Issue Brief
No. 11 October 2011

The High Cost of Wind Energy as a Carbon-Dioxide Reduction Method

Robert Bryce, Senior Fellow, Manhattan Institute

Executive Summary

For years, politicians, environmental groups, and the renewable energy lobby have been claiming that widespread use of wind energy would result in substantial reductions in carbon-dioxide emissions.

This report—which relies on data published by the Energy Information Administration and the National Renewable Energy Laboratory— finds that if wind energy were to reduce carbon dioxide, the savings would be so small as to be insignificant and so expensive as to be impractical.

Achieving the oft-stated goal of getting 20 percent of U.S. electricity needs from wind by 2030 would require a total expenditure of more than $850 billion. Yet the likely carbon-dioxide savings from that expenditure would be just 2 percent of global emissions in 2030.

If the "20 by '30" target were achieved, it would impose a tax on U.S. electricity consumers of $45 to $54 for each ton of carbon dioxide that was removed. The tax would take the form of an increase of as much as 48 percent over the current price of residential electricity in coal-dependent regions of the country.

A carbon tax at that level would be 23 to 28 times higher than the carbon-taxation regime now being used in the eastern United States. It would greatly exceed the carbon tax recently imposed in Australia and be more than three times as costly, on a per-ton basis, as the European Union's Emission Trading Scheme.

Introduction

In 2008, the National Renewable Energy Laboratory (NREL), an arm of the U.S. Department of Energy, issued a report that said the United States could produce 20 percent of its electricity from wind by 2030.[1] The report said that the United States is working toward generating more "energy that can be cost-effective, and replaced or 'renewed' without contributing to climate change or major environmental impacts."[2] Since the report was released, the wind industry, along with numerous politicians and environmental groups, has promoted wind energy as an integral part of the strategy to increase the use of renewable energy.

President Barack Obama has expressed his support for a federal Renewable Portfolio Standard (RPS), which will "require that 25 percent of electricity consumed in the U.S. is derived from clean, sustainable energy sources, like solar, geothermal, wind, and biomass, by 2025."[3] In July 2011, the Governors' Wind Energy Coalition, which represents governors from 24 states, implored Obama to push for policies that will "support the continued development of wind manufacturing in the United States." The group asked that the president extend the tax credits for wind energy production "for at least seven years." [4]

Two bills now pending in the Senate—S.559 and S.741—would require the United States to get 25 percent of its electricity from renewables by 2025.[5]

About two-thirds of the U.S. population now face RPS mandates—29 states and the District of Columbia have passed rules requiring that varying amounts of electricity used by consumers come from renewable sources. Those mandates cannot be met just with solar energy, which, despite enormous growth in recent years, remains a tiny player in the renewable sector. (In 2010, the United States produced more than 70 times as much electricity from wind as it did from solar.)[6] Therefore, if policymakers want to comply with the mandates, wind energy will be the primary source of renewable generation.

The Obama administration is providing money for numerous wind projects. In August, the Department of Energy finalized a $102 million loan guarantee for a 50-megawatt wind project in Maine.[7] That deal follows the June announcement of a conditional loan guarantee for a $135 million, 99-megawatt wind project in New Hampshire.[8] In announcing the Maine deal, Energy Secretary Steven Chu said that it was part of the administration's goal of "doubling clean energy produced in America by 2035." He added that "clean energy is a major driver of American competitiveness, and investments like these are essential to secure our position as global leader."[9]

Behind the rhetoric about "clean" energy—and wind energy in particular—is the claim that using more of it will result in major reductions in carbon-dioxide emissions.

Costs

Last year, according to the Energy Information Administration (EIA), electricity generation in the United States totaled 4.1 trillion kilowatt hours.[10] Of that amount, wind energy produced 94.6 billion kilowatt hours, or about 2.3 percent of total generation.[11] For wind to expand so that it could supply 20 percent of U.S. electricity consumption, it would require a nine-fold increase in the size of the installed wind generation base, which, at the end of 2010, stood at about 40,000 megawatts of capacity.[12]

Therefore, meeting the "20 by '30" goal would likely require the United States to obtain about 360,000 megawatts of wind-generation capacity. That's a huge amount given that the total installed electric-generation capacity in the United States (from all sources, i.e., coal, natural gas, nuclear, hydro, etc.) is about 1 million megawatts.[13]

The land requirements for 360,000 megawatts of wind-generation capacity would be substantial. The Roscoe Wind Complex in Texas, one of the world's largest wind projects, has a capacity of 781.5 megawatts and covers about 154 square miles—about 0.2 square miles per installed megawatt of wind capacity.[14] Using Roscoe as an example, then, 360,000 megawatts of capacity would require about 72,000 square miles of land to be occupied with wind turbines.

That area, if taken together, would rank as the 17th-largest state in the country, just ahead of North Dakota, which has 69,000 square miles.[15] Put another way, that much land is equivalent to nearly ten New Jerseys.[16] Few people could live on that 72,000 square miles because the noise (including infrasound) generated by the wind turbines is so disruptive. The deleterious health effects of wind-turbine noise have been documented by health professionals in the United States, Australia, New Zealand, and Canada.[17]

Even if we assume that the installation of massive amounts of new wind capacity poses no health risks, and creates no conflicts with rural landowners, the costs of attempting to achieve the "20 by '30" goal will be staggering. The latest data from the EIA put the cost of installing one megawatt of wind-energy capacity at $2.43 million.[18] (Note that this is a major increase over the estimate of $1.7 million per megawatt used by NREL in its 2008 report.)[19] The cost of locating wind turbines offshore will be even higher. The latest EIA estimate for installing one megawatt of wind-generation capacity offshore is $5.97 million.[20] (Here, too, the cost is increasing, not decreasing. In 2009, EIA's offshore estimate was $3.4 million per megawatt.)[21]

The United States has already spent about $68 billion installing the 40,000 megawatts of wind capacity now in place.[22] Installing an additional 320,000 megawatts of wind power at $2.43 million per megawatt will cost the United States about $777.6 billion, or about $44.7 billion every year for the next 19 years. (As noted above, if policymakers prefer to pursue offshore wind, the annual total would be more than double that sum.)

An allocation of $44.7 billion per year would exceed the current combined budgets of the Environmental Protection Agency, Commerce Department, Treasury Department, and Interior Department.[23] It's not clear how such a program would be funded, however, since the federal government has no money to spare. State governments are also in financial peril. According to the Center on Budget and Policy Priorities (CBPP), a nonpartisan research and policy institute, the states had a combined budget shortfall of $130 billion for fiscal year 2011. In 2012, the CBPP expects the combined shortfall to be $103 billion, with another $46 billion shortfall looming in 2013.[24]

Adding the $68 billion spent on existing wind generation capacity to the $777.6 billion cited above produces a total $845.6 billion. But that figure doesn't include any money for the gas-fired generation capacity that will be needed to counteract the intermittency of the wind. Nor does it include any money for the construction of the additional transmission lines that will be needed to carry the electricity from windy rural areas to customers in distant cities.

Building new transmission capacity will be extremely expensive. For instance, Texas alone is planning to spend about $7 billion on new transmission capacity for wind energy.[25] Adding the expected transmission costs in Texas to the sum mentioned above (while ignoring the additional transmission costs and gas-fired generation costs that will be incurred in other states) shows that achieving the "20 by '30 goal" will cost more than $850 billion, or about $7,548 for each U.S. household.[26]

Potential Carbon-Dioxide Reductions

The Global Wind Energy Council (GWEC), an industry group, maintains that reducing the amount of carbon dioxide going into the atmosphere "is the most important environmental benefit from wind power generation."[27] For its part, the American Wind Energy Association (AWEA), a national trade association, says "there is no need to wait for a new climate solution. Wind power is one of only a few near-term options to reduce emissions."[28] In its 2008 report, the NREL claimed that if the United States were to derive 20 percent of its electricity from wind, it "could avoid approximately 825 million metric tons of carbon dioxide in the electric sector in 2030."[29]

How does that 825 million tons of carbon dioxide compare with global emissions? In 2010, global carbon-dioxide emissions totaled 33.1 billion tons.[30] Thus, if the United States were somehow able to instantly increase its wind-generated electricity to 20 percent of total consumption, doing so might reduce global emissions by about 2.5 percent. But it is unlikely that global emissions will be the same in 2030 as they were in 2010. By 2030, the International Energy Agency (IEA) expects global emissions will total about 40.2 billion tons.[31] Thus, the 825 million tons that NREL claims might be reduced by achieving the "20 by '30" goal will result in a global reduction of just 2 percent.[32]

Therefore, to justify a total investment of $850 billion in wind, U.S. policymakers would have to agree that reducing carbon dioxide in the year 2030 is worth spending $1,030 per ton. Of course, that amount would not be spent all at once. Instead it would be allocated over the coming 19 years and would be, in effect, a carbon tax set at $54 per ton.

However, the actual cost may be somewhat lower. In its 2008 report, NREL claimed that only 305,000 megawatts of wind capacity would be needed to meet the "20 by '30" goal. Recall that the United States has built about 40,000 megawatts of wind capacity at a cost of about $68 billion. Thus, building an additional 265,000 megawatts of wind capacity (again, at $2.43 million per megawatt) at a cost of $644 billion, would lead to a total cost of $712 billion, thereby implying that cutting one ton of carbon dioxide by 2030 would cost about $863. Spread over the next 19 years, the cost would be the equivalent of a carbon levy set at $45 per ton.

Achieving the "20 by '30" goal will have a significant impact on electricity rates. In 2007, Steven Hayward and Kenneth Green of the American Enterprise Institute (AEI) estimated that a $15 carbon tax would likely increase the cost of coal-fired generation by about $0.0163 per kilowatt-hour. Therefore, we can assume that a carbon levy of $54-per-ton could increase electricity rates in coal-reliant regions by about $0.058 per kilowatt-hour. That's a major increase given that the average price of electricity for residential consumers in the United States is currently $0.12 per kilowatt-hour.[33]

Put another way, if the United States were to achieve the "20 by '30" goal, U.S. residential electricity prices in coal-dependent regions could increase by about 48 percent over current levels. If we use the lower range of wind costs outlined by NREL in its 2008 report, and assume that reducing a ton of carbon by 2030 will cost $45 per year, the increase in electricity costs in coal-dependent areas will amount to about $0.049 per kilowatt-hour. That would result in an increase of 40 percent over current levels for residential customers in those regions.

These higher electricity costs will likely accelerate the pace of electric rate increases now underway around the country. Since 2004, the average cost of residential electricity has gone from $0.0895 per kilowatt-hour to $0.1218 per kilowatt-hour, an increase of 36 percent.[34]

A Comparison of Existing Carbon-Tax Regimes

Achieving the "20 by '30" goal would create a carbon tax—at $45 or $54 per ton—that would be far higher than similar levies being imposed by other regulatory jurisdictions. The only extant carbon-pricing regime in the United States, the Regional Greenhouse Gas Initiative (RGGI), a carbon market established by 10 states in the eastern part of the country, recently sold allowances for $1.89 per ton.[35] (Each allowance gives the owner the right to emit one ton of carbon.) And RGGI, America's first carbon market, is faltering. In May 2011, New Jersey governor Chris Christie announced that his state would be quitting the program.[36] Christie said the program "is not working as it was intended to work. It's a failure."

The California Carbon Allowance cap-and-trade system began trading in August 2011 at a price of $17 per ton.[37] But the program will not launch until 2013. And while the trading now underway will help market participants to structure forward deals and consider compliance strategies, it remains to be seen how the allowances will be priced when covered entities must begin actually complying with the cap-and-trade system.[38]

In mid-2012, the Australian government is to begin imposing a carbon tax of about $24 per ton on major industrial plants.[39] That levy, which is being fought by Australia's big industrial users, is scheduled to rise by 2.5 percent per year until 2015, after which the country expects to switch to a carbon-trading system. Meanwhile, in Europe, the price of carbon allowances under the European Union's Emission Trading Scheme is falling rapidly as the region's economic troubles have become more pronounced. In early May, the cost of a one-ton carbon allowance was more than $24. By mid-October, that allowance was trading for about $14.[40]

Conclusion

Wind energy is not a cost-effective method of reducing carbon-dioxide emissions. Any effort—whether at the state level or the federal level—to dramatically increase the use of wind energy will result in a new tax on electricity consumers. If the United States were to achieve the "20 by '30" goal, the effective carbon tax of $45 to $54 per ton would far exceed any such tax regime currently in place. Further, if the stated goal were met by 2030, the likely reduction in carbon dioxide emissions would amount to just 2 percent of the expected global total.

Supporters of Wind Energy – On Both Sides of the Aisle

"I'm all for solar, wind."[41] —Mitt Romney, 2011

"It is important to have consistency in policy to support the continued development of wind manufacturing in the United States. Extending the production tax credit and investment tax credit, without a gap, is critical to the health of wind manufacturing in our nation."[42] —Governors' Wind Energy Coalition, 2011

"Wind energy is good for the environment, good for the economy and good for West Texas, because there is an ample supply."[43] —Rick Perry, 2006

"Ultimately, I believe wind will make our energy supply more affordable."[44] —Rick Perry, 2008

"[The administration will] establish a 10 percent federal Renewable Portfolio Standard to require that 10 percent of electricity consumed in the U.S. is derived from clean, sustainable energy sources, like solar, wind and geothermal, by 2012."[45] —Barack Obama, 2008

"We need a renewable portfolio standard to require 20 percent of electricity produced from wind, solar and other renewables by 2020."[46] —Hillary Clinton, 2006,

"Wind energy makes a compelling economic case with new installed wind prices dropping from around 6 cents per kilowatt-hour to 3 cents per kilowatt-hour or lower, while turbine technology increases capacity factors to about 50 percent or more…The price of Kansas wind is now competitive with the traditional sources of energy, and you can get guaranteed rates for the next 20 years."[47] —Sam Brownback, 2011

"Climate change is a serious problem that necessitates serious solutions. Everything must be on the table – particularly renewable sources of energy like wind and solar, nuclear power and clean coal technologies. The potential for renewable wind energy in southwest Michigan is great – not only for our local energy supply, but for our local economy as well. Wind turbines throughout southwest Michigan will not only power our communities, they will help power our local economic engine and create jobs."[48] —Fred Upton, 2009

From Australia to Ontario: The Global Blowback Against Industrial Wind Development

—Europe has more than 400 anti-wind energy organizations spread among 22 countries.[49]

—The United Kingdom alone has about 250 anti-wind groups. [50]

—The Canadian province of Ontario has more than 50 anti-wind groups. [51]

—The United States has about 170 anti-wind groups.[52]

—In 2009, a standing committee of the Parliament in New South Wales, Australia, recommended 'a two-kilometer minimum setback between wind turbines and neighboring houses.'[53] The committee concluded that 'reputable research has shown that noise annoyance is an adverse health effect that can result from wind farms, as it can result in effects such as negative emotions and sleep disturbance."[54]

— In 2010, a book published in New Zealand, *Sound, Noise, Flicker and the Human Perception of Wind Farm Activity*, which includes 23 peer-reviewed articles by acousticians and engineers, concludes that 'the latest research indicates that nuisance noise from wind farms is associated with psychological distress, stress, difficulties with falling asleep, and sleep interruption."[55]

—In September 2010, the Copenhagen Post reported that "state-owned energy firm Dong Energy has given up building more wind turbines on Danish land, following protests from residents complaining about the noise the turbines make." The article goes on to quote the Danish wind giant's CEO, Anders Eldrup: "It is very difficult to get the public's acceptance if the turbines are built close to residential buildings, and therefore we are now looking at maritime options."[56]

—In November 2010, five people, several of them from Earth First!, were arrested near Lincoln, Maine, after they blocked a road leading to a construction site for a 60-megawatt wind project on Rollins Mountain. According to a story written by Tux Turkel of the Portland Press Herald, one of the protesters carried a sign which read, "Stop the rape of rural Maine."[57]

—On May 27, 2011, 1,500 protesters descended on the Welsh Assembly, demanding that a massive wind project planned for central Wales be halted.[58]

—In mid-2011, the state government of Victoria, in southeastern Australia, announced that it would enforce a two-kilometer setback between wind turbines and homes. The state's planning minister said the setback was needed for health reasons. [59]

— In July 2011, dozens of protesters in Denmark camped on a tract in Northern Jutland to prevent the clearing of a protected forest where the government planned to build a test center that aims to install a series of wind turbines 250 meters high. [60]

—In August 2011, in a peer-reviewed article in the Bulletin of Science, Technology and Society, Carl V. Phillips, a Harvard-trained Ph.D., concludes that there is "overwhelming evidence that wind turbines cause serious health problems in nearby residents, usually stress-disorder type diseases, at a nontrivial rate." [61]

—In October 2011, Alex Salt, an otolaryngology professor at Washington University in St. Louis who has studied the effects of low-frequency noise, says that if industrial wind turbines are placed within a mile of residential structures, "you're asking for trouble."[62]

ENDNOTES

1. Department of Energy, "20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply," May 2008, http://www.nrel.gov/docs/fy08osti/41869.pdf.
2. Ibid, 1.
3. Barack Obama, "Promoting Rural America's Leadership in Developing Renewable Energy," undated, http://my.barackobama.com/page/content/INruralenergy/.
4. Governors' Wind Energy Coalition, letter to Obama, July 20, 2011, http://www.governorswindenergycoalition.org/assets/files/President%20Obama%20Wind%20Energy%20Letter%20(July%2024,%202011).pdf.
5. S.741 is sponsored by Tom Udall (D-N.M.). The measure has 10 co-sponsors, nine of whom are Democrats. The tenth sponsor is Bernie Sanders (I-VT). The Congressional Research Service summary of S.741 is available here: http://thomas.loc.gov/cgi-bin/bdquery/D?d112:1:./temp/~bda59s:@@@D&summ2=m&|/home/LegislativeData.php| S.559 is sponsored by Amy Klobuchar (D-MN) and Tim Johnson (D-S.D.). The Congressional Research Service summary of S.559 is available here: http://thomas.loc.gov/cgi-bin/bdquery/D?d112:1:./temp/~bd9FMa:@@@D&summ2=m&|/home/LegislativeData.php.
6. In 2010, the United States produced 94.6 billion kilowatt-hours from wind and 1.3 billion kilowatt-hours from solar. EIA data, http://www.eia.gov/totalenergy/data/monthly/pdf/sec7_5.pdf.
7. Department of Energy, https://lpo.energy.gov/?p=5096.
8. Department of Energy, https://lpo.energy.gov/?p=4764.
9. Department of Energy, https://lpo.energy.gov/?p=5096.
10. EIA data, http://www.eia.gov/totalenergy/data/monthly/pdf/sec7_5.pdf.
11. EIA data, http://www.eia.gov/totalenergy/data/monthly/pdf/sec7_5.pdf
12. American Wind Energy Association, http://www.awea.org/learnabout/industry_stats/index.cfm
13. EIA data, http://205.254.135.24/cneaf/electricity/epa/epates.html
14. Another comparison: Duke Energy's Los Vientos wind project to be built in Willacy County, Texas. The project, announced in August 2011, will have 200 megawatts of capacity and cover 30,000 acres, or nearly 47 square miles. Thus, the land requirement is about 0.23 square miles per installed megawatt. (Another way to do the calculation: 200 million watts on 121.4 million square meters = 1.65 watts per square meter.) For more on the Duke project, see: http://www.brownsvilleherald.com/articles/wind-129933-energy-farm.html. In its 2008 report, NREL estimates the land needed to achieve the "20 by '30" goal at 61,000 square kilometers, or about 23,552 square miles. That assumes a power density of 5 watts per square meter, or as NREL puts it, 5 megawatts per square kilometer. See NREL, op cit, 156.
15. http://www.worldatlas.com/aatlas/infopage/usabysiz.htm
16. New Jersey covers 7,418 square miles.
17. See, for instance, Shepherd D, McBride D, Welch D, Dirks KN, Hill EM, "Evaluating the impact of wind turbine noise on health-related quality of life." Noise Health [serial online] 2011 [cited 2011 Oct 10];13:333-9. Available: http://www.noiseandhealth.org/text.asp?2011/13/54/333/85502. That paper, written by a group of New Zealand-based researchers, found that people who live near wind turbines report "lower overall quality of life, physical quality of life, and environmental quality of life. Those exposed to turbine noise also reported significantly lower sleep quality, and rated their environment as less restful. Our data suggest that wind farm noise can negatively impact facets of health-related quality of life."
18. EIA data, http://www.eia.gov/oiaf/beck_plantcosts/pdf/updatedplantcosts.pdf, 7, 2-10.
19. NREL, op cit, 147.
20. EIA data, http://www.eia.gov/oiaf/beck_plantcosts/pdf/updatedplantcosts.pdf, 7.
21. NREL, "Cost and Performance Assumptions for Modeling Electricity Generation Technologies," November 2010, http://www.nrel.gov/docs/fy11osti/48595.pdf, 96
22. This assumes that the capacity already installed cost at $1.7 million per megawatt.

23. OMB data, http://www.whitehouse.gov/omb/budget_factsheets_departments/ Here are the specifics for the 2012 requested department budgets: EPA, $9 billion; Commerce, $8.8 billion; Treasury, $14 billion; Interior, $12 billion.
24. Center on Budget and Policy Priorities, http://www.cbpp.org/cms/index.cfm?fa=view&id=711. Note that budget shortfalls in 2010 totaled $191 billion. Data for 2012 and 2013 are current as of June 17, 2011.
25. Robert Bryce, "Texas Wind Energy Fails, Again," *National Review*, August 29, 2011, http://www.nationalreview.com/articles/275673/texas-wind-energy-fails-again-robert-bryce?page=2
26. U.S. Census says there are about 112.6 million households. http://quickfacts.census.gov/qfd/states/00000.html
27. Global Wind Energy Coalition, http://www.gwec.net/index.php?id=92
28. American Wind Energy Association, http://www.awea.org/_cs_upload/learnabout/publications/4136_1.pdf
29. NREL, op cit, 14.
30. BP Statistical Review of World Energy, 2011.
31. International Energy Agency data, http://www.iea.org/co2highlights/co2highlights.pdf
32. 825 million divided by 40.2 billion = 2.05 percent.
33. EIA data, http://www.eia.gov/cneaf/electricity/epm/epm_sum.html.
34. EIA data, as of July 2012, http://www.eia.gov/cneaf/electricity/epm/epm_sum.html. Older retail price of electricity data from EIA is here: http://www.eia.gov/cneaf/electricity/epa/epaxlfile7_4.pdf
35. The June 2011 auction of allowances under RGGI had a clearing price of $1.89 per allowance. See: http://www.rggi.org/docs/Auction_12_Release_Report.pdf. That price is a significant reduction from the September 2008 auction, during which allowances sold for $3.07. See: http://www.rggi.org/docs/rggi_press_9_29_2008.pdf. Each allowance is good for one ton of carbon dioxide.
36. Shifra Mincer, "Christie Announced NJ to Quit RGGI," AOL Energy, May 31, 2011, http://energy.aol.com/2011/05/31/video-christie-announces-nj-to-quit-rggi/
37. Intercontinental Exchange, "ICE Announces First Trade of Californian Emissions Contract," August 29, 2011, http://ir.theice.com/releasedetail.cfm?ReleaseID=601455
38. Anne C. Mulkern, "Offsets Could Make Up 85% of Calif.'s Cap-and-Trade Program," *New York Times*, August 8, 2011, http://www.nytimes.com/gwire/2011/08/08/08greenwire-offsets-could-make-up-85-of-califs-cap-and-tra-29081.html?pagewanted=all
39. http://www.reuters.com/article/2011/07/11/us-australia-carbon-idUSTRE7690C520110711
40. Pricing data are available from Bloomberg: http://www.bloomberg.com/apps/quote?ticker=EUETSYR1:IND#chart
41. http://newhampshireprimary.blogspot.com/2011/07/mitt-romney-on-renewable-energy.html
42. http://www.governorswindenergycoalition.org/assets/files/President%20Obama%20Wind%20Energy%20Letter%20(July%2024,%202011).pdf
43. http://governor.state.tx.us/news/speech/10010/
44. http://governor.state.tx.us/news/speech/4652/
45. "Barack Obama: New Energy for America," August 2008, http://www.scribd.com/doc/4481665/Barack-Obamas-New-Energy-Plan-For-America
46. Energybiz.com, "The Presidential Debate," October 10, 2007, http://www.energybiz.com/article/07/10/presidential-debate?quicktabs_11=1&quicktabs_4=0&quicktabs_6=0
47. Gov. Sam Brownback, "Wind offers clean path to growth," *The Wichita Eagle*, September 11, 2011, http://www.kansas.com/2011/09/11/2011116/gov-sam-brownback-wind-offers.html#ixzz1YEopU9dD
48. *River Country Journal*, "Upton hails KVCC wind energy program as Congress debates climate change bill," April 24, 2009. (The document is identified as a "news release from Congressman Fred Upton.")
49. http://www.epaw.org
50. http://www.countryguardian.net/Campaign Windfarm Action Groups.htm
51. Wind Concerns Ontario, http://windconcernsontario.wordpress.com/member-pages/
52. Industrial Wind Action Group, http://www.windaction.org/orglist
53. General Purpose Standing Committee, "Rural Wind Farms," December 2009, http://www.parliament.nsw.gov.au/Prod/parlment/committee.nsf/0/ea247659081d31fdca25768e001a2e2a/$FILE/091216%20Report%20-%20Rural%20wind%20farms.pdf, xv.
54. Ibid, xvii.
55. Bruce Rapley and Huub Bakker, eds, *Sound, Noise, Flicker and the Human Perception of Wind Farm Activity*, Palmerston North, New Zealand: Atkinson & Rapley Consulting Ltd, 2010, 7.
56. http://www.cphpost.dk/news/scitech/92-technology/49869-dong-gives-up-on-land-based-turbines.html
57. http://www.pressherald.com/news/Protesters-arrested-at-Lincoln-maine-windfarm.html
58. http://www.bbc.co.uk/news/uk-wales-13563168
59. http://www.abc.net.au/news/2011-06-27/wind-farm-setbacks-policy-to-remain/2772716
60. http://www.nationalttestcenter.dk/archives/4882#disqus_thread
61. http://www.windturbinesyndrome.com/news/wp-content/uploads/2011/07/Phillips-1.pdf
62. Lou Wilin, "Can turbines generate health problems?" *The Courier*, October 5, 2011, http://www.thecourier.com/Issues/2011/Oct/05/ar_news_100511_story4.asp