor of Prospect and first Selectman of Colebrook. He stated that the two projects will be the first fairly large wind projects undertaken by the CT Siting Council. Mr. Hedman noted that both projects have submitted FAA applications and approval for Wind Colebrook was granted.

Mr. Hedman explained that one of the milestones was to have one year of wind resource data. He noted that 9 to 10 months of the wind data has been provided, and the data and extrapolations indicate sufficient wind resource data to move to Phase 2. Mr. Hedman stated that both projects are dependent upon federal funding through tax credits and loan guarantees, and the developer has requested that the timing for Phase 2 be moved ahead in order to meet the deadlines associated with federal funding.

Mr. Hennessy raised questions about public relations and outreach. Mr. Hedman stated that the developer has been focusing on obtaining the data needed to move to Phase 2 and understanding the markets for the turbines. He noted that the activities for outreach and public relations will begin in the near future and before filing with the Siting Council.

Mr. Hedman reviewed the milestones proposed for Phase 2 and budgets for both sites. He stated that the wind resource data provides sufficient information to indicate that the projects should be feasible, and staff recommends funding for Phase 2.

The Committee members discussed the costs for the projects in comparison with other technologies. CCEF staff explained that costs are reasonable. CCEF staff will continue to follow this project very closely and will assist with community public relations as needed.

Upon a motion made by Mr. Greene, seconded by Mr. Hennessy, the Committee members voted unanimously in favor of adopting the following resolution regarding funding for Phase 2 for Wind Prospect and Wind Colebrook:

RESOLVED:

(1) that the Wind Prospect project and Wind Colebrook project ("Projects"), 10 MW each wind system seeking funding under the Pre-Development Program for Phase 2 of the Projects, to be located in Prospect and Colebrook, Connecticut have been determined by the Connecticut Clean Energy Fund, Board of Directors ("CCEF Board") to be consistent with and in the furtherance of the CCEF Comprehensive Plan and that a loan be approved to fund said Projects in an amount not to exceed $397,625 for Wind Prospect and $380,375 for Wind Colebrook;

(2) that if sufficient funds are available to fund the Projects, then Peter Longo, President and Executive Director of Connecticut Innovations, Inc. (CI), Lise Dondy, Vice President of CI and President of the CCEF, or any other duly authorized officer of CI, is authorized to execute and deliver for, and on behalf of the CCEF, not later than May 31, 2010, any contract or other legal instrument necessary to effectuate such grant on terms and conditions as he or she shall deem to be in the interests of the CCEF and ratepayers, in conformance with the wishes of the CCEF Board, and in conformance with Section VI of the operating procedures of the CCEF Board. The authorized officer's approval thereof is hereby authorized to be conclusively evidenced by the execution and delivery of said legal instrument; and

(3) that the proper CI officers are authorized and empowered to do all other acts and execute and deliver all other documents as they shall deem necessary and desirable to effect the above-mentioned legal instrument.

Other business:

Ms. Dondy mentioned that information was provided about the pipeline for municipal projects which are anticipated to be funded with Regional Greenhouse Gas Initiative proceeds.

4. **<u>Adjournment</u>:**

Upon a motion made by Mr. Greene, seconded by Mr. Hennessy, the Committee members voted unanimously in favor of adjourning the November 12, 2009 meeting at 10:30 a.m.

Respectfully submitted,

____

Jerry Peters, Chairman of the Committee

Projects Committee of the
Connecticut Clean Energy Fund Board
Minutes
Thursday, June 24, 2010

A regular meeting of the **Projects Committee (the "Committee") of the Renewable Energy Investments Board hereinafter referred to as the "Connecticut Clean Energy Fund Board"** was held on June 24, 2010, at the office of the Connecticut Clean Energy Fund, 200 Corporate Place, Rocky Hill, CT.

1. **Call to Order**: Noting the presence of a quorum, Mr. Greene, Chairman of the Committee, called the meeting to order at 10:04 a.m. Committee members present: Alan Greene (by phone), Kevin Hennessy (by phone), Matthew Ranelli (by phone) and John Olsen (by phone). Absent: Robert Maddox .

Staff and Adjunct Staff Attending: George Bellas, Christin Cifaldi, Lise Dondy (by phone), Dale Hedman, Elizabeth Olney, and Rick Ross.

Others Present: Jennifer Vece, UTC Power.

2. **Public Comments:** There were no public comments. Mr. Greene thanked Jennifer Vece for attending

3. **Approval of Meeting Minutes:**

Mr. Greene asked the Committee members to consider the minutes from the May 27, 2010 meeting.

> **Upon a motion made by Mr. Hennessy, seconded by Mr. Ranelli, the Committee members voted unanimously in favor of adopting the minutes from the May 27, 2010 meeting as presented.**

4. **On-Site DG Program Project Proposals:**

"Cromwell Middle School, Cromwell—PV Project"

Before beginning the presentation, Mr. Ranelli noted a potential conflict of interest and recused himself from any discussion or vote on this proposal. Ms. Cifaldi discussed the proposal by the Town of Cromwell under the On-Site Renewable DG Program for a 202.9 kW_{STC} PV system to be installed on the roof of the Cromwell Middle School in Cromwell, Connecticut. The final application for the project was submitted in May 2010. An energy audit was performed, and several energy efficiency measures were recommended and will be implemented prior to CCEF funding. Ms. Cifaldi described the project, the project participants, the efficiencies, the estimated annual energy output, total costs, and the recommended incentive.

Upon a motion made by Mr. Hennessy, seconded by Mr. Greene, the Committee members voted in favor of adopting the following resolution regarding the PV project for the Cromwell Middle School, Cromwell (Mr. Ranelli did not participate in the vote for the project):

RESOLVED:

(1) that the 202.9 kW_{STC} solar photovoltaic system to be located at the Cromwell Middle School, 6 Mann Memorial Drive, Cromwell ("Project"), has been determined by the Connecticut Clean Energy Fund, Board of Directors ("CCEF Board") to be in the furtherance of the CCEF Comprehensive Plan and in the interests of ratepayers, and that funding be approved for the Project in an amount not to exceed $690,169 ("Grant"), which includes $13,069 as the present value incentive of the estimated Renewable Energy Credits or Certificates ("RECs") to be produced by the Project over its contractual life, but that legal title to the RECs produced by the Project shall remain with CCEF for the contractual life of the Project, and that said Grant is contingent upon sufficient funds being available to CCEF for the purpose of funding renewable energy projects under CCEF's On-Site Renewable Distributed Generation Program or other CCEF installed capacity programs;

(2) that if sufficient funds are available to fund the Project, then Peter Longo, President and Executive Director of Connecticut Innovations, Inc. (CI), Lise Dondy, Vice President of CI and President of the CCEF, or any other duly authorized officer of CI, is authorized to execute and deliver for, and on behalf of the CCEF, not later than September 30, 2010, any contract or other legal instrument necessary to effect the Grant on terms and conditions as he or she shall deem to be in the interests of the CCEF and ratepayers, in conformance with the wishes of the CCEF Board, and in conformance with Section VI of the operating procedures of the CCEF Board. The authorized officer's approval thereof is hereby authorized to be conclusively evidenced by the execution and delivery of said legal instrument; and

(3) that the proper CI officers are authorized and empowered to do all other acts and execute and deliver all other documents as they shall deem necessary and desirable to effect the above-mentioned legal instrument.

"Whole Foods Warehouse, Cheshire—PV Project"

Ms. Cifaldi presented the proposal by SunEdison under the On-Site Renewable DG Program for a 141.0 kW_{STC} PV system to be installed on the roof of the Whole Foods Distribution Center in Cheshire, Connecticut. The project is a Power Purchase Agreement owned by SunEdison. An energy audit was performed, and several energy efficiency measures were recommended and will be implemented prior to CCEF funding. Ms. Cifaldi described the project, the project participants, the efficiencies, the estimated annual energy output, total costs, and the recommended incentive.

Upon a motion made by Mr. Greene, seconded by Mr. Hennessy, the Committee members voted unanimously in favor of adopting the following resolution regarding the PV project for the Whole Foods Distribution Center, Cheshire:

RESOLVED:

(1) that the 141.0 kW_{STC} solar photovoltaic system to be located at the Whole Foods Distribution Center, 400 East Johnson Avenue, Cheshire ("Project"), has been determined by the Connecticut Clean Energy Fund, Board of Directors ("CCEF Board") to be in the furtherance of the CCEF Comprehensive Plan and in the interests of ratepayers, and that funding be approved for the Project in an amount not to exceed $344,970 ("Grant"), which includes $8,970 as the present value incentive of the estimated Renewable Energy Credits or Certificates ("RECs") to be produced by the Project over its contractual life, but that legal title to the RECs produced by the Project shall remain with CCEF for the contractual life of the Project, and that said Grant is contingent upon sufficient funds being available to CCEF for the purpose of funding renewable energy projects under CCEF's On-Site Renewable Distributed Generation Program or other CCEF installed capacity programs;

(2) that if sufficient funds are available to fund the Project, then Peter Longo, President and Executive Director of Connecticut Innovations, Inc. (CI), Lise Dondy, Vice President of CI and President of the CCEF, or any other duly authorized officer of CI, is authorized to execute and deliver for, and on behalf of the CCEF, not later than September 30, 2010, any contract or other legal instrument necessary to effect the Grant on terms and conditions as he or she shall deem to be in the interests of the CCEF and ratepayers, in conformance with the wishes of the CCEF Board, and in conformance with Section VI of the operating procedures of the CCEF Board. The authorized officer's approval thereof is hereby authorized to be conclusively evidenced by the execution and delivery of said legal instrument; and

(3) that the proper CI officers are authorized and empowered to do all other acts and execute and deliver all other documents as they shall deem necessary and desirable to effect the above-mentioned legal instrument.

"Loomis Chaffee, School, Windsor—Request for Extension of Deadline"

Ms. Cifaldi mentioned the Loomis Chaffee School has requested a 90 day extension to execute the Financial Assistance Agreement. The Projects Committee previously approved an incentive for the installation under the On-Site Renewable DG Program for a 144.0 kW_{STC} PV system at the school. The original expiration date was May 31, 2010, and the school would like to extend the expiration date to August 31, 2010.

Upon a motion made by Mr. Ranelli, seconded by Mr. Hennessy, the Committee members voted unanimously in favor of adopting the following resolution regarding the extension of the execution of the Financial Assistance Agreement for the Loomis Chaffee School, Windsor:

RESOLVED:

(1) that the 144.0 kW_{STC} solar photovoltaic system to be located at the Loomis Chaffee School, 4 Bathelder Road, Windsor ("Project"), has been determined by the Connecticut Clean Energy Fund, Board of Directors ("CCEF Board") to be in the furtherance of the CCEF Comprehensive Plan and in the interests of ratepayers, and that funding be approved for the Project in an amount not to exceed \$527,412 ("Grant"), which includes \$16,812 as the present value incentive of the estimated Renewable Energy Credits or Certificates ("RECs") to be produced by the Project over its contractual life, but that legal title to the RECs produced by the Project shall remain with CCEF for the contractual life of the Project, and that said Grant is contingent upon sufficient funds being available to CCEF for the purpose of funding renewable energy projects under CCEF's On-Site Renewable Distributed Generation Program or other CCEF installed capacity programs;

(2) that if sufficient funds are available to fund the Project, then Peter Longo, President and Executive Director of Connecticut Innovations, Inc. (CI), Lise Dondy, Vice President of CI and President of the CCEF, or any other duly authorized officer of CI, is authorized to execute and deliver for, and on behalf of the CCEF, not later than August 31, 2010, any contract or other legal instrument necessary to effect the Grant on terms and conditions as he or she shall deem to be in the interests of the CCEF and ratepayers, in conformance with the wishes of the CCEF Board, and in conformance with Section VI of the operating procedures of the CCEF Board. The authorized officer's approval thereof is hereby authorized to be conclusively evidenced by the execution and delivery of said legal instrument; and

(3) that the proper CI officers are authorized and empowered to do all other acts and execute and deliver all other documents as they shall deem necessary and desirable to effect the above-mentioned legal instrument.

"Weston Middle School, Weston—Fuel Cell Project"

Mr. Ross reviewed the proposal by UTC Power under the On-Site Renewable DG Program for a 400 kW fuel cell system to be located at the Weston Middle School located in Weston, Connecticut. The Town of Weston will enter into a 10-year Energy Service Agreement with UTC Power which may be extended upon mutually satisfactory terms and conditions. Weston has worked out an agreement with CL&P to allow the Town of Weston to net meter any excess power generation from the fuel cell to the adjacent High School's account, at the prevailing retail electric rate. However, Weston under this agreement will not be able to receive any credit for demand charges, just credit on the energy. The fuel cell will provide thermal energy in the form of hot water to the Middle School only. The project, if approved, will receive funding under the Federal American Recovery and Reinvestment Act. Mr. Ross described the project, the project participants, the estimated annual system energy output, project financials, and the recommended CCEF incentive.

Upon a motion made by Mr. Ranelli, seconded by Mr. Hennessy, the Committee members voted unanimously in favor of adopting the following resolution regarding the fuel cell project for the Weston Middle School, Weston:

RESOLVED:

(1) that the 400 kW Fuel Cell system to be located at the Weston Middle School, 135 School Road, Weston ("Project"), has been determined by the Connecticut Clean Energy Fund, Board of Directors ("CCEF Board") to be in the furtherance of the CCEF Comprehensive Plan and in the interests of ratepayers, and that funding be approved for the Project in an amount not to exceed $1,000,000 ("Grant"), and that said Grant is contingent upon sufficient funds being available to CCEF for the purpose of funding renewable energy projects under CCEF's On-Site Renewable Distributed Generation Program or other CCEF installed capacity programs;

(2) that if sufficient funds are available to fund the Project, then Peter Longo, President and Executive Director of Connecticut Innovations, Inc. (CI), Lise Dondy, Vice President of CI and President of the CCEF, or any other duly authorized officer of CI, is authorized to execute and deliver for, and on behalf of the CCEF, not later than December 31, 2010, any contract or other legal instrument necessary to effect the Grant on terms and conditions as he or she shall deem to be in the interests of the CCEF and ratepayers, in conformance with the wishes of the CCEF Board, and in conformance with Section VI of the operating procedures of the CCEF Board. The authorized officer's approval thereof is hereby authorized to be conclusively evidenced by the execution and delivery of said legal instrument; and

(3) that the proper CI officers are authorized and empowered to do all other acts and execute and deliver all other documents as they shall deem necessary and desirable to effect the above-mentioned legal instrument.

"Alexion Pharmaceutical, Cheshire—Fuel Cell Project"

Mr. Ross discussed the proposal by UTC Power under the On-Site Renewable DG Program for a 400 kW fuel cell system to be located at the Alexion Pharmaceutical plant in Cheshire, Connecticut. Alexion Pharmaceutical will enter into a 10-year Energy Service Agreement with UTC Power which may be extended upon mutually satisfactory terms and conditions. Alexion has complete buy-in from the building owner for this project and has signed a long term lease agreement. Mr. Ross described the project, the project participants, the estimated annual system energy output, project financials , and the recommended CCEF incentive.

Upon a motion made by Mr. Ranelli, seconded by Mr. Hennessy, the Committee members voted unanimously in favor of adopting the following resolution regarding the fuel cell project for Alexion Pharmaceutical, Inc.

RESOLVED:

(1) that the 400 kW Fuel Cell system to be located at the Alexion Pharmaceutical facility located at 352 Knotter Drive, Cheshire ("Project"), has been determined by the Connecticut Clean Energy Fund, Board of Directors ("CCEF Board") to be in the furtherance of the CCEF Comprehensive Plan and in the interests of ratepayers, and that funding be approved for the Project in an amount not to exceed $502,000 ("Grant"), and that said Grant is contingent upon sufficient funds being available to CCEF for the purpose of funding renewable energy projects under CCEF's On-Site Renewable Distributed Generation Program or other CCEF installed capacity programs;

(2) that if sufficient funds are available to fund the Project, then Peter Longo, President and Executive Director of Connecticut Innovations, Inc. (CI), Lise Dondy, Vice President of CI and President of the CCEF, or any other duly authorized officer of CI, is authorized to execute and deliver for, and on behalf of the CCEF, not later than December 31, 2010, any contract or other legal instrument necessary to effect the Grant on terms and conditions as he or she shall deem to be in the interests of the CCEF and ratepayers, in conformance with the wishes of the CCEF Board, and in conformance with Section VI of the operating procedures of the CCEF Board. The authorized officer's approval thereof is hereby authorized to be conclusively evidenced by the execution and delivery of said legal instrument; and

(3) that the proper CI officers are authorized and empowered to do all other acts and execute and deliver all other documents as they shall deem necessary and desirable to effect the above-mentioned legal instrument.

"Wind Prospect II and Wind Colebrook II—Extension of Deadline"

Mr. Hedman discussed the recommendation to extend the execution date for the Pre-Development Loan Agreement for Wind Prospect II and Wind Colebrook II. The original expiration date was May 31, 2010, and staff recommends an extension to July 31, 2010.

Upon a motion made by Mr. Hennessy, seconded by Mr. Greene, the Committee members voted unanimously in favor of adopting the following resolution regarding the extension of the execution of the Pre-Development Loan Agreement for Wind Prospect II and Wind Colebrook II:

RESOLVED:

(1) that the Wind Prospect and Wind Colebrook projects ("Projects"), 10 MW each wind system seeking funding under the Pre-Development Program for Phase 2 of the Projects, to be located in Prospect and Colebrook, Connecticut have been determined by the Connecticut Clean Energy Fund, Board of Directors ("CCEF Board") to be in the furtherance of the CCEF Comprehensive Plan and in the interests of ratepayers, and that funding be approved for the Project in an amount not to exceed $397,625 for Wind Prospect and $380,375 for Wind Colebrook ("Grants"), and that said Grants are contingent upon sufficient funds being available to CCEF for the purpose of funding renewable energy projects under CCEF's On-Site Renewable Distributed Generation Program or other CCEF installed capacity programs;

(2) that if sufficient funds are available to fund the Project, then Peter Longo, President and Executive Director of Connecticut Innovations, Inc. (CI), Lise Dondy, Vice President of CI and President of the CCEF, or any other duly authorized officer of CI, is authorized to execute and deliver for, and on behalf of the CCEF, not later than July 31, 2010, any contract or other legal instrument necessary to effect the Grants on terms and conditions as he or she shall deem to be in the interests of the CCEF and ratepayers, in conformance with the wishes of the CCEF Board, and in conformance with Section VI of the operating procedures of the CCEF Board. The authorized officer's approval thereof is hereby authorized to be conclusively evidenced by the execution and delivery of said legal instrument; and

(3) that the proper CI officers are authorized and empowered to do all other acts and execute and deliver all other documents as they shall deem necessary and desirable to effect the above-mentioned legal instrument.

"RGGI PV Municipal Pipeline Update"

Ms. Cifaldi provided a brief update on the municipal projects in the pipeline anticipated to be funded from the Regional Greenhouse Gas Initiative ("RGGI"). There are currently 30 projects requesting approximately $8,932,927 in grant funding. The Projects Committee has approved 15 municipal projects for a total of $2,502,397, and it is anticipated that approximately 9 more municipal projects can be approved with the anticipated RGGI funds.

5. Other Business: Ms. Dondy provided an update on projects receiving funds under the American Reinvestment Recovery Act.

6. Adjournment:

Upon a motion made by Mr. Ranelli, seconded by Mr. Hennessy, the Committee members voted unanimously in favor of adjourning the May 27, 2010 meeting at 10:50 a.m.

Respectfully submitted,

Alan Greene, Chairman of the Committee

GE
Energy

Extreme Wind Speed – Risk and Mitigation

Vinicius Ubarana
Philippe Giguere

Wind Application Engineering
Greenville, SC

Extreme Wind Speed – Risk and Mitigation

Introduction

Certain wind project sites may experience extreme wind speeds caused by a severe weather situation, such as a hurricane or tornado. Since extreme wind events may result in mechanical load levels that can lead to damage or failure of wind turbine components, the purpose of this document is to inform customers about risk from extreme wind events and suggest risk mitigation actions that are based on recognized industry practices.

GE's wind turbines are designed to withstand a certain level of loading caused by an extreme wind event. As defined in the IEC 61400-1 wind turbine design/safety standard, the largest wind speed to be considered is called "Ve50," which is the maximum gust over a 50-year return period for a 3-second averaging time. In a Ve50 situation, the control system of the wind turbine is assumed to be able to pitch the blades in a feathered position, resulting in minimal rotor torque. *Table 1* lists the Ve50 limits for different GE wind turbines for the site conditions specified in the IEC 61400-1standard.

Turbine Model	Ve50 (m/s) at Hub Height
1.5xle or 2.3	52.5
1.5sle	55
1.5s, 2.5s, or 2.5xl	59.5
1.5se	70

Table 1. 50-year, 3-sec wind speed gust (Ve50) limits for GE wind turbines at hub height.
(For site conditions specified in the IEC 61400-1 standard.)

Actual Ve50 limits can vary based on site-specific conditions, and the Ve50 limits in *Table 1* assume the following site conditions [1]:

- Maximum flow inclination angle: 8 degrees
- Air density: 1.225 kg/m³ (sea level)
- Vertical wind shear exponent: 0.11

The Ve50 limits in *Table 1* apply as long as the site-specific conditions are within those specified by the IEC standard.[1] If any or several of the site conditions in terms of flow inclination angle, air density, and vertical wind shear exceed those specified in the IEC 61400-1 standard, the actual Ve50 limit of the wind turbine of interest may be lower than that listed in *Table 1* and GE should review these conditions. Also, if one or several blades should fail to pitch to a feathered position, the maximum wind speed the wind turbine can sustain may be lower than the values listed in *Table 1*, for given site conditions.

Risk

Wind turbine component damage or failure can occur when extreme wind produces forces on the wind turbine plant buildings/machines above the Ve50 design limit. Failures may not only prohibit the operation of the wind turbine, but could also lead to third party risk. Natural disasters such as hurricanes and tornadoes are well documented and the areas they affect are well defined, but their occurrence and behavior are not well anticipated.[2] Furthermore, other natural storming wind producers such as—but not limited to—squall lines, microburst, or extra-tropical cyclones can occur at anytime, regardless of the location on the globe. With today's meteorological knowledge, predicting the maximum wind speed from a storm is unrealistic in most cases.[3]

The mode of failure of a wind turbine due to an extreme wind event cannot be generalized and depends on the turbine type and configuration, as well as the specifics of the extreme wind event and site conditions. Examples of possible failure scenarios include blade failure or a tower buckling or overturning. When winds are above the cut-out speed, the wind turbine should have its blades idling in a position creating minimal torque on the rotor. This is the only safety mechanism other than the yaw control. If a grid failure were to occur in conjunction with an extreme wind event—which is a likely scenario—the yaw control will become inactive. The loss of yaw control could increase the likelihood of damage/failure in the case of an extreme wind event. Also, the grid components/structures could also be part of the potential windborne debris. At this time, GE has no modeling capability in place that can predict the impact made to a wind plant if an extreme wind event occurs.

Risk Mitigation

The decision to build a wind site and to protect the public from negative impacts of an extreme wind event is the responsibility of the project developer/owner. For some types of wind events—such as tropical cyclones—there is meteorological expertise/data to quantify the probability of occurrence of a wind gust above the design limit of the wind turbine that is being considered for a particular area.[4] Based upon recognized industry practices, GE suggests that the following actions be considered when siting turbines in order to mitigate risk resulting from extreme wind speed events:

- **Turbine Siting.** For sites located in well-known storm areas, where winds could lead to extreme damaging gusts, a good approach is to assess the remoteness of the potential wind plant. As mentioned before, some natural disasters could lead to extreme wind speeds above the design limit of GE's wind turbines. Remote areas usually tend to reduce the potential for collateral damage in the event of storming winds, however the risk to wind turbine equipment is independent of the remoteness of the site.
- **Physical and Visual Warnings.** Should a customer decide to build on a site with extreme wind risk, GE recommends that the site be made private by using a fence and visual warning signs at the boundary of every site—regardless of its location.
- **Turbine Deactivation.** Ensure that equipment is in good working order and that turbine control systems designed to protect equipment in the event of an extreme wind speed occurrence are operational.
- **Operator Safety.** Restrict access to the wind plant by site personnel while extreme wind speed conditions exist. If site personnel must access the site while extreme wind speed conditions either exist or are probable, safety precautions may include remotely shutting down the turbine, yawing to place the turbine rotor on the opposite side of the tower access door, and parking vehicles at a safe distance from the tower. Operating a wind turbine that has experienced an extreme wind event may not be safe and the wind turbine should be thoroughly inspected before normal operation is resumed.

References

The following informative papers address the topic of wind turbines/extreme wind events and safety. These papers are created and maintained by other public and private organizations. GE does not control or guarantee the accuracy, relevance, timeliness, or completeness of this outside information. Further, the order of the references is not intended to reflect their importance, nor is it intended to endorse any views expressed or products or services offered by the authors of the references.

[1] *International Standard – IEC 61400-1, Wind Turbines – Part 1: Design Requirements*. Third Edition 2005-8 – IEC ref # IEC 61400-1:2005 (E).

[2] *Hurricanes...Unleashing Nature's Fury: A Preparedness Guide*, National Oceanic and Atmospheric Administration – NOAA.

[3] Hironori Kikugawa and Bogusz Bienkiewicz, *Wind Damages and Prospects for Accelerated Wind Damage Reduction in Japan and in the United States.*

[4] Christopher W. Landsea*, Craig Anderson**, Noel Charles***, Gilbert Clark***, Jason Dunion*, Jose Fernandez-Partagas*****, Paul Hungerford***, Charlie Neumann****, Mark Zimmer***: *The Atlantic Hurricane Database Re-analysis Project Documentation for 1851-1910. Alterations and Addition to the HURDAT Database.*

*NOAA/Hurricane Research Division, Miami, Florida, USA
**NOAA/Climate Diagnostics Center, Boulder, Colorado, USA
***Florida International University, Miami
****SAIC, Miami
*****Deceased, Contributed as a Chapter for the RPI Book, Revised - 6 January 2003.

[5] Fujita, T.T., 1971, *Proposed Characterization of Tornadoes and Hurricanes by Area and Intensity.* Satellite and Meso-meteorology Research Project Report 91, Univ. of Chicago, 42 pp. See *Table A-1* (Potential wind damages according to wind speed for supporting technical information.)

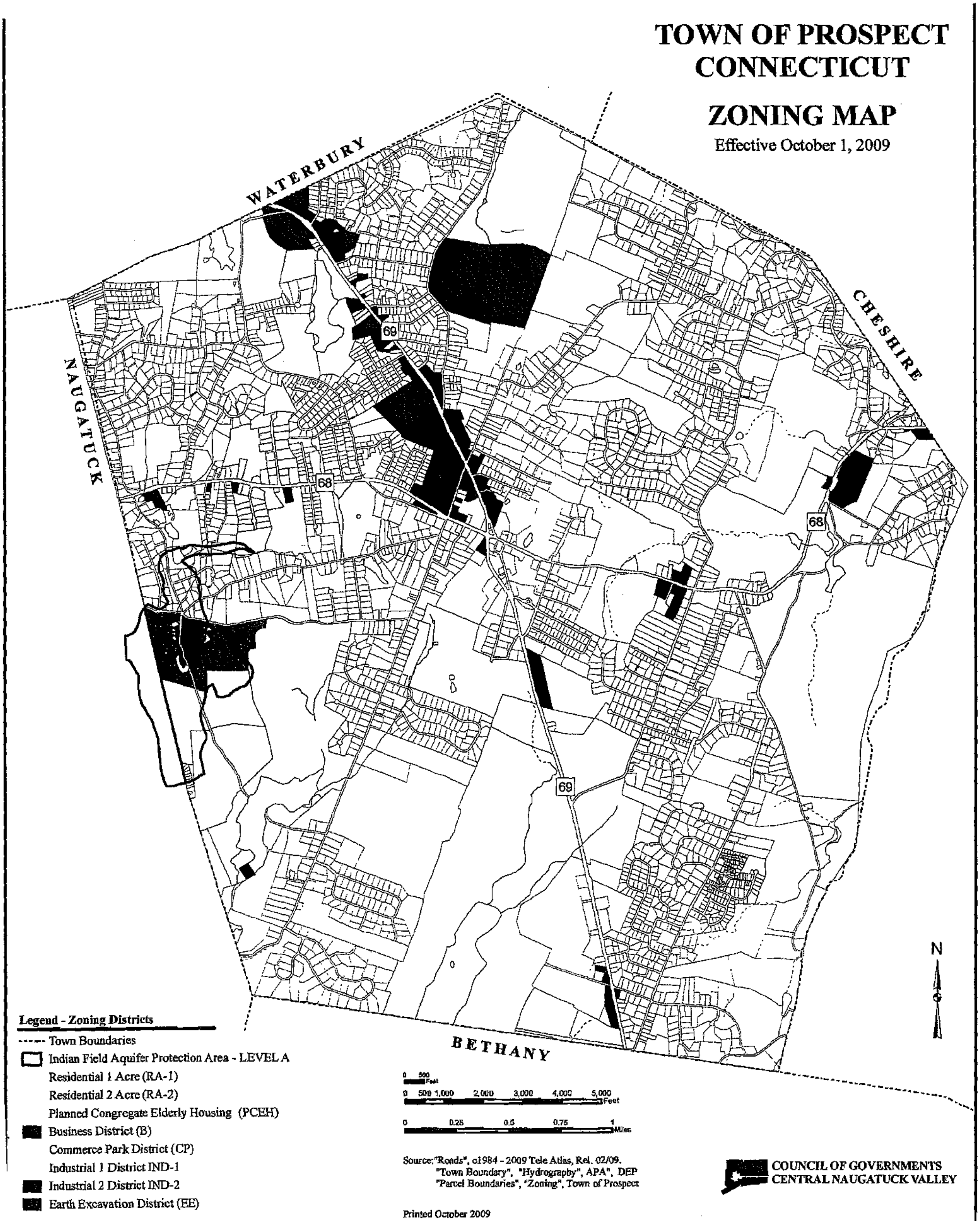
Appendix

Potential Wind Damages According to Wind Speed Distribution

Scale wind speed (mph – m/s)	Damage description
40-72 – 17.9-36.7	Some damage to chimneys and TV antennae; breaks twigs off trees; pushes over shallow-rooted trees.
73-112 – 32.1-49.5	Peels surfaces off roofs; windows broken; light trailer houses pushed over or overturned; some trees uprooted or snapped; moving automobiles pushed off road.
113-157 – 50.0-69.6	Roofs torn off frame houses leaving strong upright walls; weak buildings in rural areas demolished; trailer houses destroyed; large trees snapped or uprooted; railroad boxcars pushed over; light object missiles generated; cars blown off highway.
158-206 – 70.6-92.09	Roofs and some walls torn off frame houses; some rural buildings completely demolished; trains overturned; steel-framed hangar-warehouse type structures torn; cars lifted off the ground; most trees in a forest uprooted, snapped, or leveled.
207-260 – 92.53-116.23	Whole frame houses leveled, leaving piles of debris; steel structures badly damaged; trees debarked by small flying debris; cars and trains thrown some distance or rolled considerable distances; large missiles generated.
261-318 – 116.68-142.16	Whole frame houses tossed off foundations; steel-reinforced concrete structures badly damaged.

Table A-1. Potential wind damages according to wind speed distribution.
(See Ref. [5] *for technical source material.)*

GEK-4277 (10/07)


TOWN OF PROSPECT
CONNECTICUT
ZONING MAP
Effective October 1, 2009
WATERBURY
CHESHIRE
NAUGATUCK
BETHANY
69
68
N
Legend - Zoning Districts
Town Boundaries
Indian Field Aquifer Protection Area - LEVEL A
Residential 1 Acre (RA-1)
Residential 2 Acre (RA-2)
Planned Congregate Elderly Housing (PCEH)
Business District (B)
Commerce Park District (CP)
Industrial 1 District IND-1
Industrial 2 District IND-2
Earth Excavation District (EE)
0 500 Feet
0 500 1,000 2,000 3,000 4,000 5,000 Feet
0 0.25 0.5 0.75 1 Miles
Source: "Roads", c1984 - 2009 Tele Atlas, Rel. 02/09. "Town Boundary", "Hydrography", APA", DEP "Parcel Boundaries", "Zoning", Town of Prospect
Printed October 2009
COUNCIL OF GOVERNMENTS
CENTRAL NAUGATUCK VALLEY