Presenter:

Ernest J. Cabral, CEM
82 Bagley St.
Central Falls, RI 02863
401-724-4527

Background:
Certified Energy Manager
Run a company that provides Industrial Services
Candidate for Senate District 16

I am here to oppose the approval of the deep water project for the following reasons:

1. The high cost of this power will further exacerbate the high cost of power in this region, making the manufactures that are still here less competitive. The Providence Journal reported the Toray Plastics would have to spend an extra $260,000 and Brown University an extra $200,000 per year. In a press release from Patrick Lynch, he said the cost to consumers and businesses over the next 20 years would be $390 million over market prices. Here is a list of 61 companies who have left the state because the cost of doing business here was too high. Most of them were my customers.

2. The second issue is power quality where they connect to the grid. Power quality issues such as flicker, possible reactive power swings and voltage issues, The steps the utilities will have to take to address these issues will be born by the rate payer, a hidden added cost to wind.

3. The final, and to me the most serious issue I want to address is the difference between firm power and wind power. Firm power is the ability to provide generation to the transmission grid without interruption, plants that use coal, oil, gas or nuclear. Wind power is not reliable; it varies with the wind speed, and provides no power without wind and must be shut down when wind speed exceeds 55 mph. What this means is that the firm power must be constantly on line to meet losses and changes of power to meet the needs of the grid. What this means is we are spending money and not saving our resources because the power plants have to continue to operate, generally at reduced efficiencies. In short I believe wind power is a glaring waste of energy. Countries in Europe have reduced or eliminated subsidies and tax breaks for renewable energy and Denmark Europe's biggest producer of wind farm electricity has stopped all wind farm development. This is technology that is not developed enough and we owe it to our citizens to prevent this boondoggle.

6 Packets supporting documentation attached.

(1)

The Providence Journal projo.com

Rhode Island news

Comments 42 | Recommend 2

Business group balks at cost of wind power

01:00 AM EST on Wednesday, March 10, 2010

By Alex Kuffner

Journal Staff Writer

WARWICK — Some of Rhode Island's largest users of electricity have come out for the first time in opposition to a proposed power-purchase agreement between National Grid and the developer of an eight-turbine wind farm in waters off Block Island.

The executive director of the Energy Council of Rhode Island, a nonprofit organization known as TEC-RI that represents 35 of the state's biggest manufacturers, universities and hospitals, testified on Tuesday against an agreement under which Deepwater Wind would sell power generated by the offshore wind farm at more than twice the price National Grid pays for electricity from conventional sources.

John Farley told the state Public Utilities Commission that the higher price of power from the wind farm would be a burden on the members of TEC-RI that collectively employ 50,000 people in the state, including Hasbro and Rhode Island Hospital.

For example, Toray Plastics America, which operates a factory in North Kingstown that is the largest consumer of electricity in the state, would have to pay an additional $260,000 annually if the proposed contract were to go into effect. Brown University would face an increase of $200,000 a year.

"We have concluded that this contract includes a price that is so high that it more than negates any other potential attractive features, such as job creation, added local supply and environmental protection," Farley said.

Farley spoke during a public comment period on the first day of evidentiary hearings before the PUC, which is considering whether to approve a 20-year contract between Deepwater, a New Jersey startup that wants to build the wind farm within three miles of Block Island by 2012, and National Grid, Rhode Island's dominant electric utility.

Under the deal being reviewed, National Grid would pay 24.4 cents per kilowatt hour for power from the project starting in 2013. The price would increase by 3.5 percent a year. The utility currently pays 9.2 cents per kilowatt hour for power from natural gas-fired plants and the like.

National Grid agreed to Deepwater's price after taking into consideration that the Block Island wind farm is being developed as a demonstration project and would be the first of its kind in the United States.

"We believe that we have the best price we could get given the limitations of this project," National Grid lawyer Ronald Gerwatowski told the commission.

For a typical household that uses 500 kilowatt hours a month, the additional cost of the proposed agreement would amount to $1.35 a month, or $16.20 a year. The impact on large businesses such as Toray — which buys about 8.3 million kilowatt hours per month from National Grid — would be deeper, and could force them to rethink their operations in Rhode Island, said Farley. The proposal comes after the utility raised distribution rates on March 1.

"That's what we're really concerned about — the overall competitiveness of Rhode Island," Farley said.

The PUC must decide whether the contract is "commercially reasonable," and is considering testimony from energy-market analysts and comments from the public. The hearings will continue through the end of this week, and a vote is scheduled for March 30.

The proceedings opened with testimony from Governor Carcieri, a vocal supporter of Deepwater's project. The Carcieri administration selected Deepwater as the state's preferred developer of offshore wind in 2008.

The governor acknowledged the high price of power from the wind farm, but said the rate is reasonable considering that it is predictable compared to the volatility of fossil fuel prices. He also said the clean energy project would generate much-needed jobs in the state. Deepwater is also planning a 100-turbine development in waters off Rhode Island, and estimates that together that project and the smaller wind farm would create 800 local jobs.

An executive with Energy Management Inc., the company behind Cape Wind, an offshore wind farm proposed in Massachusetts, also testified in favor of the power-purchase agreement. His company is currently negotiating with National Grid for the sale of power from its project.

"A lot of industries are looking to pull out of this region," Energy Management vice president Dennis Duffy said. "This is one new industry that is trying to get in."

After the public comment period, the commission questioned Cliff Hamal, an energy expert hired by National Grid who analyzed prices for power from offshore wind farms installed in Europe and proposals in Canada and the U.S.

Commission Chairman Elia Germani asked Hamal if he knew of any offshore wind contracts with prices higher than 24.4 cents per kilowatt hour.

"No, I don't," said Hamal.

akuffner@projo.com

RI.gov : Rhode Island Government : Stating that RIers deserve "wind energy at a fair rate" — but shouldn't be made to pay for "a windfall for sweetheart deal-makers" — AG Lynch urges legislature to defeat Deepwater bill

Press Releases

Stating that RIers deserve "wind energy at a fair rate" — but shouldn't be made to pay for "a windfall for sweetheart deal-makers" — AG Lynch urges legislature to defeat Deepwater bill

Claiming that the amendment that the developer hoping to build a wind farm in state waters off the coast of Block Island has been circulating to nervous lawmakers recently "only underscores how bad the original bill is, and how badly it would batter Rhode Island ratepayers over the next 20 years," Attorney General Patrick C. Lynch today leveled his strongest criticism yet against Deepwater Wind LLC's eight-turbine demonstration project.

Lynch urged the RI General Assembly to reject the proposal, which would cost consumers and businesses $390 million over the market price of electricity over the next two decades, according to two different experts who testified at the months-long hearing that the state Public Utilities Commission (PUC) held on the original project.

"This 'demonstration project' off of Block Island would demonstrate how easy it is to make money off of Rhode Island; it would not be for the economic benefit of the people who work in Rhode Island," Lynch stated in an 11-page letter he sent today to legislative leaders. (Please see attachment.) He added, "Rhode Islanders deserve wind energy at a fair rate. They shouldn't be stuck with the bill for a windfall for sweetheart deal-makers."

The Attorney General said the draft revision (the "Sub-A" amendment) that Deepwater's boosters have written doesn't address any of the "substantive or process concerns" that the PUC raised in rejecting the project in March or that Lynch, environmental advocacy groups and good government groups have raised in the past several weeks.

"Instead, Deepwater's draft attempts to distract the reader with extraneous concerns. This is an attempt to reframe the debate by focusing on the new process, while ignoring the process that already transpired," he wrote. The Sub-A does not incorporate the idea of a role for the PUC on any terms, effectively makes Deepwater the only party that could appeal any aspect of its own project for the life of the project, includes "an anti-public participation provision in the form of an attorneys' fee clause," Lynch's letter states, and kills any chance for the public to "fully review the rate increases implicit in any Purchase Power Agreement," the letter says.

"How much better it would have been for Deepwater to have taken the approach of doing well by doing good," Lynch says in his letter.

In separate comments he made today, Lynch added, "Rhode Island Ratepayers will end up paying a $400 million subsidy and upwards of $200 million of that subsidy will end up in the pockets of Deepwater and its capital providers. All on the backs of ratepayers paying excessively for power, to get six permanent jobs and no promise that the utility-scale wind farm will ever be built."

(MORE)

AG urges RI General Assembly to defeat Deepwater project Page 2 of 2 5/28/10

Lynch said he is "obviously very concerned about the impact of any proposal on the people of Block Island," stating: "As the PUC indicated at its final hearing on March 30 and in its April 2 final ruling, I too am sensitive to the challenges that the businesses and residents on Block Island face. Last year, Block Island has the fifth highest cost of electricity in the United States. There are viable alternatives that can secure a stand-alone cable for Block Island, where financing can be supported with some of the same federal and state renewable energy grants contemplated to be used for the Deepwater project. These alternatives, however, will not include outsized investment gains on the backs of Rhode Island ratepayers paying excessively for power. The State should support Block Island in this manner."

###

Related links

Department or agency: Department of the Attorney General

Online: http://www.riag.ri.gov

COMPANIES and JOBS THAT HAVE LEFT THE STATE

- Air Products
- Anson, Inc.
- Bancroft Racket
- BIF
- Blackstone Webbing
- Capeway Seafood
- Clarion Chemical
- Ciba Geigy
- Collyer Insulated Wire
- E.A. Adams
- Federal Printing
- General Electric 3 plants
- Grinnell Corp
- Huhtamaki (Chinet)
- Imperial Knife
- Industrial Dye Stuff
- Kennicott Wire & Cable
- Livermore & Knight
- Mobil Oil
- Narragansett Brewing
- New England Bituminous
- Ocean State Steel
- Owens Corning Fiberglass
- RI Insulated Wire Co.
- Sales Finishing
- Kaiser Aluminum
- UniRoyal, Inc. 3 plants
- Victor Insulated Wire
- Wayland Chemical
- American Tourister
- Atlantic Tubing and Rubber
- BB Greenburg Co.
- Bird & Son
- Cadillac Textiles
- Carlton Mfg.
- Slater Dye
- Coast American
- Coro Jewelry
- Elizabeth Webbing
- Fram
- Greenhaugh Mills
- Hasbro, Inc.
- Hunt Chemical
- Improved Laminated Metals
- Keene Corporation
- Lebanon Knitting Mills
- Mine Safety Appliance
- Monet/Trafarri
- Narragansett Wire Col
- Nissen Bakery
- Okonite Co.
- Quebecor Printing
- Rumford Chemical
- Syntex Corp
- Standard Romper
- United Wire Co.
- Ward Baking Co.
- and more

JUNE 2010

TRANSMISSION + DISTRIBUTION WORLD

(4)

Tri-County Electric finds issues with the integration of wind farms on the medium-voltage grid

By **Mike Swearingen**, *Tri-County Electric Cooperative*

Supplying a growing consumer demand is the foundation of the electric power industry. In recent years, coal generation has become a major source of contention among environmental groups, government and some utility consumers. In an effort to respond to these issues, renewable energy sources have taken center stage in providing clean generation.

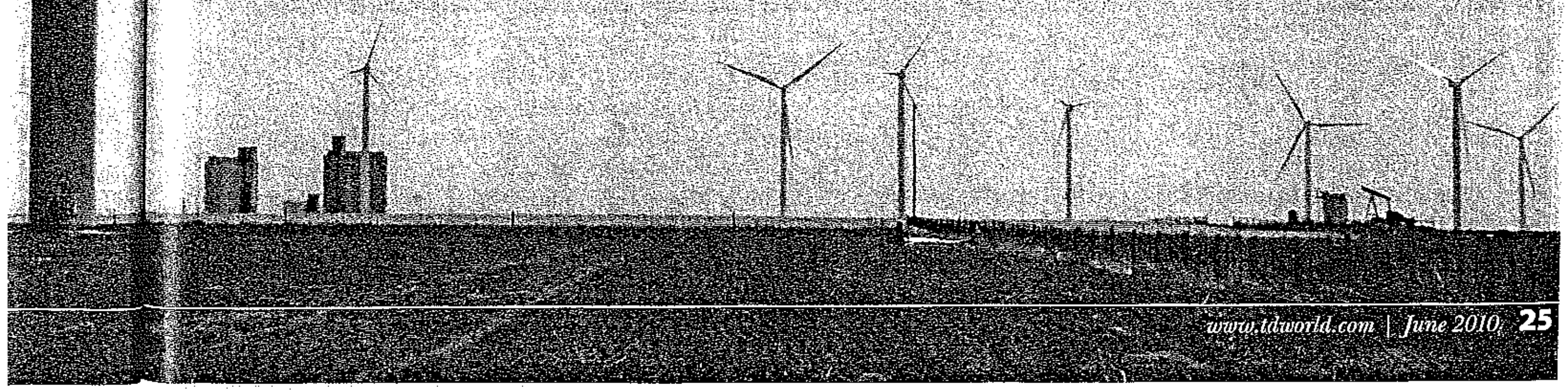
Starting in the 1980s, renewable energy started to become the topic of discussion to supplement and replace some of the country's baseline generation. Some of the early wind and solar installations did not provide the level of generation required to make them a viable part of the transmission grid. Another issue was the effect renewable energy would have on the reliability and power quality of the transmission grid.

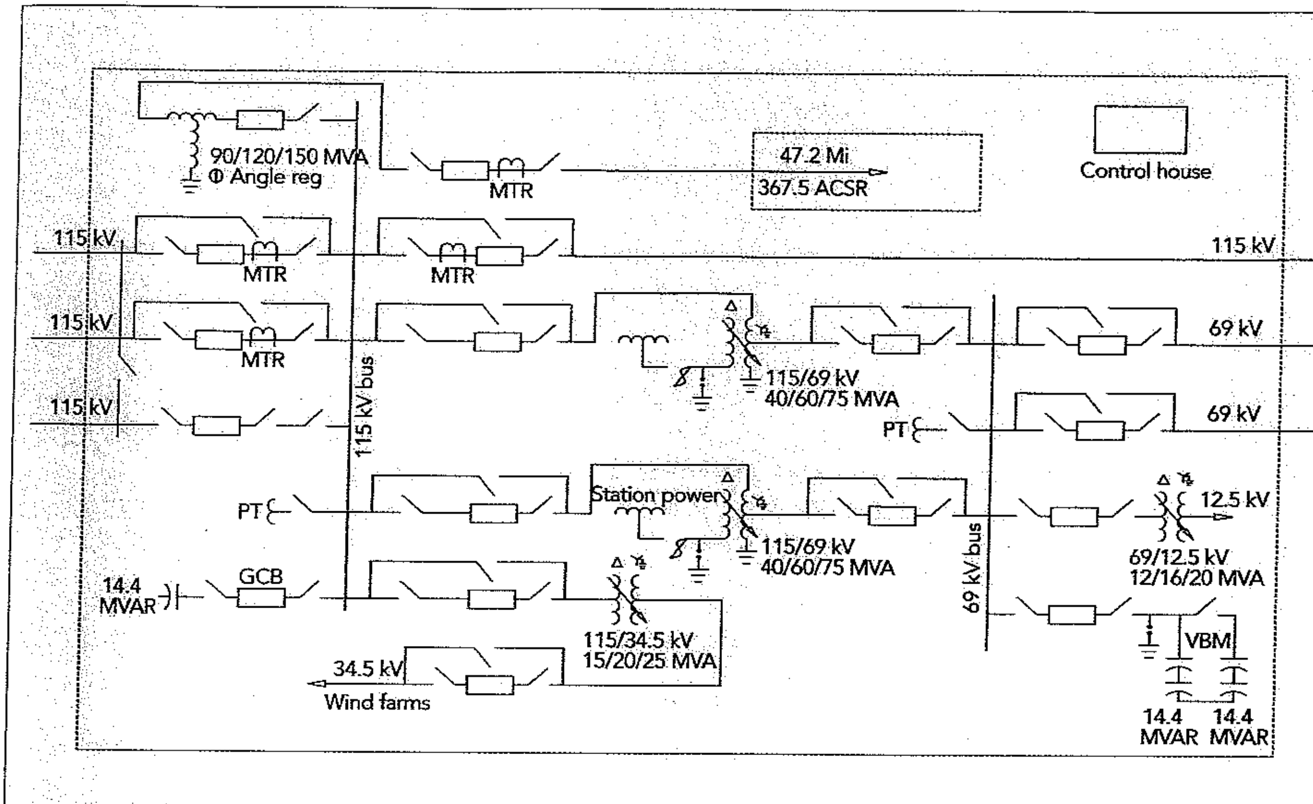
Wind Farms and the Grid

Wind has emerged as a major player in the renewable generation field and has evolved to provide a viable amount of load that can be integrated into the transmission grid. In the 1980s, wind generators contributed 50 kW to 100 kW per tower. By the 1990s, the contribution provided by each tower increased to 300 kW to 500 kW. Today wind turbines can provide 1.5 MW to 3. 5 MW per tower.

One of the issues with wind as an emerging power source is that wind does not supply firm power to the transmission grid. What is firm power? Firm power is the ability to provide generation to the transmission grid without interruption. Firm power generation such as coal, natural gas and nuclear provide power at a low cost, whereas renewable energy like wind and solar require renewable energy credits to be cost-competitive. Wind generator manufacturers are trying to expand the wind generators operating range to allow it to operate in a larger envelope of wind conditions. Other efforts are being made to improve the consistency of wind power by finding ways to convert the energy produced by the wind generator turbines into a form of energy that can be stored and used during the times of energy need. Another effort is to build enough wind generation sites in different areas, including the ocean, to provide enough generation to meet the need of the transmission grid should some of the wind facilities be down because of maintenance or lack of an adequate wind operating envelope.

While wind technology is advancing, one of the issues of wind power is its effect on the power quality of the transmission grid and the installations attached to it. In most cases, the wind generation sites of today are large and interconnected to high-voltage transmission systems through a substation that takes the collection grid voltage and transforms it to the high or extra high voltage of the transmission grid. This allows the substation relay protection schemes, automation and substation equipment to control and protect against frequency and voltage fluctuations, and to provide a stable and synchronized output to the transmission grid. However, a trend has developed among wind farm developers to divide their generation farms into several small-scale wind generation farms that can be attached to the distribution systems of most utilities.





The one-line diagram of the transmission interchange substation described in the article.

An Illustrative Installation

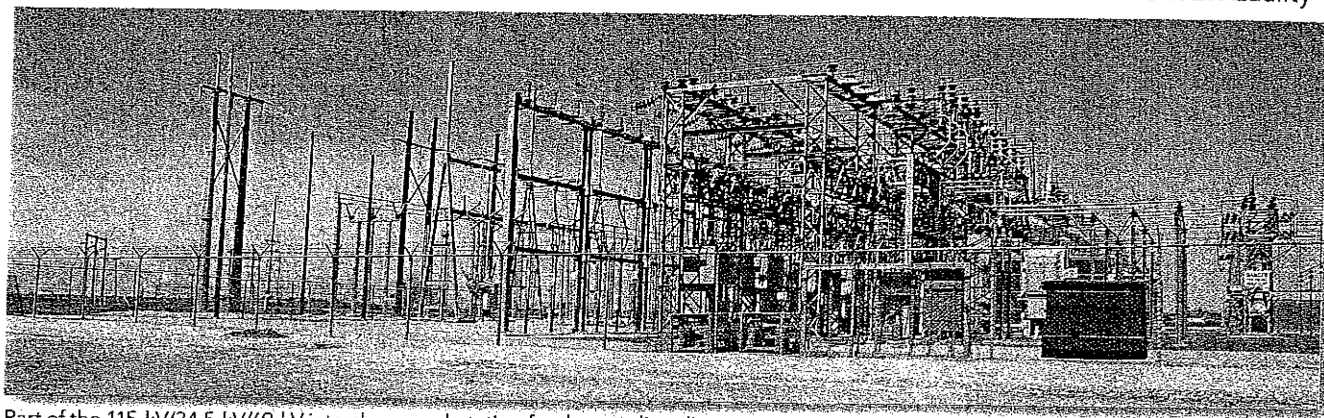
Some states will allow small wind generation farms that fall under a certain power level to connect directly onto a distribution system. One example of this is the Texas Public Regulatory Commission's Rule 25.211 Interconnection of On-Site Distributed Generation, which allows wind farms with a capacity of 10 MW or less to connect on electric systems less than 60 kV. Wind generation connections at this voltage level can cause power-quality issues that become significant problems for utilities and customers. Some examples of power-quality issues that are encountered are flicker, possible reactive power (VAR) swings and voltage issues.

An example of this situation is two identical 10-MW wind farms interconnected on the same 34.5-kV feeder 1 mile (1.6 km) apart and 11.38 miles (18.31 km) from the substation. The substation is an interchange that contains a 115-kV bus fed by two lines and also contains a 115-kV/69-kV substation with two parallel transformers and an 115-kV/34.5-kV substation. The 115-kV to 34.5-kV substation is the grid interconnection source for the two 10-MW wind farms. The tap changer on the 34.5-kV transformer is programmed with line drop compensation to meet the needs of all the circuits during summer loading. Both of the wind farms are on the same circuit and provide 15 MW to 20 MW of power to the feeder. The same feeder serves three commercial facilities, irrigation load, residential loads and another substation. The peak circuit load is 8 MW and the average load is 5 MW.

The wind generation facilities have a 34.5-kV collector system and are interconnected to the transmission grid through a vacuum recloser with a relay control that provides overcurrent protection. The generation farm's supervisory control and data acquisition system provides the ability to disconnect the wind farm from the transmission grid when the transmission system is down as a result of an outage or when other adverse conditions are being experienced by the utility. The wind turbines contain protective relays that provide for low-voltage ride through, reactive power control and time synchronization.

Power-Quality Issues

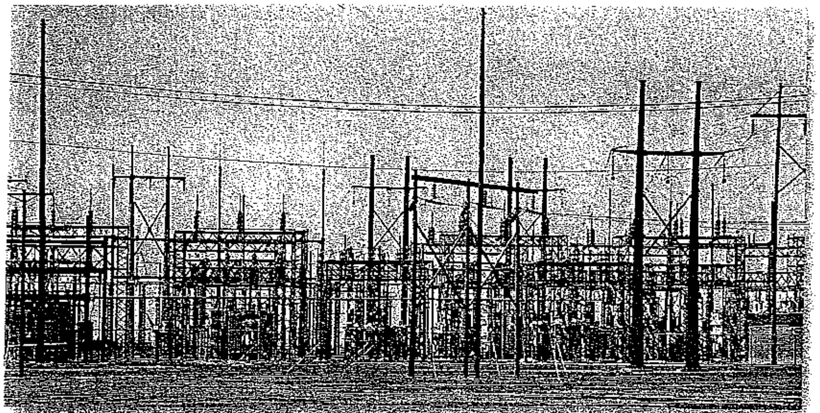
One of the first power-quality issues encountered with the wind turbines was the effect they had on the paralleling scheme of the 115-kV/69-kV transformers in the interchange substation. The reactive flow on the 115-kV bus was high enough to affect the stepping of the transformer tap changers, causing them to get out of step by more than three steps. The paralleling scheme, which is a circulating current scheme, caused the tap changers to block stepping when the tap changers are four or more steps apart. The tap changers would lock out on a weekly basis because of out-of-step blocking. After examining the operation of the tap changers, it was discovered that the reactive power from the wind turbines was traveling on the bus and through the 115-kV/69-kV transformers, at which point the tap changers were seeing enough reactance to affect the tap changer scheme. After much research, it was determined that the paralleling scheme should be changed to a master/slave scheme, otherwise known as a lock-step scheme. This change allows the master transformer to react to changes on the bus and then communicate when to step to the other transformer. Once this change was made, the transformers operated in parallel and tap changer lock-out was mitigated.



Part of the 115-kV/34.5-kV/69-kV interchange substation for the one-line diagram.

The other wind farm-related issue concerned the effect on customers who were attached to the same circuit. Two of the commercial facilities were affected by high voltage and flicker, which caused their relays to lock out. Power-quality recorders were installed at the point of interconnection of the wind farms and at the affected customer sites. The recorders showed that when the circuit was lightly loaded and the wind generation facilities were running, a high-voltage condition was present on the circuit, which caused some of the commercial facilities' equipment to be locked out by overvoltage settings within their relays. This occurred on a consistent basis, causing one of the facilities to run half of its plant on generators rather than the power system.

A study was done and the results provided information on solutions that could be taken to mitigate the problem that the consumers were experiencing. One action taken was to adjust the reactive power control relays to tighter tolerances, which resulted in the wind turbines running near unity power factor on a consistent basis. The other action taken was to adjust the settings of the tap changer control at the 115-kV/34.5-kV transformer. The adjustments included changing the line drop compensation settings and the bandwidth and reaction time of the tap changer control. After both actions had been taken, the power-quality recorders showed the voltage to be within ANSI voltage limits. The commercial customers who were contacted indicated that their recording equipment showed



A section of the 115-kV/34.5-kV/69-kV interconnection substation to which two wind farms are connected by a 34.5-kV line.

an improvement in the voltage, allowing them the ability to return their load to the power system.

Changing the World

Wind generation and other renewable energy sources are improving and can be a viable part of the distribution or transmission grid. They provide a supplement of power that can help alleviate stresses to the current transmission grid. However, it is important for utilities to work with these renewable facilities at the onset of the project and design the facilities as well as upgrade the power systems to meet the impacts of this future generation. Power systems are becoming more sophisticated and complex, so it is important to look beyond the standard practices that have served us well over the past several years and embrace the possibilities that face us with renewable energy and the smart grid.

Futurist and author Joel Arthur Barker states: "Vision without action is merely a dream, action without vision just passes time, vision with action can change the world."

As utilities, our world is changing, but it provides us with an opportunity to improve the way we deliver power to our customers, including the quality of the power. For a long time, power systems operated without much change; however, utilities have the opportunity to change the power industry much the same way as Nikola Tesla and George Westinghouse did when creating the first power systems. TDW

Mike Swearingen (mikeswearingen@tri-countyelectric.coop) received a BS degree from the Department of Computer Science and Mathematics at Eastern New Mexico University. He is the manager of engineering and operations at Tri-County Electric Cooperative in Oklahoma. Swearingen is a member of the IEEE Power & Energy Society, the Computational Intelligence Society, Nuclear and Plasma Sciences Society, and the Standards Association.

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 wind-power 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 noted that European wind power may kill up to 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—something 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.

Eric Rosenbloom is a writer and science editor living in Vermont.

Peter Lang on Australian Windpower: High Costs, Low Emission Reduction

(6)

by Kent Hawkins
January 21, 2010

The higher costs and inferior reliability of government-mandated wind power and solar power are well known to students of the electricity market. Many analyses on wind and solar have documented their real-world problems.

But another negative aspect of wind and solar technologies is their failure to live up to their raison d'être: *emissions reduction.* As I have explained in a four-part post, firming intermittent electric generation requires very inefficient fossil-fuel generation that creates *incremental emissions* compared to a situation where there is not wind or solar and fossil-fired generation can run more smoothly. This is a huge insight, a game changer, that could take the renewable energy debate in a new direction entirely.

A number of studies are emerging that quantify both the cost premium of politically-forced renewables and the minimal amounts of emissions reduction (and even notable emissions increase) resulting from their use. Country-specific studies (such as the one under review) present a methodology that is applicable to other jurisdictions (such as the U.S.) to better assess policy options and their consequences for all stakeholders, including taxpayers.

Peter Lang's important new study, *Emissions Cuts Realities – Electricity Generation,* analyzes five options for the Australian electricity system for cutting CO2 emissions over the period 2010 to 2050 compared to business-as-usual (BAU) in terms of cost. The range of CO2 emissions reductions by 2050 compared to 2010 is from zero to 80%.

The conclusions that Lang draws include:

1. The nuclear option provides the largest reduction in CO2 emissions – 80%.
2. Any CO2 emissions reduction achieved with wind and solar thermal (there are arguably none and even increases) is "achieved" at a very high cost – 250-300% of 2010 costs.

Lang's analysis is very conservative. The author's preference seems to be to gain an unassailable beachhead in a very contentious debate. But in reviewing his data, I see confirmation that new wind or solar capacity provide marginal reduction in CO2 emissions at best. I would even argue that there are emission *increases* because any reductions due to new renewables are dependent upon solar thermal technology development by 2020 providing sufficient thermal storage to allow operation for 8,000 hours per year.

Other conclusions that can be reached are:

1. The nuclear option provides an effective 'bridge' to future generation technologies.
2. The extraordinarily large funding required for the implementation of new renewables in this period would be better spent on energy efficiency/conservation programs and in research and development for other technologies, such as carbon capture and storage (CCS), nuclear waste management, nuclear fusion and solar.

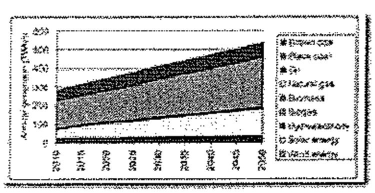
In summary, Lang's study and other considerations provide another illustration of the failure of industrial-scale new renewables, particularly wind and in the near future, solar, to meet societies' goals. They do not provide the impact that is needed in terms of energy independence, avoidance of fossil fuel use and reductions in CO2 emissions that conventional wisdom, with all its inadequacies, dictates.

My summary of Lang's paper follows.

Options Investigated

The BAU option is illustrated in the following chart from Lang's paper (all charts reproduced with permission). It shows the electricity production projected to 2050. The five options investigated replacing all the coal production by 2040 in accordance with realistic build rates, with the remaining BAU generation unchanged. The electricity production from the replacing generation must provide for that of the replaced coal plants.

Figure 1 – Electricity Production for Business as Usual



In 2010, about 70% of electricity generation uses coal, followed by natural gas and hydro. The five options considered to replace the coal portion entirely are:

1. Combined Cycle Gas Turbine (CCGT)
2. Nuclear and CCGT
3. Wind and gas, including CCGT and OCGT (Open Cycle Gas Turbine)
4. Solar thermal and CCGT
5. Solar thermal, wind and gas (including CCGT and OCGT)

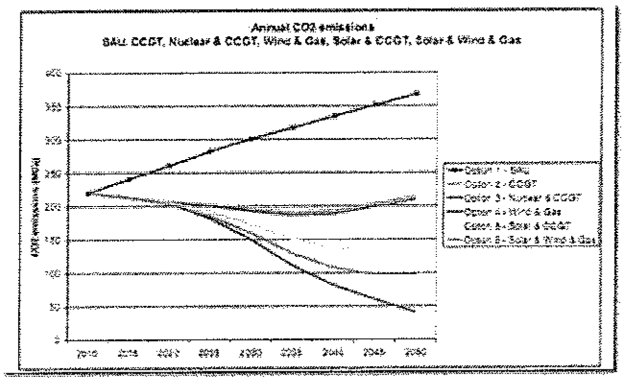
Solar thermal has some inherent storage capability due the thermal inertia of the heat transfer fluids, which will smooth out short term fluctuations. As well, it is assumed that technology development by 2020 will provide sufficient thermal storage to allow 8,000 hours per year operation, eliminating the need for shadowing/backup by other generation plants, as is required by wind.

The results show the combined effect of the BAU case, minus coal, plus that of the replacement technologies.

Results

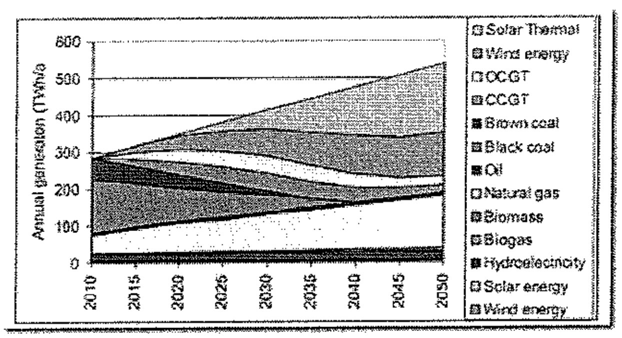
Figure 2 summarizes the outlook for CO2 emissions for all the options. Note that Option 3 (Nuclear & CCGT) provides over 80% savings, which is a target that many claim to be necessary in the context of combating climate change.

Figure 2 – Projected CO2 Emissions for Coal Replacement



Lang's options 5 and 6 merit some comment. First, Option 6 will be discussed, and to assist in this, it is necessary to look at the chart for this projection, which is shown in Figure 3.

Figure 3 – Option 6 (Solar & Wind & Gas)



In Figure 3, focus on the top four segments, Solar Thermal, Wind energy, OCGT and CCGT. This represents the coal replacement complement for Option 6. The gas component below this is that already present in the BAU scenario (see Figure 1). The model was built assuming a given build rate for solar and wind, which results in a certain level of production. The difference required to meet the necessary total MWh was then added as additional gas production, including OCGT and CCGT. However, this replacement gas production is not sufficient to balance the amount of wind present. It should be about at least twice the wind production to avoid adversely affecting electricity system reliability. This change would increase the gas component and reduce some combination of that for Solar Thermal and Wind energy accordingly. These changes would likely increase Option 6 (Solar & Wind & Gas) to about the same level of CO2 emissions as Option 5 (Solar & CCGT).

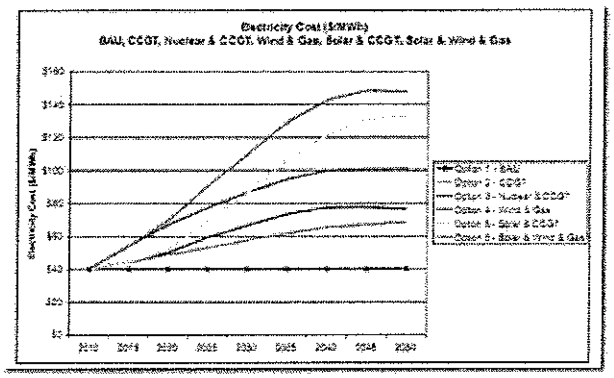
With respect to Option 5, as mentioned above, it is assumed that technology development by 2020 will provide sufficient thermal storage to allow 8,000 hours per year operation, eliminating the need for shadowing/backup by other generation plants, as is required by wind. Inasmuch as this is generous, it will overstate the benefits attributable to both options 5 and 6. The resulting CO2 emissions could easily increase to the same level as options 2 and 4, that is, showing no decease relative to 2010.

A few model parameters are generous to new renewables. Less generous treatment could easily show increases over 2010 in CO2 emissions for all options that involve wind and solar.

- The wind capacity factor of 30% is at the high end of general experience world-wide, especially in extensive implementations.
- Lang reduces my calculator's CO2 emissions increase rates for OCGT and CCGT in a wind shadowing/backup role by 50%, which is arguably conservative. Extensive studies are needed to establish the level that should be used. As I have indicated elsewhere, the availability of multiple gas turbine engine-generator sets may allow some gas turbines to run more efficiently in a wind shadowing/backup role. Countering this are other considerations, such as, the grid topology may not allow this type of co-operation of plants across an electricity system.

Turning now to costs, Figure 4 shows the resulting impact on electricity costs per MWh, which speaks eloquently for itself.

Figure 4 – Electricity Costs per MWh



Suffice it to say that the three options involving new renewable energy technologies will result in electricity cost increases from 250% to over 300% of the 2010 levels.

Conclusions

Lang presents further proof that industrial-scale renewable capacity additions, particularly wind and in the near future, solar, are problematic in terms of meaningfully reducing emissions. They do not provide the impact that is needed in terms of energy independence, avoidance of fossil fuel use, and reductions in CO2 emissions that conventional wisdom, with all its inadequacies, dictates.

Acknowledging that we must make efficient use of all our resources and in the absence over the next few decades of significant advances in CCS technologies and breakthroughs in energy conservation/ efficiency, we must look to nuclear fission plants as a bridge to future electricity generation capabilities. In the meantime, the extensive resources needed for new renewable energy implementations would be better spent on energy conservation/efficiency measures and, perhaps of greater importance, research and development for future technologies including: CCS, nuclear waste management, nuclear fusion and solar.

As electricity is an essential resource for the well-being of people in all countries, approaches to providing it must be soundly based. To that end, Lang provides a much-needed and effective road map.

Lang, Peter (2010). ***Emissions Cuts Realities – Electricity Generation: Cost and CO2 emissions projections for different electricity generation options for Australia to 2050.***

8 comments

1 **Robert Hargraves** { 01.21.10 at 8:52 am }

The focus on cost is important. I am an advocate of energy cheaper than from coal, the only way to persuade all nations to forgoe burning coal, through economic fundamentals. The liquid fluoride thorium reactor has the potential to provide power at $0.03/kWh (US). Aim High presents the benefits and technology of LFTR.

2 **Jon Boone** { 01.21.10 at 1:22 pm }

Good job, Kent Hawkins. Peter Lang's work complements your own in this important area of inquiry. Thanks for clarifying the extra components in his various options, beyond #1, making them additive, that is, beyond what is now generated, excluding the coal phase-out.

You might have pointed out that his assumptions about a 25-year life cycle for wind turbines should also be questioned, particularly for proposed off-shore projects. There are a number of indicators, including the wind industry's own insurance policies, that such life cycles don't comport with reality.

Lang's Option 6, the one with wind and solar reminds of nothing more than an Amory Lovin's wet dream, full of sound and fury, but, as you point out, signifying very little.What must happen in this scenario on a cloudy day with low wind? There's not enough reserve in the whole arsenal to compensate for such a situation--not to mention the likely insuperable problems with regulating the variability under such a load. Battery storage for such vast energies are not remotely on anyone's horizon.

I hope Lang will reexamine his latest paper in the light of your critique here, honing it more carefully, and then consider placing it in an influential energy publication, where it could influence policy makers throughout the world.

3 **Real holes in science « BraveNewClimate** { 01.22.10 at 12:18 am }

[...] Kent Hawkins from the MasterResource energy blog has done a detailed write-up of and commentary on Peter Lang's recent work on emissions reductions. It's an [...]

4 **Peter Lang** { 01.22.10 at 2:10 am }

Kent Hawkins,

Thank you for this summary. For your readers, I'll just confirm that I agree with the criticism about Option 6. Option 6 is so pie-in-the-sky for many reasons that I did not go into this level of detail in the paper. Likewise I agree with your other criticisms. The aim was to keep the paper sufficiently simple that it could be understood by the "intelligent, interested, non-specialist". However, I do note that this is one of several improvements that will be needed in a subsequent version.

I should clarify for your readers that Figure 4 is not the total cost of electricity for each option. It is the cost of electricity from the proportion that is generated by coal and the replacement generators. The full cost of electricity from each option would include the cost of the proportion of electricity generated by the other generators (oil, hydro, etc).

Jon Boone,

Thank you for your comments.

You said:
"Thanks for clarifying the extra components in his various options, beyond #1, making them additive, that is, beyond what is now generated, excluding the coal phase-out."
I am not sure I understand what you mean in this statement. The analysis is on the basis that the replacement technologies generate exactly the same power as the BAU option at all times. All six options supply the same energy per period. The replacement technologies replace the energy that would have been generated by coal as the coal generators are decommissioned. The five options beyond #1 comprise different technology mixes; they are not additive.

I agree with your comment about the assumed 25-year life for wind turbines. The comment also applies to the assumed economic life for solar thermal plant. The reason for using these figures is they are the figures in the authoritative references from which I sourced the data – e.g. EPRI (2009), NEEDS (2008). I had to use consistent figures from the authoritative references. The life expectancy affects the costs of electricity calculated in the source documents. I did not recalculate electrcity costs. The only place that I used these figures is to calculate when the installations would have to be replaced.

I think your comments about Option 6 are addressed in the paper. I did mention that the capacity margin is ignored in the calculations in this paper; the overbuild required for solar power is the subject of two previous papers (references sited in the pdf).

This is intended to be a "big picture' comparison. If I try to get too detailed and too technical, I will lose the audience I am trying to reach. I agree some items do need to be addressed in a future version and Barry Brook and I do intend to submit a paper to a peer reviewed journal.

5 **Jon Boone** { 01.22.10 at 8:57 am }

Thank you, Peter, both for your comments here and for your work in general. As I said, it's important work that merits much attention, and am delighted that you intend to submit the paper for peer reviewed publication.

Perhaps it was my careless reading of your text, but to me it was unclear, in all your options beyond #1, what you meant by keeping a floor of natural gas, then adding OCGT and CCGT, since these are fueled by natural gas. It was in this sense that I used the word "additive." In light of Kent Hawkins' comments, and now your own, it's now clear what you were doing.

That you explored–and compared– a range of fuel mix options for the future is extremely helpful. Last night I watched a debate forum in West Virginia, in which Robert Kennedy Jr claimed that wind and solar could replace coal generation in the United States within the next 20 years–this based on articles in the magazine, Scientific American, and on several recent Department of Energy feasibility reports.

But he did not say that such a scheme would offset meaningful levels of CO2 emissions (although he likely assumed this). Your work here, and that of Kent Hawkins, should go a long way in showing how feckless wind technology is as a means of avoiding this CO2 emissions.

As it is, even government reports like the one issued yesterday from the National Renewable Energy Lab, which admitted that even with extensive wind buildout, beginning with $93 billion of tax revenue spending, "the projected global warming benefits are modest: a drop of about 4.5 percent in emissions, at best." Using your methodology for assessing the thermal behavior of all units involved with wind integration, even such a seemingly inconsequential figure of 4.5 percent will be seen as a gross exaggeration. At the scale imagined by the NREL report, and using your calculations, it's likely that wind integration would actually increase the volume of CO2 emissions well beyond what they would have been without any interjection of wind technology at all.

Perhaps you and Kent Hawkins–and others–could one day collaborate on a multinational analysis that would be the methodological basis for evaluating any grid system's potential for having wind technology used to abate CO2 emissions–assuming that real data will be made available for this purpose.

6 **Steve Darden** { 01.24.10 at 4:32 am }

Thank you for investing the effort to analyze Peter Lang's report. I have only one suggestion for today: I would prefer different priorities for better investing the money currently being wasted on renewable subsidies. You wrote:

> *In the meantime, the extensive resources needed for new renewable energy implementations would be better spent on (...) future technologies including: CCS, nuclear waste management, nuclear fusion and solar.*

If I were "king" I would amend that list to a single program: Gen IV sustainable nuclear power, meaning fast neutron reactors, such as the IFR design which was shut down by the Clinton administration. This class of nuclear reactor consumes what is currently defined as "nuclear waste" as well as newly mined uranium-238 — while producing as a side-benefit of power production, new fissile fuel of similar or greater energy-content as the input fuel. Unlike nuclear fusion this is not a search for breakthrough technology.
Rather it is an effort to accelerate the arrival of volume commercial scale deployment of already demonstrated experimental designs. I would also fund proof of concept implementation of another Gev IV reactor design, the LFTR (Liquid Thorium Floride Reactor) to assess what development investment and timeframe is likely required to reach commercial scalability. The LFTR is likely to be more cost-effective than the IFR design, but we have less experience with the design. LFTR may have a number of significant benefits w/r/t IFR, but time to implementation appears a risk because we haven't operated LFTR designs.
And I believe we need to start replacing new coal generation by about 2030 and old coal power soon after. This is a staggering industrial challenge – though a minor challenge compared to a policy that relies only on "renewables" like on/off-shore wind and PV/thermal solar generation.
Any useful low-carbon electrical (and thermal) generation solution must be "cheaper than coal", at least cheaper than the coal price + realistic future carbon price, or the coal price + CCS price. We are not going to see a carbon price in the near future. My limited study on CCS reached the conclusion that we need to know if coal can be any part of the generation profile around 2050. The answer is determined by the true life cycle cost of CCS and the extent to which CCS is actually scaleable (and what geographies are scaleable). I am pessimistic on both, but believe we should risk a relatively small amount of taxpayer-supported R&D to evaluate CCS at scale — i.e., outfitting existing 1 GW coal-fired generation inland and near suitable ocean subfloor geology.
If we could pass a nearly-global increasing carbon price that electric utility executives believed to be real, the market might do the required development. As I said, a believable carbon price will not happen in the foreseeable future. So we need to incentivize the electric utility executives to choose nuclear over new coal, and (harder) to persuade them to replace existing coal with nuclear power. Proving out the life cycle cost of Gen IV will accomplish that.

7 **Jon Boone** { 01.24.10 at 1:09 pm }

Thanks for this post, Steve. The Gen IV should be given serious thought. But it appears as if it's primarily for baseload. Are there promising nuclear units with flexible ramping that can follow load, thus allowing nuclear ultimately to handle virtually all demand economically?

8 **Peter Lang** { 01.28.10 at 1:30 am }

Jon Boone,

The European EPR Gen III reactor being built in Finland, France and China claims to have the capability of ramping at the rate of 80 MW per minute and can operate down to 25% of its capacity. Of course, baseload is the most economic.

Leave a Comment

Name