R&C

Wind Energy

and Renewable Fuels Requirements

October 2007

Research & Commentary

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October 2007
Research & Commentary on Wind Energy and Renewable Fuels Requirements

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The Columbus Dispatch
Ohio's Greatest Online Newspaper

Generate jobs with wind power, study says

Strickland proposal also pushes quota for renewable sources

Friday, August 24, 2007 3:27 AM

BY PAUL WILSON
THE COLUMBUS DISPATCH

If more of Ohio's electricity had to come from wind,
thousands of jobs would be created in the state, according to research released yesterday.

The report, by environmental advocacy group Environment Ohio, comes ahead of an energy plan that Gov. Ted Strickland has promised since his campaign. Both will be part of an escalating debate on Ohio's energy future that stems from the failed attempt to deregulate the state's electricity market.

Ohio would gain 3,100 jobs, primarily in the manufacturing of wind-related products, if wind generated 20 percent of the state's electricity by 2020, the report said. It also would prevent the release of 170 million metric tons of carbon dioxide, equivalent to the emissions of more than 2 million cars, the report said.

Strickland's proposal, which he will give to legislators, also would require that power be generated from renewable sources such as wind, solar or hydroelectric energy. Nuclear power and coal technologies that reduce emissions will be part of the proposal.

Details of Strickland's plan aren't known, but if it is approved by legislators, Ohio would become one of more than 20 states that require that some electricity come from renewable sources.

"Gov. Strickland and Ohio's leaders have an incredible opportunity, but a small window," said Amy Gomberg, an advocate for Environment Ohio. "A commitment to wind is a job-creator."

The lack of such a policy has discouraged wind-energy companies from establishing operations in Ohio, said Mark Shanahan, Strickland's energy adviser.

"They say, 'You must not want us,' " he said.

The Office of the Ohio Consumers' Counsel also endorses the use of renewable sources. Representatives joined Environment Ohio in releasing the report yesterday, as did officials from organized labor and manufacturers involved with wind energy.

"We need something to help us create some jobs, considering that we've lost 200,000 manufacturing jobs in the past six years," said Tim Burga, chief of staff for the Ohio AFL-CIO.

The plan could mean lost jobs in other industries, notably coal, which generates nearly 90 percent of the state's electricity, said James Newton, chief economic adviser at Commerce National Bank.

More than 3,000 Ohioans work in the coal industry, according to the Ohio Coal Association, not counting employees at coal-burning utilities, such as Columbus-based American Electric Power, which has more than 7,000 Ohio workers.

Environment Ohio said any job losses would be more than offset by gains in fields such as manufacturing, construction, and banking and finance. Newton was skeptical.

"It's unlikely that all of that activity would be contained in the state of Ohio," he said. "All of those jobs and the spinoff effects would have to happen in Ohio."

The math makes more sense, Newton said, if federal laws are passed to limit emissions of carbon dioxide, considered the leading culprit behind global warming. That effort is picking up steam in Washington.

Environment Ohio's research is the latest voice in the state's deregulation debate. Utilities, manufacturers and consumer groups also have weighed in.

All agree that it would be best if legislators approve new electricity rules by the end of this year. Transition plans that allowed utilities small rate increases since January 2006 will expire at the end of 2008, and state regulators think they will need a year to sort through any new policy.

Some of Ohio's largest manufacturers said the state should establish a new rate structure before addressing the issue of renewable sources, which they say would bog down the process. Environment Ohio and other groups oppose that idea.

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Report doubts future of wind power

Luke Harding in Berlin, John Vidal and Alok Jha
Saturday February 26, 2005

Guardian

Wind farms are an expensive and inefficient way of generating sustainable energy, according to a study from Germany, the world's leading producer of wind energy.

The report, which may have ramifications for the UK's rapidly growing wind farm industry, concludes that instead of spending billions on building new wind turbines, the emphasis should be on making houses more energy efficient. Drawn up by the German government's energy agency, it says that wind farms prove a costly form of reducing greenhouse gases.

It costs €41-€77 (£28-£53) to avoid emitting a tonne of carbon dioxide by using wind energy, the report says.

The study is likely to feed the bitter debate on whether Britain should continue to emulate Germany and dramatically expand its wind farm programme. Germany has the largest number of wind farms in the world, producing more wind energy than Denmark, Spain and the US put together.

The UK's wind power movement is the fastest growing in the world, with up to £10bn expected to be invested in the next five years, attracting government subsidies of roughly £1bn.

But more than 100 national and local groups, led by some of Britain's most prominent environmentalists, including David Bellamy, Sir Crispin Tickell, and James Lovelock, have argued that wind power is inefficient, destroys the countryside and makes little difference to Britain's soaring carbon emissions.

"At last. This report confirms what we have been saying," said Angela Kelly, director of Country Guardian, an umbrella group for the anti-wind-power lobby. "Wind power is three times more expensive than conventional electricity. It is a scandalous waste of taxpayers' money."

The report comes when the British government is promoting wind power as a means of getting 10% of energy need from renewables by 2010.

The German report estimates that it will cost €1.1bn to link Germany's existing wind farms to the national grid if it is to meet its target of producing 20% of its electricity from renewable sources by 2015.

About 800 miles of cables will have to be laid or upgraded, and power plants will have to be replaced or adapted to cope with the large fluctuations in wind-derived energy. This programme will cost each German household €16 a year, it says.

"Wind energy is expensive. That's true. You can't dispute it," Stephan Kohler, the head of Germany's energy agency told the Guardian. "Conventional methods are cheaper. But you have to do both."

In the past 15 years Germany has constructed more than 15,000 turbines, half of them in the past five years. The number is due to double again by the end of the decade.

In November British and German ministers announced plans for cooperation on alternative energy development.

The 1,034 big turbines now running in Britain produce about 700MW of electricity - about as much as one conventional power station - but in the next seven years more than 7,000MW of generating power will be installed on 73 new farms.

Last year 22 onshore wind farms with a capacity of 475MW were built, but developers are increasingly moving to shallow water off the coasts. Altogether, 9,000MW of new wind power is planned to be installed by 2010, enough to meet the government's targets.

Critics of wind energy in Germany said it would be cheaper and more environmentally efficient to insulate old houses or to renew existing power stations.

"The problem with wind farms is that you have to build them in places where you don't need electricity. The electricity then has to be moved somewhere else," Klaus Lippold, a Christian Democrat opposition MP, said.

"There is growing resistance in Germany to wind farms, not least because of the disastrous effect on our landscape."

The German environment minister, Jürgen Trittin, of the Green party, hit back, saying that the "central parts" of the report vindicated his claim that an expansion of wind energy could be done quickly and cheaply. "There are no grounds for pessimism," he said.

Last year more than 10% of Germany's energy consumption came from renewable sources, a record.

Jim Footner of Greenpeace said the German study would inevitably be used by opponents of wind power as an argument against further investment. But he remained confident that wind power was the best option for Britain's energy needs.

"You can't energy-efficiency your way out of climate change," he said. "You need to have clean forms of energy generation, and wind power is the technology that's competitive, current and it's the one that's available now."

The British Wind Energy Association said it was wrong to compare wind energy in Britain and Germany.

"The UK has a far greater wind resource than Germany. The winds blow harder and therefore the economics of wind power in the UK will be better than those of our European neighbours", said Richard Ford of the BWEA.

The National Audit Office, reporting on renewable energies last week, said wind was the most expensive way to fund carbon emission reductions in Britain. It gave a figure of £70-£140 a tonne of carbon saved - more than in Germany.

But it did not condemn wind, saying that a mix of renewable energies and energy savings was needed.

The New York Times
nytimes.com

June 6, 2006

Debate Over Wind Power Creates Environmental Rift

By FELICITY BARRINGER

OAKLAND, Md. — Dan Boone has no doubt that his crusade against wind energy is the right way to protect the Allegheny highlands he loves. Let other environmentalists call him deluded at best, traitorous at worst. He remains undeterred.

For four years or more, Mr. Boone has traveled across the mid-Atlantic to make every argument he can muster against local wind-power projects: they kill birds and bats; they are too noisy; they are inefficient, making no more than a symbolic contribution to energy needs.

Wind farms on the empty prairies of North Dakota? Fine. But not, Mr. Boone insists, in the mountainous terrain of southwestern Pennsylvania, western Maryland or West Virginia, areas where 15 new projects have been proposed. If all were built, 750 to 1,000 giant turbines would line the hilltops, most producing, on average, enough electricity to power 600 homes.

Wind projects are in the midst of a huge growth spurt in many parts of the country, driven by government incentives to promote alternatives to fossil fuels. But Mr. Boone, who wields a botanist's trowel and a debater's knife with equal ease, wants to slow them down with community activism, regulatory action and legal challenges.

His crusade harks back to the campaigns against nuclear power plants, toxic-waste dumps and dams on scenic rivers that were building blocks of the modern environmental movement. But the times, and the climate, are changing. With fears of global warming growing more acute, Mr. Boone and many other local activists are finding themselves increasingly out of step with the priorities of the broader movement.

National groups like Greenpeace and the Sierra Club used to uniting against specific projects are now united for renewable energy in general. And they are particularly high on wind power — with the caveat that a few, but only a few, special places should be turbine-free.

"The broader environmental movement knows we have this urgent need for renewable energy to avert global warming," said John Passacantando, executive director of Greenpeace U.S.A. "But we're still dealing with groups that can't get their heads around global warming yet."

Indeed, the best winds, especially in the East, tend to blow in places that are also ideal for hiking, sailing, second homes and spirit-soothing views. These include the Green Mountains, the Adirondacks, the Chesapeake Bay, Cape Cod and the ridges of northern Appalachia. Local opposition to unwanted development remains a potent force.

So when it comes to wind, the environmental movement is riven with dissonance and accusations of elitism.

Robert F. Kennedy Jr.'s very public opposition to the 130-turbine Cape Wind energy facility proposed off Nantucket Sound has driven a wedge between activists. Dan Boone's circuit riding against wind projects, while not attracting the same celebrity notice, has exasperated many Sierra Club compatriots even more.

Like Mr. Kennedy, Mr. Boone says the areas he wants to protect are uniquely vulnerable. His family owns property near the proposed projects, just as Mr. Kennedy's does near the Cape Wind site.

But Mr. Boone says that wind supporters are the ones pursuing their own agenda at the expense of the public interest.

"I'm not sure that wind turbines in this region will significantly reduce the outcome of global climate change or actually have any role," Mr. Boone said. "The very limited benefit doesn't justify the risk of wiping out a lot of interior forest habitat."

National environmental leaders reject this argument.

"There's no free lunch," said Paul Hansen, executive director of the Izaak Walton League of America, a venerable sportsmen's group. " 'Not in my backyard' is not environmentalism."

The Alleghenies are a big backyard, with views that are both spectacular and problematic. Flowering shrubs like shadbush and preening flowers like trillium are framed by oaks, maples and longleaf pines. But intermittent industrial tree farming has repeatedly denuded some mountainsides. On both sides of the border near here in far western Maryland, second-home development is booming. The air has often been fouled by the Mount Storm coal-fired power plant.

If Ned Power, a wind-energy development company, puts up 100 or so turbines along 14 miles of ridgeline near Mount Storm, wind-energy supporters say, how much does that further spoil the landscape?

Kevin Rackstraw, a regional manager of Clipper Windpower whose proposed 40-turbine project in western Maryland has drawn Mr. Boone's fire, said opponents lacked perspective.

"Dan looks at all the impacts of a given wind project," Mr. Rackstraw said, "but doesn't say: 'If we didn't have wind, what would we have?' Coal. Think of the impact of acid rain and mountaintop removal."

The Ned Power project is just one target of Mr. Boone, 49, a former state wildlife biologist who now works as a consultant. In interviews, he said he first focused on the issue when working as a botanist on a study related to an early wind power project. The environmental-impact statements, he said, were grossly inadequate.

Now he drives from Highland County in western Virginia (where 38 turbines are proposed on Tamarack Ridge) to Bedford, Pa. (where early discussions of an unnamed project are under way) to talk to local groups or crystallize their objections for them. In Annapolis, Md., and Charleston, W.Va., he uses state utility regulators' licensing hearings to throw up roadblocks before wind projects. He is eager to argue with industry officials in any venue, questioning their facts, assumptions and motives.

"The rush is on now because a lot of the places they've targeted have no zoning, and it's easy to get in that kind of large-scale development," he said. "This part of the country has really good energy prices. Developers

are keying in on that."

Mr. Boone's quiver of anti-wind arguments includes economic analyses, but his first line of attack is biological: he contends that they are a threat to bats and potentially to migratory birds and that they break up forest habitat.

Scores of raptors and other birds were killed by the first generation of wind turbines set up at Altamont Pass in Northern California. Since the Altamont Pass turbines were erected in the early 1980's, turbine design has been altered, and most subsequent studies have shown that birds tend to fly above the height of most turbines though some experts say more studies are needed.

But the turbines south of here in Thomas, W.Va., have been lethal to bats. More than 2,000 were killed in 2003 at the Mountaineer project, whose 44 turbines are owned by FPL Energy, a big power company that is the wind industry's dominant player.

Industry officials agree that the bat mortality measured at the Mountaineer site is unacceptable, and they are studying the benefits of deterrent devices and the best ways to modify turbine operations in bat-rich areas.

To Mr. Boone, wind energy will never make a big enough difference to justify its impact in the region. "You have to remember that these tax advantages are so huge," he said, "that these developers are keen to latch onto all the mythology — whether it's global warming or something else."

Asked if he thought global warming was a myth, he said: "No, I'm not calling it mythology." But industry officials, he contended, will "take things out of context."

Mike Tidwell, the director of Chesapeake Climate Action Network and one of Mr. Boone's adversaries, bristles at the attack. "Wind industry guys are the straightest-shooting people," Mr. Tidwell said. "Most got into it because they had an environmental ethic."

But Mr. Boone has plenty of allies, too. "He's the greatest naturalist I've even known," said Betsy Johnson, chairwoman of the Maryland chapter of the Sierra Club. "Dan has been very helpful in educating us with what problems there can be with an energy source like wind."

The industry Mr. Boone regards so suspiciously is on a roll. The total share of energy that wind farms generated nationwide in 2004 was tiny — about one-third of 1 percent, according to the Energy Department. But by 2020, according to industry estimates, wind's share of the county's energy portfolio could grow ten- or twentyfold.

For the environmental movement, wind supporters say, the transition from the protection of place to the protection of planet is bound to be wrenching.

"Wilderness conversations are spiritual," said David Hamilton, the Sierra Club's national director of global warming and energy programs. "We've always been a place-based organization, protecting places," but "protecting our climate" is "just looking at it from a different angle and a different elevation."

Wind turbines taking toll on birds of prey

By John Ritter, USA TODAY
1/4/2005

ALTAMONT PASS, Calif. — The big turbines that stretch for miles along these rolling, grassy hills have churned out clean, renewable electricity for two decades in one of the nation's first big wind-power projects.

But for just as long, massive fiberglass blades on the more than 4,000 windmills have been chopping up tens of thousands of birds that fly into them, including golden eagles, red-tailed hawks, burrowing owls and other raptors.

After years of study but little progress reducing bird kills, environmentalists have sued to force turbine owners to take tough corrective measures. The companies, at risk of federal prosecution, say they see the need to protect birds. "Once we finally realized that this issue was really serious, that we had to solve it to move forward, we got religion," says George Hardie, president of G3 Energy.

The size of the annual body count — conservatively put at 4,700 birds — is unique to this sprawling, 50-square-mile site in the Diablo Mountains between San Francisco and the agricultural Central Valley because it spans an international migratory bird route regulated by the federal government. The low mountains are home to the world's highest density of nesting golden eagles.

Scientists don't know whether the kills reduce overall bird populations but worry that turbines, added to other factors, could tip a species into decline. "They didn't realize it at the time, but it was just a really bad place to build a wind farm," says Grainger Hunt, an ecologist with the Peregrine Fund who has studied eagles at Altamont.

Across the USA — from Cape Cod to the Southern California desert — new wind projects, touted as emission-free options to oil- and gas-fueled power plants, face resistance over wildlife, noise and vistas. The clashes come as wind-energy demand is growing, in part because 17 states have passed laws requiring that some of their future energy — 20% in California by 2010 — come from renewable sources.

Environmental groups, fans in principle of "green" power, are caught in the middle. "We've been really clear all along, we absolutely support wind energy as long as facilities are appropriately sited," says Jeff Miller, Bay Area wildlands coordinator for the Center for Biological Diversity, which took 12 companies to court.

Wind energy is a tiny but fast-growing share of U.S. energy — 0.4%, up from less than 0.1% five years ago. Since November, when Congress reinstated a key tax credit for wind producers, the industry is poised to expand by as much as a third this year, the American Wind Energy Association says.

In 2004, wind generated enough electricity to power 1.6 million households, the association says. Altamont's turbines are the nation's No. 2 producer. Few energy experts think environmental concerns will discourage wind development long-term because the tradeoff is too appealing.

"When you opt for wind turbines, you don't opt for pollution that harms children and crops from fossil-fuel power plants," says Dan Kammen, an energy professor at the University of California-Berkeley.

But windmills — derisively dubbed by some "toilet brushes in the sky" — draw fire when they're planned in areas prized for their pristine landscapes:

• Cape Cod groups are fighting what they call visual pollution from 130 turbines, each taller than the Statue of Liberty, sought for Nantucket Sound. Fishermen fear loss of prime fishing grounds from the USA's first offshore project.

• Rep. Nick Rahall, D-W.Va., asked the Government Accountability Office to study the effects more windmills would have in the Appalachians. Research found that existing turbines killed up to 4,000 bats on Backbone Mountain last year.

• In the Flint Hills of Kansas, the Audubon Society worries that windmills could despoil views in one of America's few remaining stands of native tallgrass prairie and harm habitats of migrating prairie birds.

• Acting Gov. Richard Codey last month ordered a 15-month wind-power moratorium on the New Jersey shore, where the desire to preserve Atlantic views has collided with plans for offshore turbines near Ocean City and other sites.

Altamont Pass bird kills have been known for years, but turbine owners and federal regulators ignored them except to urge more research, says Miller of the Center for Biological Diversity. But a California Energy Commission study in August found bird fatalities much higher than had been thought and laid out steps to limit them.

At the same time, 20-year-old county permits were up for renewal, and the U.S. Fish and Wildlife Service decided to crack down. "Twenty years has just been too long to resolve this problem," says Scott Heard, the agency's chief Northern California enforcement agent.

Fish and Wildlife can prosecute those responsible for kills under federal laws that protect eagles and migratory birds.

The center's lawsuit was withdrawn but filed again in November because the wind companies' bird-protection plan was "not a serious attempt," Miller says. The center is appealing Alameda County's approval of new permits.

The state study's key recommendation would be costly for companies: replace old turbines with fewer, larger-capacity modern ones, relocate them away from favorite bird haunts and build them more than twice as high so blades rotate above the birds' flight paths.

Environmentalists want 3-year permits that can be renewed only if companies show progress. The companies, citing financial pressures, have proposed at least 13-year permits and want their own timetable for installing new turbines.

Alameda County is trying to broker a deal. "We can't put them out of business by telling them to take out all their old turbines," says assistant planning director Steven Buckley.

Turbine owners say Altamont's 4,000-plus windmills are outdated and eventually will be replaced by 1,000 or fewer new ones. G3 Energy, a small Altamont operator, is replacing 180 obsolete turbines with 38 larger ones.

Others are more cautious. FPL Energy, Altamont's biggest operator with 2,000 turbines, wants the study's findings tested. "Certainly the turbine owners hope fewer, taller turbines reduce collisions," says FPL spokesman Steve Stengel. "But there has not been research done to verify that."

Green Bay Press-Gazette

Wind energy debate goes to county level

By Deb Fitzgerald
deb@doorcountyadvocate.com August 18, 2007

The debate has simmered for five years over America's first offshore wind farm proposed for Horseshoe Shoal in Nantucket Sound.

Some say the 24-square-mile, 130-turbine, Cape Wind development will spoil one of the country's most majestic expanses of open water. Others say it will provide a fine source of renewable energy.

There are no projects like Cape Wind being proposed in Door County — the Peninsula is still grappling with the possibility of land-based models.

Yet whether it's the spoiling of pristine water or of the the pristine Peninsula, the arguments for and against wind energy amount to the same.

Both sides of that argument exist within the Peninsula, and are represented on the Door County Resource Planning Commitee.

They met Thursday evening during their discussion of the final draft of the countywide wind energy ordinance.

The committee has been overseeing revision of the document since March. But public comments are not allowed during the RPC's regular business meetings.

So while wind turbine discussions have taken place at the local municipal level, the opportunity for a countywide conversation hasn't happened — until now.

The RPC effectively finished tweaking the ordinance, and voted unanimously to move the final draft to a public hearing.

The county has minimum posting requirements of 30 days before the public hearing can be held.

What the public will have is an opportunity to comment on an ordinance that pertains to wind turbines exceeding 170 feet.

The $500 permit process requires an applicant to submit a sound study, a shadow flicker and blade glint study, a critical communications study, a life cycle and decommissioning plan and proof of financial assurance.

"I encourage wind energy," said Hugh Mulliken, supervisor for parts of Baileys Harbor,

Gibraltar and Liberty Grove. “Perhaps it’s not totally cost-effective, but the more you add financial burden on these things, the less cost-effective they become.”

The turbines must be set back from the nearest residence, school, hospital, church, or public library a distance no less than 1,000 feet.

“I’m opposed to these things in Door County,” said Merrell Runquist, RPC chairman. “I think this is too close for people to live. But why belabor the point because it accounts for nothing.”

Wisconsin counties are not allowed to craft wind energy ordinances that are more restrictive than state statutes.

And the final draft of the ordinance the committee scheduled for a public hearing has reached that, “salient point.

“We’ve reached the point where (the ordinance) is as restrictive as the statute allows,” said Grant Thomas, corporation counsel.

When the RPC holds a public hearing, further public comment is not allowed once the ordinance reaches the County Board floor.

The committee members expressed interest in altering that policy for the wind turbine issue.

“With most ordinances we don’t allow public comment at County Board, but this is a unique situation,” Thomas said. “Certainly we can vote by a majority so it’s possible to have a public comment period (on the wind energy ordinance) at the County Board.”

August 4, 2003

Not Cheap, Not Green

by Jerry Taylor

Jerry Taylor is director of natural resource studies at the Cato Institute.

A few days ago, the Senate passed an energy bill that is 5 parts corporate welfare to 1 part Soviet-style central planning. An example of the latter aspect is a provision ordering power companies to get 10 percent of their electricity from renewable fuels. While environmentalists are giddy over it, they should think again — a renewable energy mandate will harm, not help, both the economy and the environment.

Here's the basic problem: Renewable energy is simply far more expensive than energy produced from natural gas or coal. If it were otherwise, government would not have to contemplate forcing companies to use renewables. How much more expensive? Well, it depends on the specific fuel and the particular facility, but the cheapest sources of renewable energy — biomass (wood, plant fiber, and the like) and wind — cost almost twice as much on average as gas or coal-fired electricity.

Even the blizzard of federal and state tax subsidies and preferences already showered on renewable fuels — subsidies that, on average, reduce costs about 50 percent — have been unable to close the gap. If we take hydropower out of the mix, renewable energy generates about 2.2 percent of the electricity humming along the national grid. Wind power — the darling of the left — generates all of 0.13 percent of the electricity on the nation's grid, and solar is responsible for only 0.02 percent.

While proponents of renewable energy blame subsidies for competing fuels for their tiny market share, the charge falls flat. After studying the matter, the U.S. General Accounting Office found that fossil fuel subsidies are "too small to have a significant effect on the overall level of energy prices and consumption in the United States."

What about this exponential increase in renewable energy, particularly wind power, we keep hearing about? Well, it doesn't take much to show huge increases in market share when current production is so infinitesimal. But the main reason for the growth in renewables isn't improving economics, it's increasingly bossy politicians. Of the 5,356 megawatts of renewable energy production currently on the drawing board, only 291 megawatts would be generated voluntarily. The remainder is being built because state legislators have ordered it to be built.

Tired of piling subsidy upon subsidy with still nothing to show for it, the Senate take the states' "build-it-or-else" approach nationwide by requiring power companies to use renewable energy for 10 percent of their electricity by 2020. Proponents argue (correctly) that these production orders would only increase the price of power by a few percentage points — so why not put the pedal to the metal?

If the prospect of larger electricity bills isn't a good enough reason to oppose this form of corporate welfare, how about the virtual guarantee that these provisions would worsen environmental quality?

The root of the problem: The cheapest form of renewable energy today is biomass. The Energy Information Administration (a respected analytic arm of the Energy Department) projects about 80 percent of the renewable energy produced to comply with a 10 percent renewable energy mandate would come from biomass fed into existing coal plants.

A recent comprehensive review of the literature undertaken by Thomas Sundqvist and Patrik Soderholm in the Journal of Energy Literature suggests the scope of the possible environmental damage. The median finding of 22 separate studies concerning the environmental effect of biomass fuels is that they impose about 7 cents of environmental damage for every kilowatt of energy produced — much greater than the environmental damage caused by nuclear power (about 4 cents), about the same as the environmental damage caused by natural gas-fired electricity, and only slightly less than the environmental damage caused by coal-fired electricity (about 9 cents).

Accordingly, a renewable fuel mandate will worsen the environment because biomass co-fired with coal is clearly more environmentally problematic than is natural gas, the fuel that is currently attracting about 98 percent of the investment dollars for new electricity generation and the fuel most likely to be displaced by a federally imposed renewable energy mandate.

If the Senate were serious about promoting environmentally friendly energy technologies, it would simply impose a tax to reflect the unpriced environmental damages done by various fuels and leave decisions to the marketplace thereafter. But

simply ordering the electricity sector around as if the Senate were the Politburo and private utilities were arms of the state will benefit neither the economy nor the environment.

This article appeared in The Washington Times *on August 4, 2003.*

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BPA opens rate case to prepare for recovery of increasing wind integration costs

> *The Bonneville Power Administration has initiated a rate case to set the price for balancing services for wind generation because of the rising expense of integrating increasingly large amounts of the intermittent resource in its control area. ... The agency must also be able to absorb the highest hour of expected generation because it runs the risk that its existing resources cannot absorb the added energy. In the case of hydro or pumped storage, the agency would have to spill water rather than use it to generate power or use it at a less efficient time. Therefore, the agency will have to assess a sink charge.*

September 12, 2007 by Jeff Stanfield in SNL Interactive

The Bonneville Power Administration has initiated a rate case to set the price for balancing services for wind generation because of the rising expense of integrating increasingly large amounts of the intermittent resource in its control area.

The cost to integrate wind started low, but will more than double as wind generation approaches 30% of the resources mix, according to BPA. Preliminary estimates, excluding some costs, are that the cost of integrating wind at 5% of peak load costs $1.90/MWh but rises to $2.40/MWh at 10%, $3.70/MWh at 20% and $4.60/MWh at 30%. Integration costs are comparatively low when integrating wind with hydropower, which has substantial flexibility, but rise as more wind is added and ultimately reach a plateau at the cost of integrating wind with natural gas-fired power plants.

Bonneville says it will integrate 650 MW of wind in 2007 alone for a total of 1,400 MW in its control area. That will be 15% of the agency's 9,000-MW peak load, but the ratio is going up year after year, with projections for 1,300 MW of wind to be added in 2008 and 1,500 MW in 2009.

BPA intends to develop a rate to be effective Oct. 1, 2008, that recovers the costs of providing within-hour balancing services for wind generators connected to BPA's system, according to an Aug. 27 open letter from Transmission Services Policy and Strategy Manager Elliot Mainzer. A workshop was held Sept. 11 and two more are slated for Sept. 27 and Oct. 25 as the agency seeks to collaborate with its customers and wind generators to develop the rates.

BPA said it may make a policy decision to offer resource support services under its tiered rate design, with five levels of "Tier 2" service. Services for resources offered above its "high water mark" level would fall into the higher Tier 2 rates. BPA must build or reserve capacity equal to the average amount of energy produced by a resource minus that resource's lowest hour of expected generation. The reserved capacity must be charged at a rate equivalent to the fixed capital costs of the marginal capacity resource at around $8.50/kW per month.

Tier 2 rate pool costs will include the costs of resource shaping services specific to each set of resources underlying power purchase agreements for the output from specific resources. The costs of each power purchase agreement are unique and may vary by rate period, with embedded escalation provisions.

The agency must also be able to absorb the highest hour of expected generation because it runs the risk that its existing resources cannot absorb the added energy. In the case of hydro or pumped storage, the agency would have to spill water rather than use it to generate power or use it at a less efficient time. Therefore, the agency will have to assess a sink charge.

The need for these services and a specific rate to pay for them was identified in the Northwest Wind Integration Action Plan completed earlier this year.

Because wind output varies, other generation capacity must be available to meet variations.

To develop the rates, the additional balancing service required for wind generation must be forecast, along with methods for determining costs and a rate design to recover those costs. BPA plans to issue

an initial rate proposal in February and a record of decision in May 2008, and FERC approval will be sought next summer.

Ancillary services include generation-supplied reactive and voltage control, operating reserves, regulating reserves, generation and supply imbalance needs.

Wind generation affects both near real-time regulation and the balance-of-the-hour requirements. For 4,000 MW, that would increase the balancing requirement by about 50 MW over the 80 MW otherwise required, BPA said.

The balance of the hour for wind output fluctuations would increase about 200 MW over the 500 MW otherwise required, the agency continued. That does not count extreme wind ramp events, which, if included in balancing requirements, could double the amount of balancing required and more than double the cost of providing additional balancing. Wind ramps are large unscheduled changes in output of a wind farm or collection of wind farms, and extreme ramps could greatly add to operating reserve requirements and costs. Large wind farms have fewer ramps due to spatial and directional placements. Studies continue on balancing requirements.

While larger wind farms spread over a wide, geographically diverse area smooth the impacts, dramatic swings in wind output sometimes still occur. Ramp controls are being considered as alternatives, but would only be imposed for system reliability events. Estimated costs of lost wind generation with ramp controls will have to be worked out.

In addition, integration of large amounts of wind will require dynamic voltage control at wind farm sites or available transmission capacity, and grid performance will be reduced, according to the agency.

Costs to support wind and reshape it for flat annual block products would add to within-hour and hour-to-hour and ramping costs.

BPA is studying various options for its rate design. Under one option, the agency would treat resources the same as load, with charges for production of less energy than forecast and credits for performance higher than forecast. Another way would be to address over- and under-performance through periodic true-ups of customer rates in resource pools. A third means would be to use a forecast guarantee with updates.

Web link: http://www.snl.com/InteractiveX/snapshot.aspx?ID=4058810"

The Land Institute.
Site URL: http://www.landinstitute.org.

Don't be fooled by wind power's 'green' image

David Van Tassel

Released March 25, 2004

Environmentalists urge farmers and ranchers in windy regions to let energy companies build rows of huge turbines for feeding our nation's electricity demands. The environmentalists argue that clean wind power will boost rural economies as well as reduce greenhouse-gas emissions.

But some residents in areas targeted for wind "farms" fear that new high-tension lines and access roads crisscrossing prairie will destroy its spacious character and threaten finicky and increasingly rare grassland birds.

Ranchers should not be prevented from putting turbines on their land. But they also should not feel shamed or pressured to do so by energy corporations or misguided environmentalists.

There is now a push to build wind turbines in Kansas' Flint Hills, the only remaining American prairie of any meaningful size, and a place that has retained a distinctive ranch culture. But there are plenty of other places to put turbines.

And reducing national carbon emissions is not really the responsibility of ranchers or farmers there or anywhere else. As long as most Americans can imagine that somewhere, someone is taking care of the problem, that someone is generating cleaner power somewhere far away, we will be no closer to a real solution. The solution is a thrifty, energy-frugal culture.

Environmentalists fought against oil drilling in the Arctic National Wildlife Refuge, fearing it would spoil one of the last pristine places and that the rigs and access roads would hurt caribou. These are very close to the arguments against filling places like the Flint Hills with turbines.

We should not let wind power's "green" image trick us into abandoning the principle that some places and some species should be saved for their own sakes. We should reject the argument that everything must be "useful," that every place and every aspect of life should be commercialized.

The problem of fossil fuel consumption belongs to each community and each person. Rural people contribute, of course, every time they drive a truck or flip on a light switch. But this is negligible compared with the impact of urban areas.

You might argue that rural communities are in a unique position to help us, and that they will suffer the effects of climate change as much as anyone. But the truth is that simply adding new energy sources, even green ones, without a firm plan to reduce, or at least cap, our total energy production will not reduce national carbon emissions.

Let's turn the question around. Why wouldn't each of us want to take a few simple steps to reduce our energy use and save places like the Flint Hills and the arctic refuge? Why even consider spoiling a new place or investing another penny in massive new projects when the opportunities for huge energy savings are all around us?

As for wind turbines' supposed economic infusion into rural communities: Who will own the machines? Who will own the power lines? Who will set the prices? Who will own the leases? Who will take most of the profits? Wind power will be just like every other commodity that cities extract from rural areas: something acquired at rock-bottom prices and sold back expensively.

A final danger is that environmentalists will place too much faith in solutions that are big, centralized and high-tech. Large projects such as dams, nuclear plants and wind farms go on the cheapest land and among the most powerless people. When we shift the extraction to some place out of sight and out of mind, we can ignore unpleasant consequences and our own responsibilities as consumers.

For behavior to change, we humans need immediate, visible consequences. For an ethic of conservation to take root, energy consumption must be more costly and inconvenient. Only then will wind power be anything more than another cheap commodity.

If the ranchers and farmers courted by wind companies care about climate change and pollution, they will tell urban environmentalists to first put turbines and solar panels in their own back yards.

—David Van Tassel is a scientist at the Land Institute in Salina, Kan., and a member of the institute's Prairie Writers Circle.

This essay is the opinion of the writer and does not necessarily reflect the views of the Land Institute. ■

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WUTHERING HEIGHTS

The Dangers of Wind Power

By Simone Kaiser and Michael Fröhlingsdorf

Wind turbines continue to multiply the world over. But as they grow bigger and bigger, the number of dangerous accidents is climbing. How safe is wind energy?

It came without warning. A sudden gust of wind ripped the tip off of the rotor blade with a loud bang. The heavy, 10-meter (32 foot) fragment spun through the air, and crashed into a field some 200 meters away.

The wind turbine, which is 100 meters (328 feet) tall, broke apart in early November 2006 in the region of Oldenburg in northern Germany -- and the consequences of the event are only now becoming apparent. Startled by the accident, the local building authority ordered the examination of six other wind turbines of the same model.

PHOTO GALLERY: BLOWING IN THE WIND

Click on a picture to launch the image gallery (9 Photos)

The results, which finally came in this summer, alarmed District Administrator Frank Eger. He immediately alerted the state government of Lower Saxony, writing that he had shut down four turbines due to safety concerns. It was already the second incident in his district, he wrote, adding that turbines of this type could pose a threat across the country. The expert evaluation had discovered possible manufacturing defects and irregularities.

Mishaps, Breakdowns and Accidents

After the industry's recent boom years, wind power providers and experts are now concerned. The facilities may not be as reliable and durable as producers claim. Indeed, with thousands of mishaps, breakdowns and accidents having been reported in recent years, the difficulties seem to be mounting. Gearboxes hiding inside the casings perched on top of the towering masts have short shelf lives, often crapping out before even five years is up. In some cases, fractures form along the rotors, or even in the foundation, after only limited operation. Short circuits or overheated propellers have been known to cause fires. All this despite manufacturers' promises that the turbines would last at least 20 years.

Gearboxes have already had to be replaced "in large numbers," the German Insurance Association is now complaining. "In addition to generators and gearboxes, rotor blades also often display defects," a report on the technical shortcomings of wind turbines claims. The insurance companies are complaining of problems ranging from those caused by improper storage to dangerous cracks and fractures.

The frail turbines coming off the assembly lines at some manufacturers threaten to damage an industry that for years has been hailed as a wild success. As recently as the end of July, the German WindEnergy Association (BWE) crowed that business had once again hit record levels. The wind power industry expanded by a solid 40 percent in 2006, according to the BWE, and it now provides work for 74,000 people.

Germany, moreover, is the global leader when it comes to wind power: More than 19,000 windmills now dot the countryside -- more than in any other country. Green power has become a point of pride in Germany in recent years, and Environment Minister Sigmar Gabriel would now like to construct vast new wind farms along the country's North Sea and Baltic Sea coasts.

No Time for Testing

Generous government subsidies have transformed wind power into a billion-euro industry within just a few years. Because energy providers have to purchase wind power at set prices, everyone, it seems, wants in.

But it is precisely the industry's prodigious success that is leading to its technological shortcomings. "Many companies have sold an endless number of units," complains engineer Manfred Perkun, until recently a claims adjuster for R+V Insurance. "It hardly leaves any time for testing prototypes."

Wind power expert Martin Stöckl knows the problems all too well. The Bavarian travels some 80,000 kilometers (49,710 miles) across Germany every year, but he is only rarely able to help the wind farmers. It is not just the rotors that, due to enormous worldwide demand, take forever to deliver, but simple replacement parts are likewise nowhere to be found. "You often have to wait 18 months for a new rotor mount, which means the turbine stands still for that long," says Stöckl.

"Sales Top, Service Flop" is the headline on a recent cover story which appeared in the industry journal *Erneuerbare Energien*. The story reports the disastrous results of a questionnaire passed out to members of the German WindEnergy Association asking them to rank manufacturers. Only Enercon, based in Germany, managed a ranking of "good." The company produces wind turbines without gearboxes, eliminating one of the weakest links in the chain.

Even among insurers, who raced into the new market in the 1990s, wind power is now considered a risky sector. Industry giant Allianz was faced with around a thousand damage claims in 2006 alone. Jan Pohl, who works for Allianz in Munich, has calculated that on average "an operator has to expect damage to his facility every four years, not including malfunctions and uninsured breakdowns."

Many insurance companies have learned their lessons and are now writing maintenance requirements -- requiring wind farmers to replace vulnerable components such as gearboxes every five years -- directly into their contracts. But a gearbox replacement can cost up to 10 percent of the original construction price tag, enough to cut deep into anticipated profits. Indeed, many investors may be in for a nasty surprise. "Between 3,000 and 4,000 older facilities are currently due for new insurance policies," says Holger Martsfeld, head of technical insurance at Germany's leading wind turbine insurer Gothaer. "We know that many of these facilities have flaws."

Flaws And Dangers

And the technical hitches are not without their dangers. For example:

- In December of last year, fragments of a broken rotor blade landed on a road shortly before rush hour traffic near the city of Trier.

- Two wind turbines caught fire near Osnabrück and in the Havelland region in January. The firefighters could only watch: Their ladders were not tall enough to reach the burning casings.

- The same month, a 70-meter (230-foot) tall wind turbine folded in half in Schleswig-Holstein -- right next to a highway.

- The rotor blades of a wind turbine in Brandenburg ripped off at a height of 100 meters (328 feet). Fragments of the rotors stuck into a grain field near a road.

At the Allianz Technology Center (AZT) in Munich, the bits and pieces from wind turbine meltdowns are closely examined. "The force that comes to bear on the rotors is much greater than originally expected," says AZT evaluator Erwin Bauer. Wind speed is simply not consistent enough, he points out. "There are gusts and direction changes all the time," he says.

But instead of working to create more efficient technology, many manufacturers have simply elected to build even larger rotor blades, Bauer adds. "Large machines may have great capacity, but the strains they are subject to are even harder to control," he says.

Even the technically basic concrete foundations are suffering from those strains. Vibrations and load changes cause fractures, water seeps into the cracks, and the rebar begins to rust. Repairs are difficult. "You can't look inside concrete," says Marc Gutermann, a professor for experimental statics in Bremen. "It's no use just closing the cracks from above."

The engineering expert suspects construction errors are to blame. "The facilities keep getting bigger," he says, "but the diameter of the masts has to remain the same because otherwise they would be too big to transport on the roadways."

Not Sufficiently Resilient

Still the wind power business is focusing on replacing smaller facilities with ever larger ones. With all the best sites already taken, boosting size is one of the few ways left to boost output. On land at least. So far, there are no offshore wind parks in German waters, a situation that Minister Gabriel hopes to change. He wants offshore wind farms to produce a total of 25,000 megawatts by 2030.

Perhaps by then, the lessons learned on land will ward off disaster at sea. Many constructors of such offshore facilities in other countries have run into difficulties. Danish company and world market leader Vestas, for example, had to remove the turbines from an entire wind park along Denmark's western coast in 2004 because the turbines were not sufficiently resilient to withstand the local sea and weather conditions. Similar problems were encountered off the British coast in 2005.

German wind turbine giant Enercon, for its part, considers the risks associated with offshore wind power generation too great, says Enercon spokesman Andreas Düser says. While the growth potential is tempting, he says, the company does not want to lose its good standing on the high seas.

Forbes.com

On The Cover/Top Stories

KissyKat And The Magic Diesel

Daniel Fisher 02.26.07

When the cry goes up, "Renewable Energy!" an army of penny-stock operators swings into action.

An aerial photo on the web site of U.S. Sustainable Energy Corp. shows a plant in Natchez, Miss. where the company says it will soon begin producing 1.5 million gallons a day of biodiesel-like fuel from soybeans. To put that in perspective, that's double the current biodiesel output in the entire country.

John Rivera, U.S. Sustainable's chairman, admits he gets some skeptical looks when he describes his "secret" process for turning soybeans into liquid gold at a rate (five gallons per bushel) that experts say defies the laws of chemistry and physics. "Everybody comes out here and says, 'Hey, you're full of it,' and then they see me do it," says Rivera, who in the 1990s promoted a similar process for turning used tires into fuel oil. "That's when I turn to them and say, 'Welcome to the Liars Club. Because now nobody's gonna believe you, either.'"

Somebody's buying Rivera's story. His company, which has not yet reported any revenue (it intends to start filing financials with the Securities & Exchange Commission "soon"), carries a market value of $227 million. Hey, that's nothing. A December news release from U.S. Sustainable says that the company could have "an immediate market value" of $12 billion.

Things only get more confusing if you follow the trail to EarthFirst, a Tampa outfit that told the SEC it loaned $3.3 million to U.S. Sustainable Energy last year. EarthFirst Chairman John Stanton put out a news release in April trumpeting U.S. Sustainable's revolutionary biofuel process. In the days before the release EarthFirst's trading volume spiked to 5 million shares from several hundred thousand and the stock price bounced to 17 cents, briefly arresting a long slide to a nickel a share.

No, no, says Stanton. That's a *different*
U.S. Sustainable Energy. Rivera wanted to use the same name for his company, explains Stanton, who admits doing business with Rivera in the past.

Details, details. The big picture: Everyone is in love with renewable energy--George Bush, any congressman you could name, the eminent venture capitalist Vinod Khosla, Goldman Sachs. At the upper end of the investment spectrum the field has attracted $53 billion in private capital over the last three years for windmills, solar panels and low-carbon energy sources. At the lower end there are the penny stocks.

Watch your wallet. Des Moines lawyer Steven Wandro is trying to recover $3.8 million stolen a few years ago from a group of grain farmers who thought they were investing in an ethanol plant. The money passed instead to a film studio and a Florida scamster named Jerry Drizin, allegedly at the behest of a Nigerian in Germany, as detailed in a federal judge's ruling in the case. "People are just running to this thing in a way that I think is scary," sighs Wandro, who recalls how legitimate ethanol projects in Iowa collapsed after oil prices fell in the mid-1980s. "It's a prescription for dashed expectations."

Capitalizing on the popular mania for sustainable energy, the penny-stock operators are converting failed Canadian mining outfits and Internet firms into green machines with names like Western Wind Energy and Hydrogen Power International. Western Wind, run by Vancouver mining-stock executive Jeffrey Ciachurski, paid Khandaker Partners, a New York research firm, $22,000 for a November report touting a "price target" of $11.59 a share. Ambitious, given that the price is now hovering around a buck. Western Wind is trading lawsuits with former employees who accuse the wife of the chief executive of posting unflattering comments on a stock bulletin board, including one suggesting that one of those employees was "caught shagging some Red Head" near the proposed wind-farm site. (Ciachurski denies his wife ever

made such comments.) Hydrogen Power of Englewood, Colo. says it has a revolutionary method for making hydrogen fuel out of aluminum. One problem: The fuel source weighs more than the high-pressure hydrogen tank it is supposed to replace. That problem is being worked on.

Cornell Capital of Jersey City, N.J. has pumped at least $100 million into green-themed companies in the past couple of years. "Solar, wind, clean technology plays--we love the space," says Troy Rillo, a Cornell managing director. "We think the trends are great."

Great for Cornell, which gets shares at a discount that it can then sell in the open market. Great for investors paying full price?

Check out some Cornell clients. NewGen Technologies, which says it plans to build several hundred million dollars' worth of ethanol refineries, was formed out of a shell company. XsunX, formerly known as Sun River Mining, is now a solar-cell company with no revenue and no orders. Market cap: $86 million. Earth Biofuels, whose mascot is country music star Willie Nelson, raised $52.5 million from Cornell and other convertible-debt buyers but sank more than half the dough into a Louisiana ethanol refinery project that has stalled amid charges of excess costs and failed financial commitments. Power Technology
is on the verge of producing what it claims is a revolutionary lightweight lead-acid battery but has yet to find any potential customers. Still, it's aiming to raise capital in a public share offering; proceeds will repay a $1.4 million loan from Cornell.

Don't like the Cornell portfolio? Maybe there's something in the cozy family of GreenShift Corp., a holding company for six publicly traded entities--combined shares outstanding: 3 billion--with names like gs CleanTech and GS AgriFuels. GreenShift is working on technology to feed carbon dioxide to algae and then harvest the algae as if they were corn stalks. If you find this impractical you are presumably not among the investors whose enthusiasm has given GreenShift a market cap of $114 million.

In 2005 a predecessor of a GreenShift unit, called Incode, was flogging KissyKat, an online dating service for pet lovers. That operation didn't work out. Reincarnated as resource firm, GreenShift lost $9 million on sales of $17 million over the first nine months of 2006. Most of that revenue came from a waste-disposal business and a machine shop in Ohio. But GreenShift's chairman and controlling shareholder, Kevin Kreisler, has dreams, and the algae venture is just one of them. Another is to convert the waste material from corn ethanol plants into oil that can be used to make biodiesel. GreenShift says it has sold several of the $1.6 million units so far, but there's a reason it has the business largely to itself: Michael Ladisch, a Purdue University engineering professor, says that few ethanol plants produce enough waste oil to justify trucking it to a biodiesel plant.

No problem, says Thomas Scozzafava, president of GreenShift's gs AgriFuels unit and a former Lehman Brothers merchant banker. All you do is cluster the corn-oil units around biodiesel plants that use another money-saving GreenShift innovation: a "continuous base catalyst reaction" system that relies on a "proprietary process intensification and advanced separation technologies"--whatever those are. There are plans to use them in a new Mean Green Biofuels plant, in Memphis. Mean Green is meantime applying for emissions permits.

EarthFirst, John Stanton's firm, claims to be at "the forefront of alternative energy sources," according to its Web site, but still gets most of its revenue from moneylosing waste-disposal and biodiesel-import businesses, and recently filed to allow Laurus Capital to sell 76 million shares, whose proceeds would be used to retire convertible debt held by Laurus. A self-described turnaround expert, Chairman Stanton doesn't disclose in EarthFirst's sec filings anything about the $157 million collapse of Keller Financial, a used-car finance firm in Florida he briefly ran. A plaintiff attorney reportedly claimed that Keller preyed on unsophisticated, elderly investors. Stanton later paid $181,000 to settle a bankruptcy trustee's claim.

Stanton owns stakes in U.S. Energy Initiatives, which lost $4.5 million on sales of $426,000 in the first half of 2006 trying to sell kits to reconfigure diesel engines so they run on natural gas; and U.S. Sustainable Energy, which claims a catalytic vacuum distillation process that sounds remarkably similar to the one John Rivera is cranking up over in Natchez. Both involve heating organic materials in a vacuum until they break down into carbon and vapors that can be condensed into a low-grade fuel oil. "Why you'd put soybeans in there, I don't know," says Thomas Adams, a biofuels expert at the University of Georgia. "Sewage works just as well."

Adams questions how Rivera can produce biodiesel without methanol--or transform 60 pounds of soybeans into 37 pounds of biodiesel, versus the 27 pounds generally considered the limit. Rivera says his process is a secret and now claims he means "biofuel." He's not the only one pushing the limits of science: In its sec filings EarthFirst claims it can create more than 20 pounds of carbon, fuel oil, combustible gas and scrap steel from a 20-pound tire.

While scrambling for green-energy investments they can trumpet in news releases, penny-stock operators invariably collide. That's what happened in Plaquemines Parish, south of New Orleans, where Earth Biofuels of Dallas last year announced plans to restart an alcohol refinery, closed since the first ethanol boom went bust in the early 1990s. Months

later South-ridge Enterprises, a onetime mining operation now in the ethanol business, said it was buying $6 million worth of equipment from the same plant to build its own 60-million-gallon-a-year ethanol refinery. Its shares jumped 20 cents to $1.84 on the news.

Earth cried foul, saying it owned the equipment. Southridge has sued Earth's partner in the deal, blaming it for the loss of $60 million in market value. A lawyer for the Louisiana partners says he expects the case to be dismissed, but the point seems moot: Earth has since imperiled its own $27 million investment by failing to come up with $80 million to finish the refurbishment by a Dec. 4 deadline. Earth says the project is "still viable."

So, apparently, is AFV Solutions of Irvine, which plans to import hybrid natural-gas/electric buses from China. Up until early 2005 AFV was known as Dogs International and planned a chain of "bed and biscuit" upscale kennels. (It still owned one in Flagler Beach, Fla. as of its most recent sec filing in November.) Dogs International turned green after Jeffrey Groscost, former speaker of the Arizona House of Representatives, took over as chief executive. Groscost was famous in Arizona for pushing through a subsidy program for alternative-fuel vehicles in 1999 that cost the state more than $200 million before it was shut down; buyers could get up to half the cost of a $50,000 suv back from the state.

AFV shares surged from $1.60 in 2005 to $11.30 in May 2006. That's when it announced $4.8 million in financing and plans to import Chinese buses. AFV has yet to sell a bus, and its share price has since deflated to $4.50. Groscost died suddenly in November.

Some schemes are outright fraud. LeeRoy Allen was ordered to pay $270,000 and barred from involvement with public companies last October after the sec accused him of converting a penny stock called J-Bird Music Group (former home of faded stars like Billy Squier and The Guess Who) into a purported biodiesel company with "no assets, funding or viable product." Allen consented to the charges without admitting or denying guilt.

In New Jersey the state attorney general last fall filed civil fraud charges against Brian Smith and his wife for promoting Digital Gas. The company lacked even a bank account yet had shares trading on the pink sheets that briefly soared to 90 cents a share last spring, giving it a theoretical value of $22 million. As he pumped the stock with press releases like the one claiming Digital Gas had a "high temperature fuel cell" that would unlock as much as 1.1 billion gallons of oil from a neglected oil shale deposit, New Jersey officials say, Smith was using stock to renovate his home and pay his attorney.

Smith insists, in an e-mail, that he's innocent and his company "is actively seeking to commercialize its energy savings, alternative energy and farming opportunities." For assets, his Web site offers a grainy image of the deed to a 178-acre granite quarry in Nova Scotia, Canada. Despite Digital's legal problems, "We're still in the pipeline," says Theo van Bakkum of iccu Holding bv, a Smith partner who is working on a new method for storing electricity.

"We are here to help farmers, lessen the heavy yoke of imported fuel, help to create food and jobs for Americans and offer the greatest solution to the world's need for energy since humans harnessed the power of fire itself," says Taylor Moffit, chief executive of Originally New York, an o-t-c bulletin board and would-be ethanol producer with a grand total $331 in revenue since it launched in 2001. Dream on--you'll get a lot of investors to dream with you.

Policy Analysis
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Evaluating the Case for Renewable Energy

Is Government Support Warranted?

by Jerry Taylor and Peter VanDoren

Executive Summary

Solar, wind, geothermal, and biomass energy are used in about 2 percent of total U.S. electricity generation and are expected to produce only 2.8 percent by 2020. The use of renewable energy and forecasts of its growth are low because the cost of renewable energy–fired electricity is greater than that of its main competitor, combined-cycle natural gas. Few analysts believe that this will change any time soon.

Renewable energy sources are also capital intensive compared with combined-cycle natural gas. In deregulated electricity markets, investors lack any guarantee that capital costs will be recovered from customers. Accordingly, investors favor technologies that have higher marginal but lower capital costs, such as combined-cycle natural gas.

Advocates of renewable energy argue that the demand for renewables would rise if conventionally generated electricity were priced to reflect its pollution costs. But a reasonable interpretation of the evidence suggests that the additional cost of further pollution reduction would exceed the additional health benefits. Even if current regulatory costs are insufficiently reflective of true environmental costs, "getting prices right" will not significantly affect consumer choices of fuel. For example, reducing emissions of nitrogen oxides and sulfur dioxide by 75 percent below 1997 levels would increase electricity prices by only about 1 percent, too little to trigger a shift from coal or natural gas to renewable energy.

Cracking down on greenhouse gas emissions to comply with the Kyoto Protocol would provide economic help for renewable energy technologies, but such initiatives would result in only a 7 percent market share for renewable energy and a 43 percent increase in electricity prices in return for benefits that are still very uncertain.

Jerry Taylor is director of natural resource studies and Peter VanDoren is editor of Regulation *magazine at the Cato Institute.*

Although renewable energy is often thought of as an "infant industry," the truth is that the largest corporate conglomerates in America have long devoted themselves to making renewable energy markets a reality.

Introduction

Ever since the energy crises of the 1970s, the U.S. government has promoted the use of "renewable energies"—primarily wind, solar, biomass (burning wood and plant material for power), and geothermal (tapping the hot steam or rock beneath the earth)—as desirable substitutes for conventional fossil fuels. Renewable energy (which, for the purposes of this paper, does not include nuclear power or hydropower)[1] is widely thought to be not only more environmentally benign than coal or oil but also nearly as attractive economically.

The state and federal campaign to promote the use of renewable energy, however, has not yet significantly affected electricity generation patterns. Since the establishment of the U.S. Department of Energy in 1978, the federal government has spent more than $11 billion to subsidize—via investment tax credits, production credits, accelerated depreciation of capital costs, publicly funded research and development (R&D), and mandatory purchases at avoided cost—wind, solar, biomass, and geothermal power.[2] Yet those fuels account for only a tiny share of the electricity produced.

Advocates of renewable energy continue to insist that it is poised to gain significant market share over the next several years. Although renewable energy is still more expensive than conventional energy, production costs have come down significantly over the past 22 years, and the gap between the cost of conventional and renewable energy has narrowed substantially.[3] And if nations reduce greenhouse gas emissions, environmentalists argue, renewables will become the lowest-cost sources of electricity fuel on the market.

This study examines the economics of renewable energy in the electricity market and the case for government intervention to promote its use. We reach three conclusions:

- Renewable energy is not likely to gain significant market share in the foreseeable future without a significant increase in government subsidies or mandates.
- Rationales for subsidies for renewable energy and other preferences are without sound economic foundation.
- The threat of global warming is speculative, and such warming is not necessarily deleterious from an economic perspective. Even if restrictions on greenhouse gas emissions were necessary, replacing conventional energy sources with renewable energy would be more costly and less efficient than other emission abatement strategies.

The Economics of Renewable Energy

Although renewable energy is often thought of as an "infant industry" facing an uphill and unfair struggle against "Big Oil" and the coal industry, the truth is that the largest corporate conglomerates in America have long devoted themselves to making renewable energy markets a reality. Starting in the mid-1970s, Exxon, Shell, Mobil, ARCO, Amoco, General Electric, General Motors, Texas Instruments, and Grumman all initiated aggressive renewable energy R&D projects.[4]

The widespread belief that oil companies have incentives to stymie advances in renewable energy is belied not only by such facts; it's also belied by the economics of the electricity industry. According to the Energy Information Administration, a semi-independent agency of the U.S. Department of Energy, oil, which is primarily a transportation fuel, does not compete with renewable energy, which is primarily an electricity fuel.[5]

The most aggressive renewable energy development initiatives today continue to be undertaken by large multinational corporations. In the United States, Zond Energy Systems, owned by Enron Corporation (once the world's largest integrated national gas company with 1997 revenues of $20 billion), is the largest domestic wind turbine manufacturer and the only manufacturer of large-capacity turbines (those typically installed by electric generating companies).[6] Likewise, 65 percent of the global

market for photovoltaic cells (the key component of most solar power facilities) in 1999 was dominated by five large multinational corporations: British Petroleum, Kyocera, Sharp, Siemens, and Sanyo (in descending order of market share).[7]

To advocates of renewable energy, heavy corporate investment in renewable energy technologies is evidence of the potential competitiveness of alternative fuels in the near future. But some perspective is necessary. Total private-sector investment in solar, wind, and biomass energy in 1995 was less than 1 percent of total world energy investments.[8] Royal Dutch Shell's highly publicized planned expenditure of from $500 million to $1 billion on renewable energy development, for instance, is at most 10 percent of the corporation's $10 billion capital spending budget.[9]

As Table 1 indicates, solar, wind, geothermal, and biomass energy account for only about 2 percent of total U.S. electricity generation, according to the most recent data.

Cost Data

Accurate estimates of the cost of renewable energies are surprisingly hard to obtain. A 1997 study undertaken jointly by the U.S. Department of Energy and the Electric Power Research Institute[10] argued that no renewable energy source was competitive with combined-cycle natural gas turbine technology, the primary source of new electric power capacity, which produces electricity at about 3 cents per kilowatt-hour (kWh).[11]

Renewable energy costs, however, include numerous government subsidies and preferences that mask the true cost of generating electricity from those sources. The impact of preferences varies by fuel source and facility, but they reduce the true cost of renewable energy production by at least 2 cents per kWh.[12] The most important of those subsidies include

- a 1.7 cent per kWh federal tax credit for output produced during the first 10 years of operation for new wind power plants built before 2001;[13]
- a 10 percent investment federal tax credit for solar and geothermal technologies that generate electricity;[14]
- five-year accelerated depreciation for some renewable energies;[15]
- state-imposed "public benefit charges,"

Solar, wind, geothermal, and biomass energy account for only about 2 percent of total U.S. electricity generation.

Table 1
Net Generation of Electricity from Various Fuels, 2000

Fuel	Kilowatt-hours (millions)	Percentage of Total Electricity Generation
Nonrenewables and hydro	3,799,944	97.79
Renewables		
Biomass	39,498	1.04
Waste combustion	24,590	0.65
Geothermal	14,197	0.37
Wind	4,953	0.13
Solar	844	0.02
Total renewables	84,082	2.21

Source: Energy Information Administration, Monthly Energy Review Interactive Data Query System, http://tonto.eia.doe.gov/mer.

Without policy privileges, the renewable energy industry (at least the portion that generates electricity for the power grid) would cease to exist.

which impose taxes on nonrenewable energy sources to subsidize renewable energy projects;[16] and
- state sales tax credits, investment tax credits, and subsidized low-interest loans to investors.[17]

Without policy privileges, the renewable energy industry (at least the portion that generates electricity for the power grid) would cease to exist. For instance, Christine Real de Azua, an analyst at the Wind Energy Association, concedes that "the fact remains that wind energy, while close to being competitive with conventional generating technologies . . . was still not competitive enough [as of 1998] to win all-source bids from utilities in the absence of policies that either created a steady assured market for renewable energy, or ensured that its environmental attributes were adequately captured and valued in the marketplace."[18] Stanford University engineers Mark Jacobson and Gilbert Masters concede that wind is competitive only if government intervenes to internalize environmental externalities of conventional electricity production (an issue addressed later in this paper).[19]

The cost estimates shown in Table 2 are too low for several reasons. First, they do not include the costs of transmission because those costs are site specific and hard to estimate.[20] The cost of transmitting electricity produced by renewable energy, however, is often higher than that of transmitting electricity generated from fossil fuel because the best renewable energy sites are far from urban areas. Transmission costs will thus increase the figures in Table 2.

Second, production costs of renewable energy vary tremendously by location. Ideal sites will produce lower-cost power, but the number of ideal sites in the United States (and, indeed, in the world) is limited,[21] a consideration so fundamental to the economics of wind power, for example, that the EIA states bluntly that "because of limits to windy land area, wind is considered a finite resource."[22] Moreover, ideal sites will be developed before higher-cost sites, so the expected trajectory should be rising, not decreasing, costs, all other things being equal.[23]

Finally, production costs and generation capacity of wind and solar power facilities are heavily dependent on weather conditions,

Table 2
Levelized Cost of Renewable Energy

Fuel	Cents per kWh
Geothermal/hydrothermal	3.3–3.9
Wind/advanced horizontal axis turbines	5.0–6.4
Biomass	7.3–8.7
Geothermal/hot dry rock	10.9
Solar thermal/parabolic trough	17.3
Photovoltaic/residential	37.0
Photovoltaic/concentrators	49.1
Phtovoltaic/utility scale	51.7
Solar thermal/dish engine	134.3

Source: U.S. Department of Energy, Office of Utility Technologies, Energy Efficiency and Renewable Energy, and the Electric Power Research Institute, "Renewable Energy Technology Characterizations," TR-109496, December 1997, p. 7-3.

which makes those energy sources unsuitable for continuous, or baseload, generation. For example, Traverse City Light & Power installed one of the largest wind generators in the country in 1996. But wind speeds have been 15–20 percent below projected averages, and the plant has produced only 67 percent of the electricity anticipated. The turbine was particularly unproductive during the summer months when peak demand was highest.[24]

"Green Power" Offerings in a Deregulated Market

While renewable energy is more expensive than conventionally generated energy, public opinion polls continue to suggest that consumers are willing to pay higher energy costs if doing so will improve environmental quality.[25] Accordingly, a number of independent power marketers in seven states have packaged "green power" electricity plans (made up almost entirely of wind-fired electricity) and marketed those plans to ratepayers in states that give consumers the right to choose their power suppliers.[26]

Eighty utilities in 28 states also offer special packages of renewable energy to ratepayers at a premium.[27] "Green power" costs from 0.4 cents to 20 cents per kWh more than conventional power in these plans, with a median premium of 2.5 cents per kWh.[28] Because of higher costs, no more than 1.5 percent of the retail customers in any state have signed up for such independently marketed programs, and participation in utility-sponsored programs is generally around 1 percent or less.[29] Clearly, there is a difference between what people tell pollsters about their "willingness to pay" for environmental quality and their actual willingness to pay in the marketplace.

While consumer preferences may change, even advocates of renewable energy concede that, until renewable-fired electricity costs become comparable to those of conventional energy, green marketing programs are unlikely to attract many customers.[30]

Forecasts for Growth

Advocates of renewable energy often use recent trends in the wind industry—a growth rate of nearly 70 percent from 1997 through 2000, for example—as the basis for predictions about future growth potential.[31] But such arguments can be charitably described as boosterism.[32]

The EIA generates predictions using the National Energy Modeling Systems, a sophisticated computer model of the industry that is used to forecast changes in energy markets.[33] NEMS forecasts are far less optimistic about the near or midterm prospects for renewable energy than are the forecasts of advocates of renewable energy.[34]

Absent significant changes in federal policy, the EIA projects that installed renewable energy capacity (including both direct generation and industrial cogeneration) will increase by 7.5 gigawatts by 2020, giving renewable energy 2.8 percent of net generation in the electricity marketplace and 3.1 percent of retail electricity sales.[35] Combined-cycle turbine plants, fired primarily by natural gas, are expected to account for 92 percent of new capacity over that same period[36] because their costs are expected to be lower than those of other sources of electricity.[37] Even coal-fired electricity is expected to add three times more capacity to the system than renewable-fired electricity generation.[38] To put the projected expansion of renewable energy into perspective, the additional expected power equals the electricity output from 3–4 moderately sized coal or nuclear power plants over the next 20 years.[39]

Of the 5,356 megawatts (MW) of renewable energy generating capacity currently planned through 2020, only 291 MW are being built voluntarily; the rest of the investment is a consequence of state mandates and orders.[40] Thus, government orders, not economic competitiveness, account for even the modest amount of new renewable generating capacity expected over the next two decades.

Projections of future global market share for renewable energy alternatives under a "business as usual" scenario are no more optimistic. The World Bank reports that only 1,000 MW of new renewable-fired electricity are being added annually around the world (out-

Of the 5,356 megawatts (MW) of renewable energy generating capacity currently planned through 2020, only 291 MW are being built voluntarily; the rest of the investment is a consequence of state mandates and orders.

The main disadvantage of renewable energy is its capital costs. As states deregulate their electricity markets, investors lose the guarantee that the capital costs of generators will be recovered from customers.

put equivalent to that of one moderately sized coal or nuclear power plant a year),[41] compared to the annual global addition of 75,000 MW of fossil-fired generation.[42] Even the optimistic corporate renewable energy analysts, such as those at Royal Dutch Shell, concede that by 2010 renewable energy will probably increase its global energy market share to only 2 percent from its current 1 percent.[43]

The Capital Costs of Renewables

The forecasts for growth in the use of renewables are low because the costs of renewable energy are high. The levelized cost of renewable energy–fired electricity is greater today than that of its main competitor, combined-cycle natural gas. Few analysts believe that this will change soon[44] (we'll discuss trends in fossil fuel prices more extensively below). For example, the most competitive renewable energy resource, wind, is projected to have a levelized cost of 6 cents per kWh in 2005, 50 percent above the projected levelized cost for advanced combined-cycle natural gas power plants or advanced coal plants and only slightly less than that of nuclear power.[45]

The main disadvantage of renewable energy is its capital costs. As states deregulate their electricity markets, investors lose the guarantee that the capital costs of generators will be recovered from customers. Thus, investors find it riskier to invest in capital-intensive technologies than in technologies that have higher marginal but lower capital costs.

Table 3 illustrates the capital costs (incorporating the 10 percent federal investment tax credit for geothermal and solar) for various fuels using state-of-the-art technology.[46]

Renewable technologies not only have high capital costs per kW of capacity but also require costly upgrades of the existing transmission network because attractive sites are distant from most consumers.[47] In addition, given the amount of land necessary to collect wind and solar power in an economically viable manner, renewable energy would

Table 3
Capital Costs forVarious Electricity-Generating Technologies

Technology	Capital Costs per Installed kW
Gas/oil combined cycle	$445
Advanced gas/oil combined cycle	$576
Wind	$983
Coal	$1,092
Coal gasification cycle	$1,306
Waste and landfill gas combustion	$1,395
Geothermal	$1,708
Biomass	$1,732
Fuel cells	$2,041
Advanced nuclear	$2,188
Solar thermal	$2,946
Solar photovoltaic	$4,252

Source: Energy Information Administration, "Assumptions to the Annual Energy Outlook 2001" DOE/EIA0554 (2001), December 2000, Table 43, p. 69.

have to increasingly compete with other land uses—such as agriculture and recreation—resulting in increased fixed costs for land.[48]

According to EIA, capital costs for renewable sources increase linearly—and sometimes more than linearly—with increased capacity. Geothermal drilling costs increase 33 percent for each successive 20 percent production increase, and exploration costs increase 100 percent for each successive quintile of production increase.[49] For biomass, capital costs increase by 15, 50, 75, and 100 percent for successive 20 percent increments of supply. For wind power, capital costs increase 20, 50, 100, and 200 percent.

The forecasts for growth in the use of renewables are also low because renewable sources have a cost structure (high capital and low marginal costs) that is suited to baseload production but a generation pattern that is intermittent. Wind and solar power generate electricity only when the wind is blowing or the sun is out.[50] To circumvent the intermittent nature of wind and solar power, natural gas–fired generators provide backup capacity, but this adds cost and links renewable energy production to natural gas markets. How "renewable" is renewable energy that relies on natural gas?

Natural Gas Prices and Renewables

The trouble for renewable energy is competition from combined-cycle natural gas turbines that have low capital costs (Table 3) and declining marginal costs. From 1985 through 1999, natural gas prices declined 25 percent after adjusting for inflation.[51]

In November–December 2000 average natural gas prices increased dramatically from $2 to $10 per million British thermal units. In California they averaged $25 per million Btu[52] (and reached $60 per million Btu on December 9).[53] Mark Mazur, acting administrator of the EIA, testified to the Senate Energy and Natural Resources Committee that "gas prices previously had not remained this high for a sustained period of time."[54]

Is the natural gas price spike of 2000 temporary or long-term? If long-term, then market substitutes are viable, but coal, not renewable sources, would probably gain the most market share.[55] If temporary, then renewable energy's future is no brighter today than it was yesterday.

The evidence suggests that the natural gas price increase of 2000 was temporary. Natural gas prices in late September 2001 were $2 per million Btu and inventories were 9 percent above the six-year moving average for the date.[56] Futures contracts for natural gas on the New York Mercantile Exchange suggest moderate increases in price through 2004.[57]

Industry forecasters are also optimistic. The Department of Energy believes that natural gas prices will continue to fall at least through 2004.[58] The National Petroleum Council concurs, forecasting that the average wellhead price through 2010 will be approximately $2.74 per million Btu.[59] As a result, EIA expects that electricity prices will decline from 6.7 cents per kWh in 1999 to 6 cents per kWh in 2020.[60]

Fossil Fuel Electricity Costs with Proper Pollution Accounting

Generation of electricity from renewables is limited by costs. Advocates of renewable energy know this so they argue that the demand for renewables would rise if conventionally generated electricity were priced to reflect its pollution costs.

The argument that fossil fuel extraction and combustion foul the environment in ways that are incompatible with property rights and markets has some merit.[61] Air and water resources have been treated as a public commons rather than as private property. Advocates of renewable energy argue that consumers of fossil fuels have not had to indemnify anyone for the environmental consequences of their consumption and thus prices for fossil fuels are too low. Consequently, society consumes "too much" fossil fuel.

Although a world of relatively "unpriced" pollution existed prior to 1970 and the enactment of the Clean Air Act amendments,[62]

According to EIA, capital costs for renewable sources increase linearly with increased capacity.

environmental regulation since the 1970s has imposed large costs on firms, particularly new coal-burning utilities, and those costs have been passed on to consumers. So, in a sense, consumers of electricity *have* had to pay a premium for the environmental consequences of the fossil fuels they consume. For example, the costs of compliance with the Clean Air Act through the 1970s and 1980s (the "environmental tax" on fossil fuels) were about $25 billion to $35 billion annually.[63] The relevant question, then, is whether the regulatory cost paid by consumers already covers the environmental "cost" of fossil fuel consumption.

The answer, unfortunately, is not at all clear. The estimates of the economic damage caused by fossil fuel consumption are all over the map. If we accept EPA's estimates as a reasonable point of analytic departure, however, we find that biomass and coal are somewhat undertaxed relative to their external costs, natural gas is substantially overtaxed, and gasoline is taxed correctly.[64]

But analysis cannot stop there. Economic efficiency—the explicit goal of advocates of renewable energy who cite market failure as a rationale for government intervention—requires that the additional benefits obtained from expenditures for pollution abatement exceed the additional costs. Subsidies to renewable energy sources are necessary to correct for the costs of air pollution *if and only if* incremental net benefits would arise from reduced pollution relative to the status quo. And even then an economically justified subsidy would equal only the *difference* between the existing prices of fossil fuels (which include the cost of existing pollution controls as well as some taxes) and a price that included all pollution damages.[65] Most analysts, however, conclude that the incremental costs of air pollution controls established over the past decade have far exceeded the incremental benefits.[66]

Because pollution policies already control emissions and a reasonable interpretation of the evidence suggests that the additional cost of further exposure reduction exceeds the additional health benefits, the economically efficient subsidy for alternative electricity sources is probably zero.

Even if current regulatory costs are insufficiently reflective of true environmental costs, they are not so far off the mark that "getting prices right" would significantly affect consumer decisions about fuels. The U.S. General Accounting Office reported,

> The consideration of externalities in the planning process for electricity has generally had no effect on the selection or acquisition of renewable energy sources [because] electricity from renewable energy usually costs so much more than electricity from fossil fuels that externality considerations do not overcome the difference.[67]

Moreover, as we'll see below, tightening environmental regulations on coal- and gas-fired power plants would have little effect on renewable energy's ability to compete in the electricity marketplace.

Current regulatory costs are not so far off the mark that "getting prices right" would significantly affect consumer decisions about fuels.

Does Global Warming Alter the Conclusion?

Does the threat of global warming alter the conclusion of the last section? This study will not provide a thorough review of the scientific disputes surrounding global climate change,[68] but scientists do not agree on whether anthropogenic greenhouse gases will have a significant deleterious effect on either the economy or the environment.[69]

Even if the scientific alarmists are correct about the effects of anthropogenic greenhouse gas emissions, it is not clear that the benefits of restricting fossil fuel consumption outweigh the costs.[70] And unless the benefits of "doing something" about global warming outweigh the costs, the efficient greenhouse gas "tax" on coal- or gas-fired electricity is zero.

Accordingly, the case for promoting renewable energy to "do something" about global warming is empirically weak. Moreover, as we discussed earlier, embracing a policy of "doing

something" about global warming does not necessarily translate into a policy of subsidizing renewable energy; there are far less costly means of reaching that end.

Do Subsidies for Traditional Fuels Justify Subsidies for Renewables?

The EIA reported that energy subsidies in fiscal year 1999 totaled $4 billion.[71] The oil industry received $312 million,[72] the coal industry received $489 million, and the natural gas industry received $1.2 billion (almost all of which was a tax credit for the production of alternative fuels, primarily gas from tight sands and coalbed methane).[73] Renewable energy was the recipient of $1.1 billion in subsidies in 1999.[74] Subsidies for fossil fuels amount to only 1 percent of total energy purchases[75] and are, according to EIA, "too small to have a significant effect on the overall level of energy prices and consumption in the United States."[76]

R&D dollars have not handicapped renewable energy technologies. Over the past 20 years, those technologies have received (in inflation-adjusted 1996 dollars) $24.2 billion in federal R&D subsidies, while nuclear energy has received $20.1 billion and fossil fuels only $15.5 billion.[77] To the extent that nuclear power has received heavy favor from government, the primary victims have been oil, gas, and coal—not renewable energy.

The best way to "level the playing field" is to eliminate subsidies for traditional sources rather than enact new programs for renewables.

If You Can't Sell Renewables, Mandate Them

Renewable energy has made remarkably little progress in the electricity marketplace because of its costs. And proper consideration of the pollution externalities of, and subsidies for, coal- and gas-fired electricity would not increase its price enough to close the gap. Proponents of renewable energy have responded by advancing proposals to mandate the consumption of renewable energy. This section surveys the most common proposals advanced to promote additional reliance on renewable energy.[78]

Renewable Energy Portfolio Standards

Ten states have adopted renewable energy portfolio standards (RPS), which require that a certain percentage of the state's electricity supply be produced from eligible renewable energy sources.[79]

The Clinton administration proposed a federal RPS that would require all U.S. electricity suppliers to obtain renewable energy credits equal to 7.5 percent of sales from 2010 through expiration in 2015. Under the administration's plan, credits could be obtained by generating electricity with specified renewables (one credit for every kilowatt-hour), purchasing credits from others, or purchasing credits unsupported by generation from the Department of Energy at 1.5 cents per credit, effectively setting a cap on the price of renewable energy.

Because actual renewable sources of electricity have costs that exceed 1.5 cents per kWh, retail suppliers would for the most part buy credits from the Department of Energy rather than actually purchase or produce renewable energy. The EIA estimated that the Clinton RPS would increase renewables' market share only to 3.4 percent in 2020.[80] Approximately 82 percent of the 36 billion kWh increase in renewable energy would come from mixing biomass (essentially, wood chips, paper, and various specialty plants) with coal in existing coal-fired power plants.[81] Removing the 2015 sunset provision would increase the predicted market share for renewables to 4.2 percent.[82]

The impact of the Clinton RPS on electricity prices would be small because the credit system spreads the cost of the 1.5 cent tax across all electricity sales. Costs would peak in 2010 under each of the various RPS plans (up to a 3.2 percent increase in price under a no cap, no sunset RPS) but would fall by about half under each RPS alternative by 2020.[83]

Since the unveiling of the Clinton proposal,

Subsidies for fossil fuels amount to only 1 percent of total energy purchases and are "too small to have a significant effect on the overall level of energy prices and consumption in the United States."

proponents have introduced even more aggressive RPS plans in Congress. Most of those legislative proposals require that between 10 and 20 percent of retail electricity sales by 2020 come from specified nonhydro renewable energy sources without any sort of price cap on the cost of tradable renewable energy permits and without any sunset provision.

A "hard" 20 percent RPS would provide the equivalent of a 5 cent per kWh subsidy for renewable-fired electricity,[84] increasing the amount of renewable energy sold on the market from the 135 billion kWh otherwise projected in 2020 to 932 billion kWh, a 690 percent increase.[85] Approximately 57 percent would come from biomass cofired with coal, 30 percent from wind-powered turbines, 11 percent from geothermal facilities, and 2 percent from landfill gas.[86] According to EIA, electricity prices would be 3 percent higher in 2010 and 4 percent higher in 2020 under a hard 20 percent RPS.[87]

None of the legislative proposals on the table to promote renewable energy would have much effect on greenhouse gas emissions.

In sum, moderate RPS programs accomplish little and aggressive RPS programs would prove quite expensive. Moreover, because the primary beneficiary of those programs would be biomass, which would be mixed with coal in existing coal-fired power plants, the environmental benefits would be far less than we might expect. That even aggressive RPS programs are insufficient to significantly expand the market share of wind- and solar-powered electricity underscores just how uncompetitive those technologies are today in the marketplace.

Would Stricter Pollution Controls Increase Renewable Energy Generation?

Regardless of the merits of the claim that conventional sources of electricity are underpriced because of inadequate regulation of pollution emissions, what would happen to the renewable energy industry if pollution rules were tightened on conventional electric power plants?

The main legislative proposals to reduce pollution from power plants address sulfur dioxide (a contributor to "acid rain" and regional haze), nitrogen oxides (a contributor in some regions to summertime urban smog), mercury (a toxic constituent thought by some to harm both human and ecological health), and carbon dioxide (one of the most important greenhouse gases) jointly in coordinated, comprehensive fashion. Those proposals are commonly referred to as "multi-emission" or "4-pollutant" bills.[88] President Bush, after initially calling for adoption of just such a 4-pollutant bill during his campaign for the White House, now supports instead a "3-pollutant" bill addressing sulfur dioxide, nitrogen oxides, and mercury but *not* carbon dioxide.

Reducing emissions of nitrogen oxides and sulfur dioxide by 75 percent below 1997 levels (the most common proposal) would increase electricity prices by only about 1 percent, too little to trigger a shift from coal or natural gas to renewable energy.[89] The EIA notes that, while "scrubbers, selective catalytic reduction, and selective noncatalytic reduction (the most popular technologies for controlling such emissions) can be expensive, they generally are not costly enough to make existing coal-fired plants uneconomical."[90]

Reducing mercury emissions by 90 percent below 1997 levels (the most common proposal) also would not increase renewable energy generation because, according to the EIA, "the [mercury] cap can be met more cost-effectively by retrofitting and switching from coal to natural gas than by switching to more costly renewable energy technologies."[91] In the meantime, combining the proposed mercury regulations with the proposed reductions in emissions of nitrogen oxides and sulfur dioxide (the 3-pollutant approach) would increase electricity prices by 3–4 percent by 2020.[92]

Can Renewable Energy Contribute to a Campaign against Global Warming?

Perhaps the most common argument for government promotion of renewable energy is that renewable energy can play a significant role in achieving affordable greenhouse gas emission reductions. But as Table 4 indicates, none of the legislative proposals on the table to promote renewable energy would have much effect on greenhouse gas emissions.

Because the United States must reduce greenhouse gas emissions by 30–42 percent below projected levels to meet the require-

Table 4
Carbon Dioxide Emission Reductions by 2020 under Alternative Scenarios

Scenario	Emission Reduction (million metric tons)	Emission Reduction (percentage)
EIA "high renewables" scenario	12	1.6
Clinton RPS with 1.5 cent price cap and 2015 sunset	1	0.002
Clinton RPS without price cap or sunset	32	4.2
Hard 10% RPS	56	7.3
Hard 20% RPS	137	17.7

Source: Energy Information Administration "Annual Energy Outlook 2000," DOE/EIA-0383 (2000), December 1999, p. 72; and Energy Information Administration, "Analysis of Strategies for Reducing Multiple Emissions from Electric Power Plants: Sulfur Dioxide, Nitrogen Oxides, Carbon Dioxide, and Mercury and a Renewable Energy Portfolio Standard," SR/OIAF/2001–03, July 2001, Table 10, p. 32.

ments of the Kyoto Protocol (much greater than the 17.7 percent reduction created by even the hard 20 percent RPS), it's clear that renewable energy, no matter how optimistic we might be about the technology, cannot significantly contribute to Kyoto compliance without recourse to extreme mandates.[93] Even if the government required large reductions in carbon dioxide emissions but left the compliance details to the market, firms would find it cheaper to reduce emissions by replacing coal with natural gas than by replacing fossil fuels with renewable technologies.[94]

For example, if a 7 percent reduction of carbon dioxide emissions below the 1990 baseline were mandated (a 30–42 percent reduction from projected levels), the likely increase in the market share of renewable energy would be 27 percent by 2010 and 32 percent by 2020,[95] giving renewable energy technologies 7 percent of the electricity market in 2020.[96] Biomass (primarily cofired with coal) would achieve the largest market gain, followed by geothermal and wind technologies, respectively.[97]

The costs of such a plan, however, would be significant. Absent an international emissions trading regime, electricity prices would increase by 43 percent in 2010[98]—an average annual "tax" of approximately $218 per household in 2010 and $174 by 2020.[99]

Actually stabilizing greenhouse gas concentrations at present levels would require a 60–80 percent cut in present greenhouse gas emissions[100] and, thus, the nearly complete elimination of fossil fuel consumption because fossil fuel combustion creates about 80 percent of total greenhouse gas emissions.[101] Such an undertaking is simply not conceivable.

Reducing emissions of conventional pollutants such as nitrogen oxides, sulfur dioxide, and mercury would do little to advance renewable energy technologies. Cracking down on greenhouse gas (carbon dioxide) emissions would advance renewable energy technologies, but such initiatives would still fail to give those technologies double-digit market shares and would be expensive.

Conclusion

Renewable sources of electricity are more expensive than combined-cycle natural gas. This fundamental fact inhibits their use now and in the future. Advocates of renewable energy argue that the demand for renewables would rise if conventionally generated electricity were priced to reflect its pollution

Renewable sources of electricity are more expensive than combined-cycle natural gas. This fundamental fact inhibits their use now and in the future.

The main effect of reducing nitrogen, sulfur dioxide, and mercury emissions would be to induce a shift from coal to natural gas rather than renewable energy.

costs. But the main effect of reducing nitrogen, sulfur dioxide, and mercury emissions would be to induce a shift from coal to natural gas rather than renewable energy. Only a severe reduction in carbon dioxide emissions would advance renewable energy technologies, but such initiatives would still fail to give those technologies double-digit market shares and would be expensive.

Without policy privileges, the renewable energy industry (at least the portion that generates electricity for the power grid) would cease to exist. Advocates of renewable energy understand that and are now promoting direct use of government authority to mandate the use of renewable sources. Such policies use the power of government to impose the consumption preferences of advocates of renewables on others without any legitimate philosophical or economic basis.

Notes

1. This paper does not examine two fuels that some analysts consider renewable energies—nuclear power and hydropower—because nongovernmental advocates of renewable energy generally oppose those fuels. They oppose nuclear power because of concern over both radioactive waste and general safety. They oppose hydropower because of the damage that its use does to riparian ecosystems. See Robert L. Bradley Jr., "Renewable Energy: Not Cheap, Not 'Green,'" Cato Institute Policy Analysis no. 280, August 27, 1997, pp. 26–28. Accordingly, when we use the term "renewable energy," we're referring to wind power, solar power, biomass, waste combustion and landfill gas combustion, fuel cells, and geothermal resources.

2. Ibid., p. 5.

3. James McVeigh et al., "Renewable Energy: Winner, Loser, or Innocent Victim? Has Renewable Energy Performed as Expected?" Resources for the Future Discussion Paper 99–28, June 1999.

4. Robert L. Bradley Jr., "The Increasing Sustainability of Conventional Energy," Cato Institute Policy Analysis no. 341, April 22, 1999, p. 6.

5. Only 3 percent of the electricity generated in this country is produced from oil, and that figure is expected to decline somewhat through 2020 as oil-fired steam generators are replaced with gas turbine technologies. Energy Information Administration (EIA), "Annual Energy Outlook 2001," DOE/EIA-0383(2001), p. 74.

6. U.S. General Accounting Office, "Renewable Energy: DOE's Funding and Markets for Wind Energy and Solar Cell Technologies," GAO/RCED 99-130, May 1999, pp. 15–16, 23.

7. Peter Holihan, "Technology, Manufacturing, and Market Trends in the U.S. and International Photovoltaics Industry," in EIA, "Renewable Energy Outlook 2001: Issues and Trends," February 2001, http://www.eia.doe.gov/cneaf /solar.renewables/rea_issues/solar.html. Enron, interestingly enough, sold its stake in Solarex (a joint project dedicated to commercializing sales of solar power to utility grids) to British Petroleum in 1999. According to business analyst Carl Kirst, Enron's solar investments were "costing them money and not turning a profit in the near-term. It didn't make sense to spend money on this technology." Quoted in Ann de Rouffignac, "Enron Pulls the Plug on Solar Power Operation," *Houston Business Journal*, April 16–22, 1999.

8. Martin Daniel, "Finance for Energy," *FT Energy News*, Summer 1997; and EIA, "Challenges of Electric Power Industry Restructuring for Fuel Suppliers," DOE/EIA-0623, September 1998, p. 20.

9. "Shell Unveils Renewable Energy Plan As US, EU Disagree on Climate Change," *Oil Daily*, June 15, 2001.

10. Still, Thomas Petersik, a senior renewable energy analyst at the EIA, believes that the EPRI/DOE figures reported in Table 2 are somewhat too optimistic about the true levelized cost of renewable energy and that the estimates should be adjusted upward by about a penny or two. Personal conversation with Jerry Taylor, June 26, 2001.

11. Levelized costs are the estimated capital and marginal costs of an energy facility discounted to net present value (NPV) divided by the project's energy output to yield a value in cents per kWh. The calculations in Table 2 assume a market-based rate of return approach to building, owning, and operating a power plant and balance sheet finance. U.S. Department of Energy, Office of Utility Technologies, Energy Efficiency and Renewable Energy, and the Electric Power Research Institute, "Renewable Energy Technology Characterizations," TR-109496, December 1997 pp. 7-1 through 7-3.

12. Bradley, "Renewable Energy," pp. 8–15, 28–36.

13. EIA, "Assumptions of the Annual Energy Outlook 2001," DOE/EIA-0554(2001), December 2000, p. 123.

14. Ibid.

15. Glenn Schleede, "The US Department of Energy's 'Wind Energy Initiative': A Truly Unrealistic

Proposal," Energy Market & Policy Analysis, January 7, 2000, pp. 13–15, empainc @aol.com.

16. California's state program is the most aggressive in this regard. For details, see EIA, "Annual Energy Outlook 2001," p. 12.

17. Christine Real de Azua, "The Future of Wind Energy," *Tulane Environmental Law Journal* 14, no. 2 (Summer 2001): 511.

18. Ibid., p. 501.

19. Mark Jacobson and Gilbert Masters, "Wind versus Coal," *Science*, August 24, 2001. For critiques of the article beyond those generally found in this study, see Glenn Schleede, "Science Article Is Wrong in Claiming That Wind Energy Is Cheaper Than Coal," Energy Market & Policy Analysis, August 26, 2001; and energy consultant Catharine Lawton, "Conclusions in Science Policy Forum Article on Wind Energy and Coal Are Unsupported and Contradicted by Other Evidence," September 17, 2001 (both documents available from the authors).

20. U.S. Department of Energy and the Electric Power Research Institute, p. 6-4.

21. The economics of wind power is heavily dependent on geographic wind characteristics. See "Wind Energy Resource Atlas," United States Pacific Northwest National Laboratory, http://rredc.nrel.gov/wind/pubs/atlas/. Central station solar power is obviously more economically attractive in desert areas than elsewhere. See U.S. Department of Energy and the Electric Power Research Institute, Figure 2, p. 4-3. Geothermal energy is profitable only where heat intersects with water below the earth, sites which are far from ubiquitous. "Geothermal Energy Could Provide 8% of World's Electricity," *Energy Report*, April 12, 1999. See also, generally, EIA, "Annual Energy Outlook 2001," p. 244, and EIA, "Assumptions to the Annual Energy Outlook 2001," DOE/EIA-0554(2001), December 2000, pp. 118–23.

22. Ibid., p. 119.

23. All extractive industries are subject to the same phenomenon. For a discussion of the economics of site exploitation for natural resource industries, see M. A. Adelman, *The Economics of Petroleum Supply* (Cambridge, Mass.: MIT Press, 1993), pp. 1–302.

24. "Wind Turbine Fails to Meet Expectations," *Detroit News*, August 19, 1999.

25. The U.S. Department of Energy recently surveyed a random sample of Americans and asked them if they agreed with the statement, "We must protect the environment, even if it means paying higher prices for electricity and gasoline because of it." Fifty-five percent agreed, 38 percent disagreed, and 7 percent were unsure. "Save the Environment! (And Turn Up the Air Conditioner)," *New York Times*, May 20, 2001, sec. 4, p. 5.

26. The most successful programs are being marketed in California, New Jersey, and Pennsylvania, although California suspended its retail consumer choice program on September 20, 2001. Other states where "green power" marketing is conducted include Connecticut, Maine, Massachusetts, and New York. Blair Swezey and Lori Bird, "Green Power Marketing in the United States: A Status Report," 5th ed., National Renewable Energy Laboratory, NREL/TP-620-28738, August 2000, pp. 1–2. For a critique of those green pricing programs, see Robert L. Bradley Jr., "Green Energy," in *Macmillan Encyclopedia of Energy*, ed. John Zumerchik (New York: Macmillan, 2001), vol. 2.

27. Ibid., p. 1.

28. Ibid., p. 6.

29. Ibid., pp. 1–2, 7.

30. Real de Azua, p. 519.

31. EIA, "Analysis of Strategies for Reducing Multiple Emissions from Power Plants: Sulfur Dioxide, Nitrogen Oxides, and Carbon Dioxide," SR/OIAF/2000-05, December 2000, p. 47.

32. For a good example of the typical arguments, see Christopher Flavin and Seth Dunn, "A New Energy Paradigm for the 21st Century," *Journal of International Affairs* 53, no. 1 (Fall 1999): 167–90.

33. For a discussion of the NEMS, see EIA, "Annual Energy Outlook 2001," Appendix G. For a discussion of the major underlying assumptions of the NEMS model, see EIA, "Assumptions of the Annual Energy Outlook 2001," pp. 2–12.

34. EIA's forecasts for renewable energy, interestingly enough, are a bit more optimistic than similar forecasts published by the U.S. Environmental Protection Agency, the Electric Power Research Institute, and the Environmental Law Institute, all agencies generally considered to be more bullish about the prospects for renewable energy. EIA, "Strategies for Reducing Multiple Emissions from Power Plants," 2000, Table 22, p. 70. For an overview of how the assumptions underlying the NEMS model and the forecasts differ generally from those of other analyses, see EIA, "Annual Energy Outlook 2001," pp. 102–11.

35. EIA, "Analysis of Strategies for Reducing

Multiple Emissions from Electric Power Plants: Sulfur Dioxide, Nitrogen Oxides, Carbon Dioxide, and Mercury and a Renewable Energy Portfolio Standard," SR/OIAF/2001-03, July 2001, p. 58.

36. EIA, "Annual Energy Outlook 2001," p. 73.

37. Ibid., p. 95.

38. Ibid., p. 73.

39. U.S. General Accounting Office, "Renewable Energy," p. 7 n. 9.

40. For a summary as well as a state-by-state, project-by-project breakdown, see EIA, "Assumptions of the Annual Energy Outlook 2001," pp. 123–25.

41. Ibid.

42. "World Bank Chief Says 'Systemic' Change Needed to Help Renewable Generation," *Energy Report* 27, no. 11, March 13, 2000.

43. "Shell Unveils Renewable Energy Plan As US, EU Disagree on Climate Change."

44. "The use of renewable energy technologies for electricity generation is projected to grow slowly because of the relatively low cost of fossil fuel generation and because electricity construction favors less capital intensive natural gas technologies over coal and baseload renewables." EIA, "Annual Energy Outlook 2001," p. 5.

45. EIA, "Strategies for Reducing Multiple Emissions from Power Plants," 2000, p. 18.

46. Capital costs are referred to as "total overnight cost including contingencies" in the electricity trade.

47. EIA, "Annual Energy Outlook 2001," p. 244.

48. Ibid; and EIA, "Assumptions to the Annual Energy Outlook 2001," p. 118.

49. Ibid.

50. Of course, low winds can generate power from wind turbines, but not economically. "Since the energy that wind contains is a function of the cube of its speed, small differences in average winds from site to site mean large differences in production and, therefore, in cost." Real de Azua, p. 492.

51. Alex Barrionuevo, John Fialka, and Rebecca Smith, "How Federal Policies, Industry Shifts Created the Natural Gas Crunch," *Wall Street Journal*, January 3, 2001, p. A1.

52. Edward Krapels, "Was Gas to Blame? Exploring the Cause of California's High Prices," *Public Utilities Fortnightly*, February 15, 2001, pp. 31–32.

53. Bruce Radford, "Key to the Citygate," *Public Utilities Fortnightly*, January 1, 2001, p. 4.

54. Mark Mazur, "Statement to Committee on Energy and Natural Resources, U.S. Senate," 106th Cong., 1st sess., December 12, 2000, p. 1, http://www.eia.doe.gov/pub/oil_gas/natural_gas/presentations/2000/testimony_on_natural_gas_demand/1211sen-test.pdf.

55. As noted earlier, the levelized cost of coal-fired electricity is quite a bit lower than that of renewable energy alternatives (the price differential is almost as large between renewables and coal as it is between renewables and natural gas); the capital costs of coal-fired electricity are virtually the same as those of the most competitive renewable, wind. Moreover, the EIA expects coal prices to drop dramatically over the next couple of decades, from $16.98 a ton in 1999 to $12.70 a ton in 2020 (a 1.4 percent annual decline); the price of coal delivered to utilities is expected to decline at almost the same rate (1.1 percent annually through 2020). EIA, "Annual Energy Outlook 2001," pp. 3, 92.

56. EIA, Natural Gas Weekly Update October 1, 2001, http://tonto.eia.doe.gov/oog/info/ngw/ngupdate .asp.

57. For a review of the size of North American natural gas reserves, see "Industry Confident U.S. Has Enough Gas to Meet Demand," *Energy Report*, March 5, 2001, p. 10; "Report Estimates U.S. Gas Supplies Good for 60 Years," *Energy Report*, April 9, 2001, p. 10; "Canadians Cheer White House Pro-Gas Remarks," *Energy Report*, April 9, 2001, p. 12; and Judith Gurney, "U.S. Faces Natural Gas Price Shock," *Energy Economist* 229 (November 2000): 15–18. For a discussion of technological advances on the near horizon that could dramatically expand natural gas supplies if prices stay high, see Jennifer Considine et al., "North American Natural Gas Markets," *Oxford Energy Forum*, February 2001, pp. 7–9.

58. Mazur, p. 7.

59. "Group Calls on FERC to Cap Wholesale Prices," *Energy Report*, February 12, 2001, p. 11.

60. EIA, "Annual Energy Outlook 2001," p. 3.

61. Murray Rothbard argues that air pollution should be governed by the common law strict liability rule. Murray Rothbard, "Law, Property Rights, and Air Pollution," *Cato Journal* 2 (Spring 1982): 55–99.

62. For a review of air pollution trends and regulatory policies before the Clean Air Act of 1970, see Indur Goklany, *Clearing the Air: The Real Story of the War on Air Pollution* (Washington: Cato Institute, 1999). Goklany reports that there was far more state and local regulatory activity before 1970 than most analysts realize and that air quality had been improving for decades prior to passage of the Clean Air Act. The explanation of suboptimal emissions control policies prior to 1970, according to Goklany, is that scientists came rather late to the conclusion that nitrogen oxides and other substances were truly pollutants worth worrying about. One can't fault state and local governments for not regulating substances that weren't on the public health radar screen.

63. For the 1970–90 period, Clean Air Act direct compliance expenditures are estimated to have been $500 billion. In 1978 Clean Air Act direct compliance expenditures were estimated to have been $35 billion. See J. Clarence Davies and Jan Mazurek, *Pollution Control in the United States: Evaluating the System* (Washington: Resources for the Future, 1998), pp. 128–30.

64. W. Kip Viscusi et al., "Environmentally Responsible Energy Pricing," *Energy Journal* 15, no. 2 (1994): 23–42.

65. Albert Nichols, "How Well Do Market Failures Support the Need for Demand Side Management?" National Economic Research Associates, Cambridge, Mass., August 12, 1992, p. 9.

66. The 1990 Clean Air Act amendments, for example, will probably result in additional costs that are double the additional benefits. See Paul R. Portney, "Economics and the Clean Air Act," *Journal of Economic Perspectives* 4 (Fall 1990): 173–81.

67. U.S. General Accounting Office, "Electricity Supply: Consideration of Environmental Costs in Selecting Fuel Resources," May 19, 1995, p. 2, quoted in Paul Ballonoff, *Energy: Ending the Never-Ending Crisis* (Washington: Cato Institute, 1997), p. 55.

68. For an overview of the scientific disputes, see Patrick Michaels and Robert Balling, *The Satanic Gases: Clearing the Air about Global Warming* (Washington: Cato Institute, 2000).

69. Intergovernmental Panel on Climate Change, *Climate Change 1995, Impacts, Adaptations, and Mitigation of Climate Change: Scientific-Technical Analyses* (New York: Cambridge University Press, 1996), pp. 411, 439.

70. For a review of the cost/benefit arguments, see *The Impact of Climate Change on the United States Economy*, ed. Robert Mendelsohn and James Newmann (Cambridge: Cambridge University Press, 1999); and Thomas Gale Moore, *Climate of Fear: Why We Shouldn't Worry about Global Warming* (Washington: Cato Institute, 1998).

71. The details about subsidies come from EIA, "Federal Financial Interventions and Subsidies in Energy Markets 1999: Primary Energy," SR/OIA/99-03, September 1999. Some analysts describe the Overseas Private Investment Corporation and the foreign tax credit as subsidizing oil production; see "Subsidizing Big Oil's Foreign Investments: Importing Oil, Exporting Jobs, and Making War," Citizen Action, Washington, September 1996. We will not discuss these policies because they are available to all corporations. However, the government provision of risk insurance for overseas investment does violate market principles.

72. For a more complete discussion of oil subsidies, see Ron Sutherland, "Big Oil at the Public Trough? An Examination of Petroleum Subsidies," Cato Institute Policy Analysis no. 390, February 1, 2001.

73. EIA, "Federal Financial Interventions and Subsidies in Energy Markets 1999: Primary Energy," Table ES1, p. ix.

74. Ibid.

75. Ibid., p. 5.

76. Ibid., pp. ix–x.

77. Data from the Department of Energy reported in Bradley, "Renewable Energy," p. 63.

78. This section does not explore the employment or macroeconomic impacts of the various emissions reduction or renewable energy portfolio programs discussed herein. For a review of such effects, see EIA, "Analysis of Strategies for Reducing Multiple Emissions from Electric Power Plants," 2001, pp. 63–69.

79. Texas and New Jersey have adopted the most aggressive standards. Other states that have adopted RPS programs include Arizona, Connecticut, Maine, Massachusetts, Nevada, New Mexico, Pennsylvania, and Wisconsin. For details about the Texas and New Jersey programs, see EIA, "Annual Energy Outlook 2001," p. 12.

80. EIA, "Annual Energy Outlook 2000," DOE/EIA-0383, 1999, p. 19.

81. Ibid.

82. Ibid.

83. Ibid.

84. EIA, "Analysis of Strategies for Reducing Multiple Emissions from Electric Power Plants," 2001, p. xviii.

85. Ibid., pp. xxiv–xxv.

86. Ibid., p. 59. For an examination of the regional impacts of a hard 20 percent RPS, see ibid., pp. 62–63.

87. Ibid., p. 32.

88. For a review of the various proposals, see ibid., pp. 1–2; and EIA, "Analysis of Strategies for Reducing Multiple Emissions from Power Plants," 2000, pp. 1–2.

89. EIA, "Analysis of Strategies for Reducing Multiple Emissions from Electric Power Plants," 2001, p. ix.

90. Ibid., p. xv.

91. Ibid., p. 59.

92. Ibid., p. ix.

93. Michaels and Balling, p. 200.

94. Council of Economic Advisers, "The Kyoto Protocol and the President's Policies to Address Climate Change," http://www.whitehouse.gov /WH /New/html/Kyoto.pdf. For a full discussion of that report, see Peter VanDoren, "The Cost of Reducing Carbon Emissions: An Examination of Administration Forecasts," Cato Institute Briefing Paper no. 44, March 11, 1999.

95. Ibid., p. 33.

96. Ibid., p. 60.

97. Ibid.

98. Ibid., p. x. To review the various assumptions that drive the cost estimates of carbon dioxide emission reductions, see VanDoren.

99. EIA, "Analysis of Strategies for Reducing Multiple Emissions from Electric Power Plants," 2001, p. xvii.

100. Michaels and Balling, p. 199.

101. EIA, "Annual Energy Outlook 2000," p. 40.

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