A Problem With Wind Power

Eric Rosenbloom — September 5, 2006

Wind power promises a clean and free source of electricity. It will reduce our dependence on imported fossil fuels and reduce the output of greenhouse gases and other pollution. Many governments are therefore promoting the construction of vast wind "farms," encouraging private companies with generous subsidies and regulatory support, requiring utilities to buy from them, and setting up markets for the trade of "green credits" in addition to actual energy. The U.S. Department of Energy (DOE) aims to see 5% of our electricity produced by wind turbine in 2010. Energy companies are eagerly investing in wind power, finding the arrangement quite profitable.

A little research, however, reveals that wind power does not in fact live up to the claims made by its advocates (see part I), that its impact on the environment and people's lives is far from benign (see part II), and that with such a poor record and prospect the money spent on it could be much more effectively directed (see part III).

I

In 1998, Norway commissioned a study of wind power in Denmark and concluded that it has "serious environmental effects, insufficient production, and high production costs."

Denmark (population 5.3 million) has over 6,000 turbines that produced electricity equal to 19% of what the country used in 2002. Yet no conventional power plant has been shut down. Because of the intermittency and variability of the wind, conventional power plants must be kept running at full capacity to meet the actual demand for electricity. Most cannot simply be turned on and off as the wind dies and rises, and the quick ramping up and down of those that can be would actually increase their output of pollution and carbon dioxide (CO_2, the primary "greenhouse" gas). So when the wind is blowing just right for the turbines, the power they generate is usually a surplus and sold to other countries at an extremely discounted price, or the turbines must be shut off.

A writer in *The Utilities Journal* (David J. White, "Danish Wind: Too Good To Be True?," July 2004) found that 84% of western Denmark's wind-generated electricity was exported (at a revenue loss) in 2003, i.e., Denmark's glut of wind towers provided only 3.3% of the nation's electricity. According to *The Wall Street Journal Europe,* the Copenhagen newspaper *Politiken* reported that wind actually met only 1.7% of Denmark's total demand in 1999. Besides the amount exported, this low figure may also reflect the actual *net* contribution. The large amount of electricity used by the turbines themselves is typically not accounted for in the usually cited output figures.[1] In *Weekendavisen* (Nov. 4, 2005), Frede Vestergaard reported that Denmark as a whole exported 70.3% of its wind production in 2004.

Denmark is just dependent enough on wind power that when the wind is not blowing right they must import electricity. In 2000 they imported more electricity than they exported. And added to the Danish electric bill are the subsidies that support the private companies building the wind towers. Danish electricity costs for the consumer are the highest in Europe.[2]

The head of Xcel Energy in the U.S., Wayne Brunetti, has said, "We're a big supporter of wind, but at the time when customers have the greatest needs, it's typically not available." Throughout Europe, wind turbines produced on average less than 20% of their theoretical (or *rated*) capacity. Yet both the British and the American Wind Energy Associations (BWEA and AWEA) plan for 30%. The figure in Denmark was 16.8% in 2002 and 19% in 2003 (in February 2003, the output of the more than 6,000 turbines in Denmark was 0!). On-shore turbines in the U.K. produced at 24.1% of their capacity in 2003. The average in Germany for 1998-2003 was 14.7%. In the U.S., usable output (representing wind power's contribution to consumption, according to the Energy Information Agency) in 2002 was 12.7% of capacity (using the average between the AWEA's figures for installed capacity at the end of 2001 and 2002). In California, the average is 20%. The Searsburg plant in Vermont averages 23%, declining every year. This percentage is called the *load factor* or *capacity factor.* The rated generating capacity only occurs during 100% ideal conditions, typically a sustained wind speed over 30 mph. As the wind slows, electricity output falls off exponentially.

(1 megawatt (MW, 1 million watts) of power output $\times$ 24 hours $\times$ 365 days = 8,760 megawatt-hours (MW-h) energy per year; if a 1-MW wind turbine actually produces 1,752 MW-h over a year, owing to the variability of the wind and other factors, its capacity factor is 1,752/8,760 = 0.20, or 20%.)

In high winds, ironically, the turbines must be stopped because they are easily damaged. Build-up of dead bugs has been shown to halve the maximum power generated by a wind turbine, reducing the average power generated by 25% and more. Build-up of salt on off-shore turbine blades similarly has been shown to reduce the power generated by 20%–30%.

Eon Netz, the grid manager for about a third of Germany, discusses the technical problems of connecting large numbers of wind turbines in their 2004 "Wind Report": Electricity generation from wind fluctuates greatly, requiring additional reserves of "conventional" capacity to compensate; high-demand periods of cold and heat correspond to periods of low wind; only limited forecasting is possible for wind power; wind power needs a corresponding expansion of the high-voltage and extra-high-voltage grid infrastructure; and expansion of wind power makes the grid more unstable.

Despite their being cited as the shining example of what can be accomplished with wind power, the Danish government has cancelled plans for three offshore wind

farms planned for 2008 and has scheduled the withdrawal of subsidies from existing sites. Development of onshore wind plants in Denmark has effectively stopped. Because Danish companies dominate the wind industry, however, the government is under pressure to continue their support. Spain began withdrawing subsidies in 2002. Germany reduced the tax breaks to wind power, and domestic construction drastically slowed in 2004. Switzerland also is cutting subsidies as too expensive for the lack of significant benefit. The Netherlands decommissioned 90 turbines in 2004. Many Japanese utilities severely limit the amount of wind-generated power they buy, because of the instability they cause. For the same reason, Ireland in December 2003 halted all new windpower connections to the national grid. In early 2005, they were considering ending state support. In 2005, Spanish utilities began refusing new wind power connections. In 2005, Spanish utilities began refusing new wind power connections. In 2006, the Spanish government ended—by emergency decree—its subsidies and price supports for big wind. In 2004, Australia reduced the level of renewable energy that utilities are required to buy, dramatically slowing wind-project applications. On August 31, 2004, Bloomberg News reported that "the unstable flow of wind power in their networks" has forced German utilities to buy more expensive energy, requiring them to raise prices for the consumer.

A German Energy Agency study released in February 2005 after some delay stated that increasing the amount of wind power would increase consumer costs 3.7 times and that the theoretical reduction of greenhouse gas emissions could be achieved much more cheaply by simply installing filters on existing fossil-fuel plants. A similar conclusion was made by the Irish grid manager in a study released in February 2004:[3] "The cost of CO_2 abatement arising from using large levels of wind energy penetration appears high relative to other alternatives."

In Germany, utilities are forced to buy renewable energy at sometimes more than 10 times the cost of conventional power, in France 3 times. In the U.K., the *Telegraph* has reported that rather than providing cheaper energy, wind power costs the electric companies £50 per megawatt-hour (MW-h), compared to £15 for conventional power.[4] The wind industry is worried that the U.K., too, is starting to see that it is only subsidies and requirements on utilities to buy a certain amount of "green" power that prop up the wind towers and that it is a colossal waste of resources. The BWEA has even resorted to threatening prominent opponents as more projects are successfully blocked. Interestingly, long-term plans for energy use and emissions reduction by both the U.K. and the U.S. governments do not mention wind.[5] Flemming Nissen, head of development at the Danish utility Elsam, told a meeting in Copenhagen, May 27, 2004, "Increased development of wind turbines does not reduce Danish CO_2 emissions."

Installation of wind towers can not hope to keep up with the continuing increase of energy use (not only are they very expensive for their output, they also require huge swaths of land). Denmark's annual production from wind turbines increased 28 petajoules (PJ, 1 PJ ≈ 278,000 MW-h) from 1990 to 1998, but total energy consumption increased 115 PJ. The International Energy Agency reports that from 1990 to 2002, Denmark's annual production from wind turbines rose 3,689 GW-h, but total electricity production rose 12,730 GW-h. The Danish government's National Environmental Research Institute reported that in 2003 greenhouse gas emissions increased 7.3% over 2002 levels.[6]

In the U.K. (population 60 million), 1,010 wind turbines produced 0.1% of their electricity in 2002, according to the Department of Trade and Industry. The government hopes to increase the use of renewables to 10.4% by 2010 and 20.4% by 2020, requiring many tens of thousands more towers. As demand will have grown, however, even more turbines will be required. In California (population 35 million), according to the state energy commission, 14,000 turbines (about 1,800 MW capacity) produced half of one percent of their electricity in 2000. Extrapolating this record to the U.S. as a whole, and without accounting for an increase in energy demand, well over 100,000 1.5-MW wind towers (costing $150–300 billion) would be necessary to meet the DOE's goal of a mere 5% of the country's electricity from wind by 2010.

The DOE says there are 18,000 square miles of good wind sites in the U.S., which with current technology could produce 20% of the country's electricity. This rosy plan, based on the wind industry's sales brochures, as well as on a claim of electricity use that is only three-quarters of the actual use in 2002, would require "only" 142,060 1.5-MW towers. They also explain, "If the wind resource is well matched to peak loads, wind energy can effectively contribute to system capacity." That's a big *if*—counting on the wind to blow exactly when demand rises—especially if you expect the wind to cover 20% (or even 5%) of that demand. As in Denmark and Germany, you would quickly learn that the prudent thing to do is to look elsewhere first in meeting the load demand. And we'd be stuck with a lot of generally unhelpful hardware covering every windy spot in the U.S., while the developers would be looking to put up yet more to make up for and deny their failings.

As in Denmark and Germany, the electricity from those towers—no matter how many—would be too variable to provide the predictable supply that the grid demands. They would have no effect on established electricity generation, energy use, or continuing pollution. Christopher Dutton, the CEO of Green Mountain Power, a partner in the Searsburg wind farm in Vermont and an advocate of alternative energy sources, has said (in an interview with Montpelier's *The Bridge*) that there is no way that wind power can replace more traditional sources, that its value

is only as a supplemental source that has no impact on the base load supply. "By its very nature, it's unreliable," says Jay Morrison, senior regulatory counsel for the National Rural Electric Cooperative Association.

As Country Guardian, a U.K. conservation group, puts it, wind farms constitute an *increase* in energy supply, not a replacement. They do not reduce the costs—environmental, economic, and political—of other means of energy production. If wind towers do not reduce conventional power use, then their manufacture, transport, and construction only increases the use of dirty energy. The presence of "free and green" wind power may even give people license to use *more* energy.

II.

Size

Pictures from the energy companies show slim towers rising cleanly from the landscape or hovering faintly in the distant haze, their presence modulated by soft clouds behind them. But a 200- to 300-foot tower supporting a turbine housing the size of a bus and three 100- to 150-foot rotor blades sweeping over an acre of air at more than 100 mph requires, for a start, a large and solid foundation. On a GE 1.5-MW tower, the turbine housing, or *nacelle,* weighs over 56 tons, the blade assembly weighs over 36 tons, and the whole tower assembly totals over 163 tons.

FPL (Florida Power & Light) Energy says, "a typical turbine site takes about a 42 × 42–foot-square graveled area." Each tower (and a site needs at least 15–20 towers to make investment in the required transmission infrastructure worthwhile) requires a huge hole filled with tons of steel rebar–reinforced concrete (e.g., 1,250 tons in each foundation at the facility in Lamar, Colo.). According to Country Guardian, the hole is large enough to fit three double-decker buses. At the 89-turbine Top of Iowa facility, the foundation of each 323-foot assembly is a 7-feet-deep 42-feet-diameter octagon filled with 25,713 pounds of reinforced steel and 181 cubic yards of concrete. The foundations at the Wild Horse project in Washington are 30 feet deep. At Buffalo Mountain in Tennessee, too, each foundation is at least 30 feet deep and may contain more than 3,500 cubic yards of concrete (production of which is a major source of CO_2). On Cefn Croes in Wales the developer built a complete concrete factory on the site, which is not unusual, as well as opened quarries to provide rock for new roads—neither of which activities were part of the original planning application.[7]

On many such mountain ridges as well as other locations, it would be necessary to blast into the bedrock, as Enxco's New England representative, John Zimmerman, has confirmed, possibly disrupting the water sources for wells downhill. At the Waymart plant in Pennsylvania, the foundations extend 30–40 feet into the bedrock. At Romney Marsh in southern England, foundation pillars will be sunk 110 feet. For each 6-feet-deep foundation at the Crescent Ridge facility in Illinois, another 24 feet was dug out and filled with sand. Construction at a site on the Slieve Aughty range in Ireland in October 2003 caused a 2.5-mile-long bog slide.

(Building on peat bogs is recognized as a serious disruption of an important carbon sink; the Royal Society for the Protection of Birds opposes wind development on the Scottish island of Lewis because the turbines would take 25 years to theoretically save the amount of carbon that their construction will release from the peat (not to mention the threat to birds—see below). Clearing forests for facilities on mountain ridges is an analogous situation. Such mountaintop clearing has serious runoff implications as well as documented at the Meyersdale plant in Pennsylvania.)

FPL Energy also says, "although construction is temporary [a few months], it will require heavy equipment, including bulldozers, graders, trenching machines, concrete trucks, flatbed trucks, and large cranes." Getting all the equipment, as well as the huge tower sections and rotor blades, into an undeveloped area requires the construction of wide straight strong roads. Many existing roads, particularly in hilly areas, are inadequate. For the Buffalo Mountain project, curves were widened, switchbacks were eliminated, and portions were repaved. The weight of the material has damaged existing roads. Many an ancient hedgerow in England has been sacrificed for access to project sites.

The destructive impact that such construction would have, for example, on a wild mountain top, is obvious. Erosion, disruption of water flow, and destruction of wild habitat and plant life would continue with the presence of access roads, power lines, transformers, and the tower sites themselves. For better wind efficiency, each tower requires trees to be cleared. Vegetation would be kept down with herbicides, further poisoning the soil and water. Each tower should be at least 5–10 times the rotor diameter from neighboring towers and trees for optimal performance. For a tower with 35-meter rotors, that is 1,200–2,400 feet, a quarter to half of a mile. A site on a forested ridge would require clearing 50–100 acres per tower to operate optimally (although only 4–6 acres of clearance per tower, the towers spaced every 500–1,000 feet, is typical, making them almost useless when the wind is not a perfect crosswind). The Danish grid operator Eltra has found that a turbine can decrease the production of another turbine 5 kilometers (3.1 miles) away. The proposed 45-square-mile facility on the Scottish island of Lewis represents 50 acres for each megawatt of rated capacity. FPL Energy says it requires 40 acres per installed megawatt, and the U.S. Environmental Protection Agency (EPA) says 60 acres is likely. Facilities worldwide generally use 30–70 acres per megawatt, i.e., about 120–280 acres for every megawatt of likely average output (25% capacity factor).

GE boasts that the span of their rotor blades is larger than the wingspan of a Boeing 747 jumbo jet. The typical

1.5-MW assembly is two stories higher than the Statue of Liberty, including its base and pedestal. The editor of *Windpower Monthly* wrote in September 1998, "Too often the public has felt duped into envisioning fairy tale 'parks' in the countryside. The reality has been an abrupt awakening. Wind power stations are no parks." They are industrial and commercial installations. They do not belong in wilderness areas. As the U.K. Countryside Agency has said, it makes no sense to tackle one environmental problem by instead creating another.

In Vermont, billboards are banned from the highways, and development—especially at sites above 2,500 feet—is subject to strong environmental laws, yet many who call themselves environmentalists absurdly support the installation of wind farms on our mountain ridge lines as a desirable trade-off, ignoring wind's dismal record as described in part I.

Even if one thinks that jumbo-jet-sized wind towers dominating every ridge line in sight like a giant barbed-wire fence is a beautiful thing, many people are drawn to wild places to avoid such reminders of human industrial might. Many communities depend on such tourists, who will now seek some other—as yet unspoiled—retreat.

Birds, Bats, and Other Wildlife

The spinning blades kill and maim birds and bats. The Danish Wind Industry Association, for example, admits as much by pointing out that so do power lines and automobiles. (The argument follows the æsthetic one that the landscape is already blighted in many ways, so why not blight it some more?) The industry claims that moving from lattice-work towers, which provided roosting and nesting platforms, to solid towers as well as larger lower-rpm blades solved the problem, and that studies find very few dead birds around wind turbines. They ignore the facts that the larger blades are in fact slicing the air faster (over 100 mph at their tips), that scavengers will have removed most injured and dead birds before researchers arrive for their periodic surveys, and that many areas where dead and injured birds (and bats— see below) might fall are inaccessible..

Especially vulnerable are large birds of prey that like to fly in the same sorts of places that developers like to construct wind towers. Fog—a common situation on mountain ridges—aggravates the problem for all birds. Guidelines from the U.S. Fish and Wildlife Service (FWS) state that wind towers should not be near wetlands or other known bird or bat concentration areas or in areas with a high incidence of fog or low cloud ceilings, especially during spring and fall migrations. It is illegal in the U.S. to kill migratory birds. The FWS has prevented any expansion of the several Altamont Pass wind plants in California, rejecting as well the claim that new solid towers would mitigate the problem.[8]

A 2002 study in Spain estimated that 11,200 birds of prey (many of them already endangered), 350,000 bats, and 3,000,000 small birds are killed each year by wind turbines and their power lines. Another analysis[9] found that it is officially recognized (and obscured, generally by implying monthly figures as annual) that on average a single turbine tower kills 20–40 birds each year. The U.S. FWS estimates that European wind power kills 37 birds per turbine each year. The wind industry, in contrast, cites the absurdly low results of a single very spotty study at one site as gospel.

Windpower Monthly reported in October 2003 that the shocking number of bats being killed by wind towers in the U.K. is causing trouble for developers. The president of Bat Conservation International, Merlin Tuttle, has said, "We're finding kills even in the most remote turbines out in the middle of prairies, where bats don't feed." At least 2,000 bats were killed on Backbone Mountain in West Virginia in just 2 months during their 2003 fall migration. Continuing research has found that rate to be typical all year, or even low, for wind turbines on forested ridges.

Wildlife on the ground is displaced as well. Prairie birds are especially affected by disturbance of their habitat, and construction on mountain ridges diminishes important forest interior far beyond the extent of the clearing itself. A visitor to the Backbone Mountain facility wrote,[10] "I looked around me, to a place where months before had been prime country for deer, wild turkey, and yes, black bear, to see positively no sign of any of the animals about at all. This alarmed me, so I scouted in the woods that afternoon. All afternoon, I found no sign, sight, or peek of any animal about."

Noise

The same West Virginia writer found the noise from the turbines on Backbone Mountain to be "incredible. It surprised me. It sounded like airplanes or helicopters. And it traveled. Sometimes, you could not hear the sound standing right under one, but you heard it 3,000 yards down the hill." Yet the industry insists such noise is a thing of the past. Indeed, new turbines may have quieter bearings and gears, but the huge magnetized generators can not avoid producing a low-frequency hum, and the problem of 100-foot rotor blades chopping through the air at over 100 mph also is insurmountable (a 35-meter [115-foot] blade turning at 15 rpm is travelling 123 mph at the tip, at 20 rpm 164 mph). Every time each rotor passes the tower, the compression of air produces a deep resonating thump. Only a gravelly "swishing" may be heard directly beneath the turbine, but farther away the resulting sound of several towers together has been described to be as loud as a motorcycle, like aircraft continually passing overhead, a "brick wrapped in a towel turning in a tumble drier," "as if someone was mixing cement in the sky," "like a train that never arrives." It is a relentless rumble like unceasing thunder from an approaching storm. Some people have also described an eerie screeching when the blade and nacelle assembly

turns to catch the wind.[11] Enxco's John Zimmerman admitted at a meeting in Lowell, Vt., "Wind turbines don't make good neighbors."

The penetrating low-frequency aspect to the noise, a thudding vibration, much like the throbbing bass of a neighboring disco, travels much farther than the usually measured "audible" noise. It may be why horses who are completely calm around traffic and heavy construction are known to become very upset when they approach wind turbines.[12] Many people have complained that it causes anxiety and nausea.The only way to reduce it is to reduce the efficiency of the electricity production, i.e., reduce the illusion of profitability. It can't be done.

Advocates, when not denying the noise outright, suggest that the wind itself masks any noise the turbine assembly makes. Rustling leaves, however, are a very different sound than the thumping of a wind facility. And in developers' output projections, they point out that the wind is very much more steady and stronger up at the top of the towers, so even that rustling down on the ground is not always there when the turbines are turning. This is often the case at night and always the case in winter. In Oregon, wind developers complained they could not comply with regulations limiting the increase of noise in rural and wild areas. In May 2004, the state weakened the noise regulations so installation of wind facilities could go ahead.

The European Union (E.U.) published the results of a 5-year investigation into wind power, finding noise complaints to be valid and that noise levels could not be predicted before developing a site. The AWEA acknowledges that a turbine is quite audible 800 feet away. The National (U.S.) Wind Coordinating Committee (NWCC) states, "wind turbines are highly visible structures that often are located in conspicuous settings ... they also generate noise that can be disturbing to nearby residents." The NWCC recommends that wind turbines be installed no closer than half a mile from any dwelling. German marketer Retexo-RISP specifies that turbines not be placed within 2 kilometers (1.24 miles) of any dwelling.

Communities in Germany, Wales, and Ireland claim that even 3,000 feet away the noise is significant. Individuals from Australia to the U.K. say they have to close their windows and turn on the air conditioner when the wind turbines are active. The noise of a wind plant in Ireland was measured in 2002 at 60 decibels 1 km (3,280 feet) *up*wind. The subaural low-frequency noise was above 70 dB (which is 10 *times* as loud on the logarithmic decibel scale). A German study in 2003 found significant noise levels 1 mile away from a 2-year-old wind farm of 17 1.8-MW turbines, especially at night. In mountainous areas the sound echos over larger distances. A neighbor of the 20-turbine Meyersdale facility in southwest Pennsylvania found the noise level at his house, about a half mile away,to average 75 dB(A) over a 48-hour period, well above the level that the EPA says prevents sleep. In Vermont, the director of Energy Efficiency for the Department of Public Service, Rob Ide, has said that the noise from the 11 550-kilowatt Searsburg turbines is significant a mile away. Residents 1.5 and even 3 miles downwind in otherwise quiet rural areas suffer significant noise pollution. A criminal suit has been allowed to go forward in Ireland against the owner and operator of a wind plant for noise violations of their environmental law. Also in Ireland, a developer has been forced to compensate a homeowner for loss of property value, and many people have had their tax valuation reduced. In the Lake District of northwest England, a group has sued the owner and operator of the Askam wind plant, claiming it is ruining their lives.

In January 2004, a couple was awarded 20% of the value of their home from the previous owners who did not tell them the Askam wind plant was about to be constructed 1,800 feet away: "because of damage to visual amenity, noise pollution, and the irritating flickering caused by the sun going down behind the moving blades." The towers of this plant are only 40 meters (130 feet) high, with the rotors extending a further 24 meters (75 feet). Steve Molloy of West Coast Energy responded that loss of value of a property, although unfortunate, was not a material planning consideration and did not undermine the industry's argument that the benefits of sustainable energy outweighed the objections.[13]

Don Peterson, senior director of Madison Gas & Electric, which operates 31 wind towers in Kewaunee County, Wisconsin, similarly dismisses complaints, saying that most people, but not all, will get used to the sound of the machines. "Like any noise, if you don't like it, your brain is going to focus on it," he comfortingly told the Beloit *Daily News.* Especially in relatively undeveloped areas, there can be no question that the unnatural noise from a wind facility will be prominent. Just a 10-dB increase over existing levels (a typical limit for such projects) represents the subjective perception of a *doubling* of noise level.

It has been reported that one of the farmers who leases land for the wind towers had to buy the neighbors' property because of the problems (not just noise but also flicker and lights at night). Wisconsin Public Service, operator of another 14 turbines in Kewaunee County, in 2001 offered to buy six neighboring properties; two owners accepted, but two others filed a lawsuit in January 2004.[14] On January 6, 2004, the *Western Morning News* of Devon published three articles about noise problems, particularly the health effects of low-frequency noise, from wind turbines. Another interesting report, which notes that the Nazis used low-frequency noise for torture, was published in the January 25 *Telegraph*.[15]

Jobs, Taxes, and Property Values

Despite the energy industry's claim that wind farms create jobs ("revitalize struggling rural communities," says Enxco), the fact is that, after the few months of construction—much of it handled by imported labor from

the turbine company—a typical large wind facility requires just one maintenance worker. Of the 200 workers involved in construction of the 89-turbine Top of Iowa facility, only 20 were local; seven permanent jobs were created.[16] The average nationwide is 1–2 jobs per 20 MW installed capacity.

The energy companies also claim that they increase the local tax base. But that is more than offset by the loss of open land, the loss of tourism, the stagnation or decrease in property values throughout a much wider area, the tax credits such developments typically enjoy, and the taxes and fees consumers must pay to subsidize the industry. Even surveys by wind promoters show that a quarter to a third of visitors would no longer come if wind turbines were installed. That is a huge loss in areas that depend on tourism. The wind developers say that the turbines themselves are an attraction, but visitor centers at wind farms in Britain are already closing for lack of business. A few people get more money from leasing their land for the towers (until the developer starts withholding it for some small-print reason, or even disappears after the tax advantages slow down—Altamont Pass in California is littered with broken-down wind towers owned by companies long gone), but that's the opposite of an argument for the general good.

Wind advocates insist that property values are not affected by nearby industrial turbines, because there will always be a buyer as it's just a question of taste. That is small comfort to those who already own homes near potential wind-plant sites but whose taste militates against rattling windows and humming walls, flickering lights, 100-foot blades spinning overhead, and giant metal towers and supply roads where once were trees and moose trails.

Other Problems

The industry recognizes that the flicker of reflected light on one side and shadow on the other drives people and animals crazy. And at night, the towers must be lighted, which the AWEA describes as a serious nuisance, destroying the dark skies that many people in rural areas cherish (and that the state of Vermont is on the verge of specifically protecting). Red lights are thought to attract night-migrating birds.

Ice is another problem. It builds up when the blades are still and gets flung off—as far as 1,500 feet—when they start spinning. Accumulated ice on the nacelle and tower also falls off. John Zimmerman, the developer of Vermont's Searsburg facility, wrote the following to an AWEA discussion list in 2000. "When there is heavy rime ice build up on the blades and the machines are running you instinctually want to stay away. ... They roar and sound scarey. One time we found a piece near the base of the turbines that was pretty impressive. Three adults jumping on it couldn't break. It looked to be 5 or 6 inches thick, 3 feet wide and about 5 feet long. Probably weighed several hundred pounds. We couldn't lift it. There were a couple of other pieces nearby but we wondered where the rest of the pieces went." Access to Searsburg is restricted when icing is likely. Even in good weather, they shut the turbines down when giving tours.[17]

The planners of giant wind installations in Valencia, Spain, mention the dripping and flinging off of motor oil (almost 200 gallons of which may be present in a single 1.5-MW turbine) and cooling and cleaning fluids. The transformer at the base of each turbine contains up to 500 more gallons of oil. The substation transformers where a group of turbines connects to the grid contain over 10,000 gallons of oil each.[18]

The International Association of Engineering Insurers warns of fire: "Damage by fire in wind turbines is usually caused by overheated bearings, a strike of lightning, or sparks thrown out when the turbine is slowing down. ... Even the smallest spark can easily develop into a large fire before discovery is made or fire-fighting can begin."

A 1995 study in Germany estimated that 80% of insurance claims paid for wind turbine damage were caused by lightning. Lightning destroys many towers by causing the blade coatings to peel off, rendering them useless. If the blades keep spinning, the imbalance can bring down the whole tower. The towers are subject to metal fatigue, and the resin blades are easily damaged even by wind. In Wales, Spain, Germany, France (Dec. 22, 2004), Denmark (Jan. 20, 2005), Japan (Feb. 24, 2005), New Zealand (Mar. 10, 2005), and Scotland (Apr. 7, 2005) parts and whole blades have torn off because of malfunction and fire, flying as far as 8 kilometers and through the window of a home in one case. Whole towers have collapsed in Germany (as recently as 2002) and the U.S. (e.g., in Oklahoma, May 6, 2005).[19]

Conclusion

All of these negative aspects will only become worse if even a small part of the industry's plans for hundreds of thousands of towers becomes reality. At every level, however, the negative impacts must of course be weighed against the benefits. As described in part I, these are neglible.

III.

It is wise to diversify the sources of our energy. But the money and legislative effort invested in large-scale wind generation could be spent much more effectively to achieve the goal of reducing our use of fossil and nuclear fuels.

As an example, Country Guardian calculates that for the U.K. government subsidy towards the construction of one wind turbine, they could insulate the roofs of almost 500 houses that need it and save in two years the amount of energy the wind turbine might produce over its lifetime.

Country Guardian also calculates that if every light bulb in the U.K. were switched to a more efficient one, the country could shut down an entire power plant—some-

thing even Denmark, with wind producing as much as 20% of their electricity, is not able to do. According to solar energy consultant and retailer Real Goods, if every household in the U.S. replaced one incandescent bulb with a compact fluorescent bulb, one nuclear power plant could be closed. John Etherington claims that switching the most-used bulb in every house of the U.K. would save as much as the entire output of all existing and proposed on-shore wind plants in that country.

The BWEA itself says that the cost of saving energy is less than half the cost of producing it. According to the California Power Authority (ignoring the subsidies that lower the market price of wind-generated electricity) conservation costs exactly the same per KW-h as wind power. John Zimmerman admitted at a February 2003 meeting in Kirby, Vermont, that we "could do much more for our energy balance by just tightening our belts a little."

As described in part I, wind farms do not bring about any reduction in the use of conventional power plants. Requiring the upgrading of power plants to be more efficient and cleaner would actually do something rather than simply support the image of "green" power that energy companies profit from while in fact doing nothing to reduce pollution or fuel imports. An April 2000 E.U. report found that, using existing technology, increased efficiency could decrease energy consumption by more than 18% by 2020. The U.N.-sponsored Intergovernmental Panel on Climate Change has stated that simple voluntary energy-efficiency improvements in buildings will reduce world energy use 10%–15% by 2020. They state that, with technology already in use, efficiency improvements in buildings, manufacturing, and transport can reduce world carbon emissions more than 50% by 2020.

In the U.S., 61.5% of the energy used is "lost," i.e., only 38.5% of the energy consumed is actually extracted.[20] In transmission alone, 7.34% of the electricity generated is lost. There is obviously much that can be improved in what we already have and will continue to live with for quite some time.

Electricity represents only 39% of energy use in the U.S. (in Vermont, 20%; and only 1% of Vermont's greenhouse gas emissions is from electricity generation). Pollution from fossil fuels also comes from transportation (cars, trucks, aircraft, and ships) and heating. Despite the manic installation of wind facilities in the U.K., their CO_2 emissions rose in 2002 and 2003. At a May 27, 2004, conference in Copenhagen, the head of development from the Danish energy company Elsam stated, "Increased development of wind turbines does not reduce Danish CO_2 emissions." Demanding better gas mileage in cars, including pickup trucks and SUVs, promoting rail for both freight and travel, and supporting the use of biodiesel (for example, from hemp) would make a huge impact on pollution and dependence on foreign oil, whereas wind power makes none. Some hybrid gas-electric cars (the ones that don't just add the electric motor just for a "green" acceleration boost) already use 60% less gasoline than average conventional new cars in the U.S.

Wind-power advocates often propose that wind turbines can be used to manufacture hydrogen for fuel cells. This may be an admirable plan (although *Windpower Monthly* dismisses it for several reasons in a May 2003 article) but is so far in the future that it only serves to underscore the fact that there is no good reason for current construction. And it must be remembered that as wind turbines are unable to produce significant amounts of electricity they would likewise be unable to produce significant amounts of hydrogen. On top of that, a 2004 study by the Institute for Lifecycle Environmental Assessment determined that hydrogen returns only 47% of the energy put into it, compared with pumped hydro returning 75% and lithium ion batteries up to 85%.

On a small scale, where a turbine directly supplies the users and the fluctuating production can be stored, wind can contribute to a home, school, factory, office building, or even small village's electricity. But this simply does not work on a large scale to supply the grid. Even the small benefits claimed by their promoters are far outstripped by the huge negative impacts.

We are reminded that there are trade-offs necessary to living in a technologically advanced industrial society, that fossil fuels will run out, that global warming must be slowed, and that the procurement and transport of fossil and nuclear fuels is environmentally, politically, and socially destructive. Sooner or later the realities of this modern life will have to reach into our own back yards, the commons must be developed for our economic survival, and it would be elitist in the extreme to believe we deserve better. So wilderness areas are sacrificed, rural communities are bribed into becoming live-in (but ineffective) power plants, our governments boast that they are looking beyond fossil fuels (while doing nothing to actually reduce their use), and our electric bills go up to support "investment in a greener future." And at the other end of this trade-off, multinational energy companies reap greater profits and fossil and nuclear fuel use continues to grow.

Many alternative sources of energy, as well as dramatic improvements in the use of current sources, are in development. But wind turbines exist, so they are presented by their manufacturers and managers as *the* solution. Every effort is made to maintain the illusion that they are in fact a solution when a few simple questions reveal they are not.

Notes

1. Actual information about energy consumption by the turbines themselves is difficult to discover. Their output to the grid is measured at a substation, but the meters do not "run backwards." Some information can be seen in the Greenpeace-sponsored "Yes2Wind" forum at http://www.yes2wind.co.uk/forums/showthread.php=&threadid=69.

2. A detailed and well referenced examination, "Unpredictable wind energy—the Danish dilemma," Vic Mason and the Danish Society of Windmill Neighbors, is available from Country Guardian at http://www.countryguardian.net/denmark.htm. A follow-up paper by Mason, "Danish wind power—a personal view," is at http://www.countryguardian.net/vmason.htm.
3. "Impact of Wind Power Generation in Ireland on the Operation of Conventional Plant and the Economic Implications," ESB National Grid, February 2004.
4. An article at wind-farm.org explains how wind power generators in the U.K. get paid over 3 times what they actually sell their electricity for: "Goldrush—Windfarms & Why They Are So Profitable," Ray Berry, available at http://www.wind-farm.org/index.php?name=News&file=article&sid=2.
5. See "¿Obsoleta Energía Eólica?," Mark Duchamp, available at http://www.iberica2000.org/Es/Articulo.asp?Id=1097.
6. "Progress toward the Kyoto targets—greenhouse gases," National Environmental Research Institute, Denmark, April 15, 2005.
7. A gallery of photographs showing the shocking destruction on Cefn Croes is available at http://www.users.globalnet.co.uk/~hills/cc/gallery/index.htm.
8. "Interim Guidelines To Avoid and Minimize Wildlife Impacts from Wind Turbines," U.S. Fish and Wildlife Service, Department of the Interior, March 13, 2003, available at http://www.fws.gov/r9dhcbfa/wind.pdf (3 MB).
9. "Genocidio de aves en los parques eólicos," Mark Duchamp, available at http://www.iberica2000.org/Es/Articulo.asp?Id=1253.
10. "The noise was incredible," Paula Stahl, available at http://www.greenberkshires.org/wind_power_plants_postings/stahl_letter.html.
11. "Our Wind Farm Story," Pam Foringer, available at http://xray.rutgers.edu/~matilsky/windmills/Windfarm_story.htm.
12. "Wind power or horse power?" Rosemary Dunnage, North Wales *Daily Post,* June 24, 2004, available at http://icnorthwales.icnetwork.co.uk/printable_version.cfm?objectid=14363358.
13. "Wind Farm Blows House Value Away," Justin Hawkins, The Westmorland *Gazette*, January 9, 2004, available at http://www.thisisthelakedistrict.co.uk/misc/print.php?artid=447706.
14. See "Excerpts from the Final Report of the Township of Lincoln Wind Turbine Moratorium Committee," available at http://www.aweo.org/windlincoln.html, for a report of the many serious ill effects of the Kewaunee County turbines.
15. "Wind farms 'make people sick who live up to a mile away,'" Catherine Milner, *The Telegraph,* January 25, 2004.
16. "Top of Iowa Wind Farm Case Study," Northern Iowa Windpower, 2003.
17. Issues of icing, noise, and structural damage and failure, particularly as they determine setback requirements, have been extensively documented by John Mollica in response to the proposed expansion of a wind facility on Wachusetts Mountain in Massachusetts (between Princeton and Fitchburg). The paper is available at http://www.princetonwindfarm.com/db/wind.nsf/newwind?readform.
18. Another overview of industrial wind power's environmental problems is provided by "Windfarms—an ecological and human disaster in the making," Mark Duchamp, available at http://www.iberica2000.org/Es/Articulo.asp?Id=1170.
19. "Une éolienne a explosé," *Le Dauphiné Liberé* du Rhone à Provence, December 23, 2004. "Gale-force winds snap wind turbine propellers," Mainichi *Daily News,* February 25, 2005. "Prototype blades blown away," Manawatu *Standard,* March 11, 2005. "Danger claim as turbine blade snaps off," Berwickshire *News,* April 14, 2005. "Experts try to determine why turbine broke in two and collapsed Friday," *Oklahoman,* May 10, 2005. An extensive documentation of accidents is available at http://www.caithness-windfarms.co.uk/Downloads/Accidents%20-%20June%2030%202005.pdf.
20. "U.S. Energy Flow Trends—2002," Lawrence Livermore National Laboratory, June 2004.

This paper, along with pictures, several supporting documents, and many more internet links, is available on line at www.aweo.org.

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