WIND ENERGY IS NOT THE ANSWER

by Bradley S. Tupi[i]

Abstract.

Wind energy is not the answer to climate change concerns and cannot do the heavy lifting required by the modern American economy. It would take hundreds of thousands of wind turbines to make a substantial contribution to America's energy needs. Building so many turbines inevitably causes conflicts with human and animal habitats. Wind turbine noise is a serious problem for those who live in the vicinity of so-called wind farms.

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Introduction.

Wind energy is not a modern phenomenon. Man harnessed the wind with sailboats and windmills hundreds of years ago. Charles Brush developed a wind-powered electric generator in 1888.[2] Small, wind-powered generators such as the Jacobs Wind-Electric Machine became popular in the Midwest in the early 20th Century.[3] These windmills became obsolete when Depression-era programs brought more reliable electric power to rural areas.[4]

Wind energy began a slow resurgence during the Carter administration when the Public Utility Regulatory Policies Act of 1978[5] fostered state tax incentives for wind power development and allowed non-utility energy producers to sell electricity to utilities.[6]

Currently, wind power is hailed by some as a key weapon in the battle against global warming and as an important contributor to American energy independence. This paper will argue that wind energy is neither. Wind power cannot generate enough reliable electricity to replace conventional energy sources, including those that generate greenhouse gases. Assuming for the sake of argument that carbon dioxide is contributing to global climate change, wind power will not materially reduce CO2 emissions.

1. Wind Energy Is Unreliable and Intermittent.

A coal-fired power plant will generate electricity 24/7/365. A nuclear generating station will run for two years without interruption. Even a hydroelectric plant will put out consistent, uninterrupted energy unless the flow of water stops. As a result, whenever we want to turn on a light, cool off a room or boot up a computer, electric power is at our fingertips.

Wind power is not like that. Wind is an unreliable source of energy for the obvious reason that the wind does not always blow. Sometimes it does not blow at all. Sometimes it blows at a speed too low to turn the blades of a wind turbine. And sometimes it blows too fast. High wind velocities can damage wind turbines, so turbines are set to shut off at wind speeds over 56 miles per hour.[7] The operational wind speed range of a wind turbine is between 7 mph (the "cut-in speed") and 56 mph (the "shut-down limit"). Within this operational range, small variations in wind speed have large effects on electricity output.[8] This is because a doubling of wind speed yields eight times the energy.[9] So even when the wind is blowing within the turbine's operational range, the power output is unpredictable.

Wind velocity often changes dramatically from hour to hour or from night to morning. As a result, wind power output can swing wildly over the course of a single day.[10] From month to month the swings can be striking, too. In Spain, on Aug. 27, 2009, wind supplied less than 1% of the country's electric power. On the morning of Nov. 8, 2009, wind power peaked, briefly providing 53.7% of the country's electricity.[11]

Another problem of wind power has to do with matching power production with consumer demand. High winds after dark do not satisfy the electricity demands of a hot, sultry afternoon. Wind performs worst during the summer months, when power demand peaks.[12] According to the Electric Reliability Council of Texas, wind turbines only deliver 8.7% of capacity during peak summer hours.[13]

Similarly, the windiest places do not match the places with highest energy demand. In the United States, the states with the best wind resources are in the Midwest and West.[14] The states with the highest electricity demand are in the East.[15] Because we cannot generate electricity in North Dakota, put it in a box, and ship it to Manhattan, it is difficult to match wind energy supply with demand.

We need energy to be available on demand. Because it is intermittent, wind energy cannot meet this basic requirement.

2. Wind Turbines Are Weak Generators of Electric Power.

When wind energy companies promote their output, they do so in misleading ways. They use "nameplate capacity" figures instead of actual energy output, which will be only a fraction of the turbine's nameplate rating.[16] For example, General Electric is offering a wind turbine "rated" at 2.5 megawatts (MW) capacity.[17] Actual output, however, is reduced by the intermittency of wind itself. So the actual electricity output of a wind energy facility may only be 20% of the advertised capacity.[18]

Another way to look at wind energy's paltry output is to compare wind energy facilities to conventional power plants. A typical coal-fired power plant will deliver approximately 2,000 MW. A wind energy facility would need 800 2.5 MW turbines operating at full capacity to deliver a comparable amount of power. At a more likely 30% rate of production, more than 2,600 turbines would be required. Pennsylvania's summer electricity-generating capacity as of 2008 was 45,130 MW.[19] It would take more than 60,000 turbines at 30% production to generate this much electricity. It would take hundreds of thousands of wind turbines to make a substantial contribution to America's energy needs.

3. Wind Energy and the Grid.

Despite the unreliability of wind as an energy source, many governments around the world are mandating the inclusion of wind power in the energy portfolio. For example, the U.S. Department of Energy has proposed that 20% of American energy be derived from wind power by 2030.[20] In Pennsylvania, the Alternative Energy Portfolio Standards Act of 2004 requires utilities to supply 18% of their electricity from alternative energy resources by 2021.[21] If wind energy is forced upon us in such large proportions, there will be serious technical problems in the reliable transmission of electricity. One problem has to do with storage and transmission of wind-generated electricity. Another has to do with the instability of the electricity grid that intermittent wind energy will cause.

Electricity generated by wind turbines must be either used or fed into the grid. Economical technology to store the energy does not yet exist.[22] So when wind energy facilities are built in areas remote from electricity demand, new transmission facilities are needed. Such facilities are expensive (thousands of

miles of 400-feet-wide rights-of-way) and contentious (pitting region against region).[23] The lack of transmission capacity was one of the reasons T. Boone Pickens drastically reduced his wind farm plans. One report has recommended building 22,697 miles of transmission lines at a cost of $93 billion.[24]

Once connected to the electricity grid, wind energy can create instability. This is not much of a problem at present, because wind power constitutes less than 2% of electricity generation. But if unreliable wind power were to make up, say, 5% of the grid, a sudden drop in wind energy production could require emergency measures to avoid a brownout or blackout. [25] On March 1, 2005, the Spanish grid interrupted power to 300 heavy electricity users when a loss of wind resulted in 11,000 turbines generating only 700 MW of electricity.[26] On Feb. 26, 2008, wind energy output in Texas fell from 2,000 MW to 360 MW over the course of an afternoon. At the same time, demand was peaking. The Texas grid operator had to cut power to industrial customers.[27]

Europe experienced its largest blackout on Nov. 4, 2006. Wind power did not cause the failure, but increased its severity and inhibited recovery.[28] The grid agency issued a report after the blackout that found:

> The increasing share of wind power and the regional concentration in certain areas might lead to grid situations with sudden capacity losses of more than 3,000 MW which could be followed by large-scale blackouts.[29]

Large swings in wind power "can create significant imbalances between generation and load, resulting in grid instabilities."[30] This problem will only increase as wind energy gains market share. The only way to remedy this instability is to have power sources available that can compensate quickly for unpredictable changes in wind energy supply. Wind power must have a backup that can be turned on upon short notice.[31]

4. Wind Energy Facilities Require Conventional Backup.

One of the arguments wind power advocates use, often implicitly, is that a megawatt of clean wind electricity can replace a megawatt of electricity derived from dirty fossil fuels. This argument is false because wind energy facilities require backup for those times when wind speed is unsatisfactory for generation. As a result, wind energy can only supplement, not replace, conventional sources of electricity. "No coal or nuclear power plant has ever been replaced by wind energy."[32]

Because wind energy is intermittent, and because intermittent supplies can de-stabilize the power grid, every wind energy facility requires a redundant backup with conventional power.[33] This redundancy adds unnecessary costs. If we need conventional power plants as backup anyway, why build expensive wind turbines?

This redundancy also negates another argument that wind advocates use, that wind energy will reduce CO2 emissions. Unless wind power supporters suddenly embrace nuclear power, the necessary backup power stations will burn fossil fuels and emit CO2.

> Although carbon credit schemes often assign profitable carbon credits to wind farm operators based on a theoretical displacement of carbon emitted by coal or natural gas producers, in reality these plants must keep burning to be able to quickly add supply every time the wind drops off. The formulae do not take into account carbon emitted by

> idling coal and natural gas plants nor the excess carbon generated by constant fire-up and shut down cycles necessitated to balance fluctuating wind supplies.[34]

Indeed, using fossil fuel powered generating stations as backup for wind power may *increase* the CO2 emissions of such plants because when they operate below their peak generation capability, they do not use their fuel efficiently. This increases emissions.[35] Power plants in stand-by mode cannot sell electricity and so cannot recover their costs.[36]

The United Kingdom is embarking upon an expensive ($150 billion) wind energy program to meet EU and self-imposed CO2 emissions targets. The UK could make greater CO2 reductions at a fraction of the cost by switching coal-fired power plants to natural gas. Instead, Britain is pursuing offshore wind. An Oxford University energy professor called offshore wind "one of the most expensive short-term ways you can conceive of to reduce CO2 emissions."[37]

If wind power reduces CO2 emissions at all, the benefit is dwarfed by China's growth in CO2 emissions. China has surpassed the U.S. as the world's leading CO2 emitter, largely because China has been commissioning new coal-fired power plants at a rapid pace. Unilateral CO2 reductions will not reduce global emissions. China must be happy to see the United States worrying about global warming while it builds its own manufacturing sector. Among other things, China manufactures wind turbines.[38]

5. Wind Energy Is Expensive.

Wind energy facilities are high cost and low power. To achieve percentage targets being mandated by governments will necessitate a huge investment. Unlike the oil industry, where John Rockefeller built his own energy empire, wind energy infrastructure will only be built with large infusions of taxpayer money. The question is whether taxpayer money is wisely spent on an energy resource that costs more than conventional energy sources while delivering much less electricity.

Wind-generated electricity costs substantially more per unit of energy than electricity generated by coal or natural gas. Figure 1 (below) shows that onshore wind energy costs about $80/MWh ($0.08/kWh) before government subsidies, while coal and gas cost only about $60/MWh ($0.06/kWh).[39]

Other research sources indicate an even greater cost disparity. In Ontario, where 40% of electricity comes from nuclear plants, the market price of a kilowatt hour is about 3 to 6 cents, while wind-generated electricity costs 10 to 13.5 cents.[40]

In the United Kingdom, government figures estimate the cost of electricity generation at £38/MWh for nuclear power, £50/MWh for coal, £72/MWh for on-shore wind and £92/MWh for off-shore wind.[41]

In Massachusetts, the off-shore Cape Wind project recently won federal approval over local opposition from the Kennedy family and others. Cape Wind is demanding 20.7 cents per kilowatt hour for its electricity, whereas the prevailing local rate is only about 9 cents.[42] Massachusetts Attorney General Martha Coakley, concerned about the financial impact on electricity consumers, is demanding information from Cape Wind about its costs and profits.[43]

It is well-established that wind power costs more to generate than conventional power. A free market would therefore reject wind. Wind energy exists only because of massive government subsidies and imperious mandates.

6. Government Forces Taxpayers and Consumers to Pay for Wind Energy.

The business plan of the wind energy industry depends on government support. Wind energy facilities cannot compete economically with conventional energy sources on a level playing field. They require various forms of financial assistance. With hefty government subsidies, wind facilities can offer a handsome return on investment. "Without [such subsidies], they wouldn't work," said the CEO of a Danish wind company.[44] To be fair, fossil fuels have also received tax incentives and other such support. But wind energy enjoys larger subsidies per unit of energy delivered, covering larger shares of wind companies' investments. Of the $145 billion invested in "clean" energy in 2009, approximately one-third was from government subsidies and price supports.[45] Wind's federal taxpayer subsidies are 25 times greater per megawatt hour than those awarded all other forms of electricity production combined.[46]

The history of wind energy in California shows how the industry lives and dies with government support. After Congress enacted the Public Utility Regulatory Policies Act of 1978[47], California created wind energy contracts guaranteeing prices to wind energy suppliers. The price formula was based on fuel prices, which were high and assumedly going higher. Before long, wind turbines were built at Altamont Pass, Tehachapi and San Gorgonio. In the early 1980s, government subsidies covered up to 50% of the cost of a wind turbine. But when oil and gas prices dropped in the mid-1980s, the price guarantee formula was no longer sufficient to entice investment. Wind energy companies went bankrupt, and their abandoned wind turbines littered the landscape.[48]

In 1992 Congress enacted another energy bill, the Energy Policy Act.[49] The Act favored renewable energy by creating mandates, incentives, and tax credits. The Act gave wind energy producers access to the utility grid. It established "Renewable Portfolio Standards" that compelled utilities to purchase wind power. It created "Renewable Energy Certificates" that could be bought and sold. It granted production tax credits and allowed accelerated depreciation of 40% per year.[50] Since the Act became effective in 1997, "generations of wind energy companies have soared and crashed as government tax incentives, the industry's financial fuel, fluctuated with political currents."[51]

Over the last decade, wind energy installations have blossomed with incentives and have shriveled without them. See Figure 2. [52]

The production tax credit is worth about 2 cents per kWh. The net effect is to reduce the cost of wind-generated electricity from about 9 cents per kWh to about 7 cents, making it competitive with conventional power sources.[53] Thus do taxpayers subsidize wind farms to compete with existing power plants.

"Renewable Electricity Standards" guarantee profits to wind companies by forcing electric utilities to purchase specified percentages of electricity from approved "green" sources.[54] The American Wind Energy Association is calling for a Renewable Energy Standard of 25% by 2025.[55] Such a standard would mandate that electric utilities purchase 25% of their power from wind facilities by 2025, even though wind energy is much more expensive than electricity generated from fossil fuels or nuclear reactors. The utilities pass the extra cost along to their customers. Thus do electricity consumers pay for the high cost of wind energy.

Wind energy companies also receive outright grants from federal and state coffers. The 2009 stimulus program provided for over $2.2 billion dollars in cash grants toward the costs of constructing new wind energy projects. The developer can recover up to 30% of the cost of a new facility.[56]

7. Wind Energy Facilities Have Negative Environmental Impacts.

It may not be appropriate to refer to wind energy as "green." Wind energy facilities have negative environmental impacts which, unlike global warming, are beyond dispute.

a. Wind Energy Facilities Cause "Energy Sprawl."

Due to the laws of physics, wind energy facilities require huge swaths of land. The longer the rotor blades, the greater the amount of wind energy generated. But as rotor blades lengthen, the turbines must be spaced farther apart, so the wake behind one turbine will not disrupt the airstream feeding another turbine. As a result, turbines should be spaced ten rotor diameters apart.[57] The General Electric (GE Power) 2.5 MW turbine model[58] has a rotor diameter of 300 feet, so its turbines should be spaced 3,000 feet apart. Such spacing requires a sprawling land grab.

A wind energy facility consumes more than seven times as much land as a coal-fired power plant generating the same amount of energy.[59] A nuclear power plant generates 300 horsepower per acre of land; a wind facility only 6.4 hp/acre.[60]

The proposed Shaffer Mountain Wind facility in Pennsylvania is projected to build 30 wind turbines, total capacity 60 MW, and occupy 176 acres. The nearby Homer City Power Plant generates 1,884 MW while occupying 2,400 acres.[61] At a rate of 176 acres per 60 MW, the Shaffer Mountain facility would have to occupy 5,471 acres to provide an output equivalent to Homer City's. But the 176 acres occupied by the wind turbines is only part of the story. The Shaffer Mountain wind facility has leased over 10,000 acres altogether, due to setback and siting requirements.[62] At this rate of land consumption, Shaffer Mountain would have to lease 314,000 acres (490 square miles) of land to generate the output of the Homer City coal-fired power plant. This is almost half the size of Rhode Island.

The Comanche Peak Nuclear Power Plant outside Dallas generates about 2,300 megawatts of power and occupies approximately 8,000 acres. The Pampa Wind Project promoted by T. Boone Pickens would have provided a comparable amount of power but would have occupied 400,000 acres.[63]

Needless to say, wind energy facilities occupying such vast areas have a major impact on both human and animal habitat.

b. Wind Energy Facilities Damage Natural Habitats.

At least in Pennsylvania, wind energy companies seek ridge-top sites where winds are strongest. Wind farms strip large areas of trees and cut miles of service roads through virgin forests. The kind of site clearing necessary to construct an industrial scale wind facility results in permanent habitat alteration for the lifetime of the facility. Formerly forested areas are maintained as open space for construction, site operation, and long term maintenance. Existing roads are widened (or new ones are constructed) to accommodate the transport of giant turbine parts and other materials to and from the individual turbine sites. The end results include immediate and long-lasting loss of forest habitat and wide gaps in the forest canopy along miles of ridge-top, called "habitat fragmentation." Forest interior birds are immediately displaced from historic breeding/nesting sites. Interior forest birds living in the adjacent forest are subject to increased rates of nest predation and parasitism, which can extend (from the edge of the clearing) at minimum 150 to over 300 meters into the surrounding forest.[64]

The large scale clearing associated with wind facilities can also result in the rapid establishment of invasive plant species that often out-compete native vegetation. Few of these invasive species have

ecological value for birds and other wildlife and so they only add to the general degradation of the site. Increased competition for diminished resources adds stress to local bird populations.[65]

c. Wind Energy Facilities Kill Birds and Bats.

Wind turbines are known to kill many birds and bats.[66] The 1980s-vintage wind turbine facility in Altamont Pass, California, is notorious for killing thousands of birds annually.[67] A 2008 study concluded that in two years, the Altamont wind turbines killed 8,247 birds.[68]

Increasing the number of wind turbines across the country "could lead to massive bird losses and even extinctions," say some avian scientists.[69] Some of the affected species are protected by the Endangered Species Act or other wildlife statutes. When 85 protected migratory birds were killed on ExxonMobil facilities in five western states, the company faced charges under the Migratory Bird Treaty Act. But the Altamont wind energy facility, which kills 80 protected golden eagles per year, has not faced any enforcement action.[70]

Bats are also susceptible to wind turbines. A study at a 44-turbine facility in West Virginia linked 4,000 bat deaths in a single year to the facility.[71] Last December, a federal judge halted a West Virginia wind turbine project because of the threat to the Indiana Bat, an endangered species.[72] Indiana Bats have been found on the site of the proposed Shaffer Mountain project in Pennsylvania, but so far the developer has not backed away from the location.

d. Wind Energy Facilities Are a Nuisance To Nearby Residents.

As more and more wind projects are proposed, it is inevitable that wind turbines will be sited closer and closer to homes. Because wind turbines generate noise, vibration and flicker, they are an undeniable nuisance to nearby residents. The author has represented several clients who cannot sleep comfortably in their own homes because of turbine noise.

Although wind energy representatives downplay it, wind turbines make noise. A wind turbine blade, more than 100 feet long, turns at a tip speed of up to 150 mph, leaving turbulent air in its wake. This air turbulence is the source of much of the noise. In addition, when the blade passes the tower every one or two seconds, it creates a disturbing, pulsing sound.[73] People living near wind turbines describe the sound as like a helicopter hovering overhead, or like a jet airplane that does not fly away. The noise can be loud enough to wake a person from sleep. Some people living near wind turbines report anxiety, headaches, sleep deprivation and other symptoms.[74] Dr. Nina Pierpont of Malone, New York, has published a book about the constellation of symptoms she calls "wind turbine syndrome."[75]

Even if the noise does not cause health effects in a given individual, it still causes harm. Most wind energy facilities are built in sparsely-populated areas. People living in such areas do so precisely because of the tranquil, natural surroundings they find there. Wind turbine noise robs such folks of the peace and quiet that drew them to rural living in the first place.[76]

Wind energy companies use two techniques to downplay turbine noise. First, they rely upon the background sound of wind blowing through the trees to mask much of the turbine noise. Second, wind turbine companies use a misleading sound measurement scale. Whereas noise is typically measured in decibels (dB), wind turbine companies use a noise scale called dBA, which understates the low frequency sounds. Yet low frequency sounds are the most disturbing, so using the dBA scale tends to understate the nuisance.

Wind turbines' low frequency vibrations can be tangible within private homes nearby. In one case, a woman holding a bottle of drinking water in her kitchen could feel the turbine vibrations in the bottle. Another resident said that the turbine vibrations made the electric baseboards within her home rattle and hum.

Flicker is a shadow effect caused by blades spinning in the sunlight. As each blade cuts across the Sun's path, it briefly casts a shadow. This creates an annoying, strobe-like effect in nearby homes, forcing residents to close their drapes and blinds to block out the flicker (and the view).

f. Wind Energy Facilities Cause Aesthetic Harm.

The wind energy industry portrays wind turbines as graceful and attractive. There is ample evidence that the general public feels otherwise. The recently-approved Cape Wind project, located off the coast of Cape Cod, was opposed by the Kennedy family and other residents as "visual pollution" that would ruin the view near Martha's Vineyard.[77] In North Carolina, the state senate passed a bill in 2009 that banned industrial-sized wind turbines on ridgelines above 3,000 feet, in order to protect the scenic beauty of the western part of the state.[78] In California, thousands of 1980s-era wind turbines were abandoned: "Spinning, post-industrial junk which generates nothing but bird kills."[79]

It is ironic that environmentalists, who typically treasure the ecology, have so casually dismissed the various forms of environmental harm caused by wind turbines.

8. Wind Energy Facilities Cause Economic Harm.

Wind energy creates economic harm in a multitude of ways. Locally, it diminishes the property values of nearby homes. Nationally, it distorts the economy by taking money from productive pursuits and devoting it to an inefficient and expensive source of electricity.

"Green jobs" are often cited as a justification for government subsidization of the wind energy industry. But the European experience teaches that this strategy is counterproductive. Spain was a leader in government aid to renewable energy. An academic study published in Spain in 2009 showed that for every four jobs created by green jobs subsidies, nine other jobs were lost. The root cause was rising energy prices that made Spanish manufacturers uncompetitive and pushed jobs to other countries. Each new green job in the wind industry cost, on average, more than €1 million. The Spanish government's program destroyed 2.2 jobs for every green job created. Wind power eliminated 4.27 jobs for every megawatt installed.[80] The Spanish government is now conducting a wholesale review of its energy policy.[81]

Government subsidies for wind energy constitute a gross misallocation of public resources on an inefficient technology. The inevitable result will be higher energy prices without any measurable environmental benefit. Denmark, which leads the world in wind energy, has the world's highest electricity costs. Its consumption of coal has remained steady and its greenhouse gas emissions have increased.[82]

Pursuing a "green" energy strategy will cause America to lose competitive advantage in the global marketplace. While the United States has been moving towards high-cost, low-energy sources like wind, China is building coal-fired power plants and generating ample amounts of low-cost energy. China is only too happy to build wind turbines--not for its own use, but for the American market.[83] The Chinese do not believe in global warming.

Conclusion.

Wind energy is inherently intermittent and so cannot provide a reliable source of electricity to the grid. As government compels us to increase our reliance upon wind power, wind's intermittent nature will destabilize the grid, resulting in outages. Another result of wind's intermittency is the need for backup, which negates any reduction in carbon dioxide emissions. Thus, wind energy fails to accomplish its primary mission, to reduce the threat of global climate change.

Wind energy is much more expensive per unit of power generated than electricity derived from fossil fuels or nuclear reactors. The free enterprise system has no incentive to embrace wind energy because it is uneconomical. Industrial scale wind energy facilities are constructed only with government mandates and subsidies. Taxpayers and consumers bear the cost of wind energy. The European experiment with wind power shows that the government wind energy model is unsustainable. Both our environment and our economy would be better off if wind power were abandoned again, as in the 1930s.

Investing money in wind energy is like buying expensive food that is low in calories. Every day you spend more money and lose more weight. As time goes on you have less energy and less money. Eventually, you either end up in the hospital or the poorhouse.

FIGURES

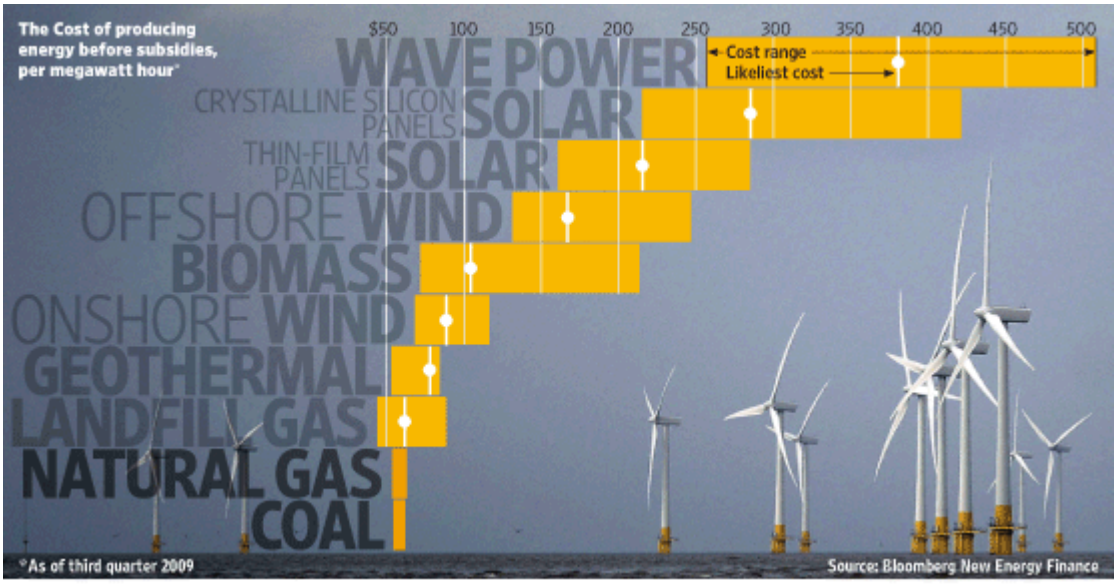

Figure 1: Relative costs of various sources of energy.[84]

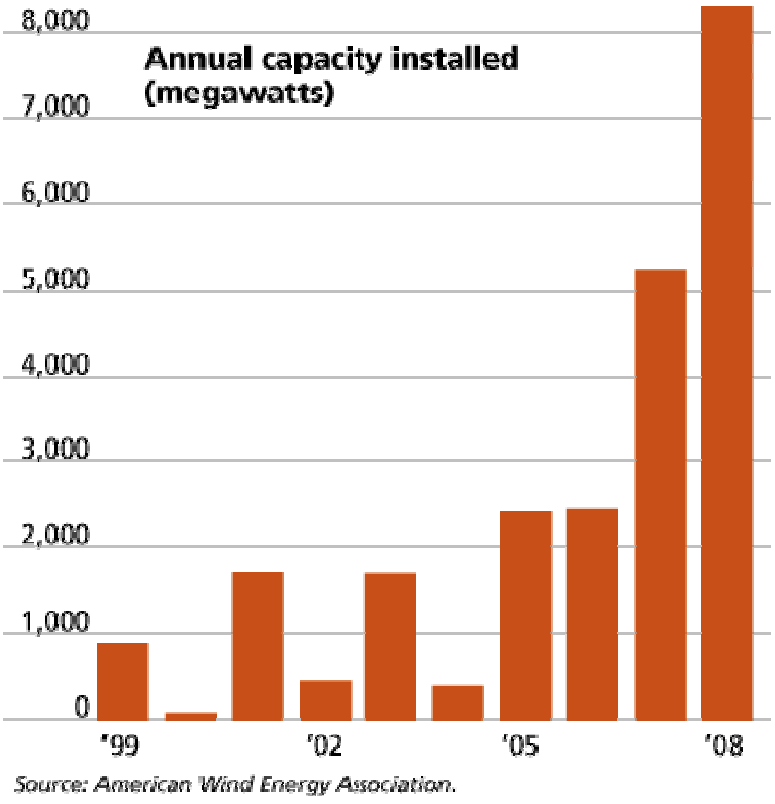

Figure 2: Wind energy installations depend on subsidies. [85]

ENDNOTES

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