

Renewable of Electricity

SAFE BET OR TILTING AT WINDMILLS?

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Excluding hydropower, renewable energy makes up a tiny portion of the nation's overall electricity supply—its roughly 2.2 percent share is dwarfed by fossil energy, nuclear power, and hydroelectric dams (see the table on page 27). But given all the environmental and safety caveats associated with more traditional energy sources, a lot of people are paying closer attention to how renewables can play a larger role in the domestic energy mix.

Hydropower continues to overwhelm all other renewable resources in magnitude, but even existing dams, much less newly built ones, are widely seen as unpopular because of their effect on commercial and recreational fishing and on ecosystems as a whole. Virtually no one expects any meaningful addition to the nation's current hydropower capacity.

In the current marketplace, the dominant renewables are wind power, wood products (used mainly as a fuel source in manufacturing), municipal solid waste, and geothermal resources. Wind power has taken the lead in this race, with an 11 percent rate of growth since 1990, pushing it from 4 percent of total renewables generation (excluding hydropower) in 1990 to 13 percent in 2003. This trend of relatively strong growth for wind power is likely to continue.

Virtues

A useful way to appreciate the virtues of renewable energy resources is to look at some of the disadvantages associated with their conventional counterparts—fossil fuels and nuclear power—that dominate today's world energy scene. Coal is cheap and abundant but its combustion produces pollutants only partially controlled by prevailing regulations, while control of carbon dioxide emissions awaits sequestration technologies not yet at hand. As trade in liquefied natural gas increases, natural gas may in time present challenges similar to those currently associated with large dependence on oil imports. And even if the nuclear option could be revived on technological and economic grounds, the public remains divided about such problems as disposal of nuclear waste.

In all of these respects, renewables are attractive. Typically, though not invariably, their use produces far less environmental damage than conventional energy. Burning of biomass such as fuelwood does result in some air pollution. At some locations, wind farm opponents cite danger to wildlife and aesthetic affronts. But these environmental concerns pale in comparison with those associated with conventional fossil fuels. Even with current pollution controls,

Sources

coal-generated power still causes more pollution than that produced by wind turbines, and that's before considering greenhouse gas emissions from coal combustion. Also, renewables are largely insulated from the rising costs that, in time, may hit depletable resources like natural gas. Finally, in moderating the demand for fuels imported from unstable parts of the world, renewables indirectly provide an energy security benefit.

To be sure, these contrasting features are a bit overdrawn: some renewable energy sources might be limited while some nonrenewables are effectively inexhaustible. For instance, among renewables, geothermal resources are, strictly speaking, exhaustible because a given site may lose heat after a number of years of extraction. Among alternatives to renewables, one could cite nuclear power, whose underlying resource requirements are effectively limitless.

Drawbacks

Although renewable energy might be beneficial overall, it is no panacea. Renewables clearly do have some drawbacks. The most important is their high cost. To compare costs, we use each technology's "levelized" cost—that is, the real cost of generation, including capital cost, over the estimated life of the plant. For some technologies, such as solar photovoltaics, the levelized cost of pro-



ducing a kilowatt-hour (kWh) can be three or four times as high as that for a new natural gas-fired combined-cycle plant, even at today's high natural gas prices. For other technologies, such as wind power, the cost differential from natural gas is smaller.

Except for biomass, renewable technologies have no fuel costs, and their other operating costs are typically low as well. So the bulk of their expense consists of the fixed costs of equipment and land. The translation of that fixed cost into a leveled cents per kilowatt-hour (kWh) of generation depends on how much electricity the facility generates. Because wind generation depends on when and how fast the wind blows, wind power installations typically operate at capacity factors of 10 to 35 percent, contributing to higher costs per kWh.

Renewables aren't on a level playing field with fossil energy. Competing coal- and gas-fired generators escape having to pay the full cost of the air pollution and other consequences they impose on society. Such externalities, though they certainly exist, are surely minimal for wind and solar generation.

The potential for renewable sources of energy to gain a larger share of the electricity market is further constrained by physical and political limits. Geothermal energy sources are limited primarily to southwestern states. Biomass generation requires conversion of large quantities

of land from other uses. A relatively strong, steady wind and land that is amenable to construction of wind towers and reasonably accessible to the transmission grid are prerequisites for the development of commercial-scale wind projects. Many offshore sites can meet these criteria, but efforts to develop offshore windpower in the United States have met with substantial resistance from those—like residents of Cape Cod—whose coastal views would be affected. Meeting the demands of opponents could add to the cost of developing windpower resources in particular sites.

All that being said, the costs of renewables have come down over time. Research at RFF shows that over the course of the 1980s and 1990s, the *cost* of electricity from renewable sources typically fell faster than had been predicted. But despite achieving lower costs, renewables failed to meet prior expectations regarding trends in the *volume* of future generation. This is because a simultaneous decline in the cost of competing fossil fuels and generation continued to place renewables at a relative cost disadvantage. How renewables fare in the years ahead will, similarly, be at least partly determined by concurrent trends in fossil or nuclear generation costs.

Policy Options

A totally hands-off governmental stance—subjecting renewables exclusively to market discipline—has abstract appeal. But fairness would dictate that other fuels would then no longer qualify for subsidies and also be subject to their full environmental costs, something that is not likely at the present time.

A number of different policies have been implemented in the United States to promote greater use of renewables in the electricity sector. One approach that gained currency with the introduction of competition in electricity markets in numerous states is “green power” marketing. Under this voluntary approach, renewable generators seek to appeal to

households willing to pay a premium—ranging, in 2003, from 0.6 to 17.6 cents per kWh—to purchase power wholly or largely generated by renewables. Roughly 400,000 households participated in such green power programs by the end of 2003—an inconsequential 0.3 percent of nationwide residential power customers.

Another, far more significant trend is the evolution of renewable portfolio standards (RPS). As of early 2005, nearly 20 states had introduced requirements that a minimum amount of electricity distributed (as well as, in some cases, produced) in the state be generated using qualified renewable systems. These rules typically impose increasingly stringent requirements over the next several decades. An important feature of RPS programs in numerous states is a tradable-credit system. Such credits, created whenever renewables-based power is generated, allow for the fact that electricity distributors vary in the ease with which they can incorporate a renewables component in their sales. In a system somewhat analogous to tradable emissions rights in sulfur dioxide and nitrogen oxides to meet stipulated clean air targets, utilities overcomplying in their renewables requirement can sell excess credits to those utilities failing to meet their quotas. Some state programs have an important provision that effectively sets an upper limit to the cost of such credits.

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the form of the Energy Policy Act, which included a requirement that renewables account for 2.5 percent of electricity generation in 2005, increasing 0.5 percent per year until reaching a 10 percent target in 2020. This legislation, similar to some state programs, included a cap of 3 cents per kWh on the price of renewable credits, but recent analysis suggests

that the credit price for a 10 percent federal RPS would fall well below this threshold. But thus far, such congressional initiatives have failed—in part because of strong opposition from traditional electricity providers.

A production tax credit (or subsidy) has so far been the main policy instrument to promote renewable generation at the federal level. In 1992, Congress authorized a renewable energy production credit (REPC) now amounting to 1.9 cents per kWh of electricity produced from wind and dedicated closed-loop biomass generators, later expanded to include electricity from geothermal, solar, and landfill gas resources. The REPC could be claimed by new generators for the first 10 years of their operation. The federal government also grants a tax credit equal to 10 percent of investment costs for new geothermal and solar generation facilities; this policy has no expiration date. Both credits make renewables more competitive than they would otherwise be.

Net metering is another renewables-promoting program at the state level. Under net metering, customers who generate electricity on site—for example, through fuel cell or solar photovoltaic systems—can sell any excess electricity back to the supplier at the retail price, essentially running the meter backward. Many states have special programs to fund R&D on renewables, and the U.S. Department of Energy has been devoting \$300 million annually to R&D into renewable energy sources, though that level may be hard to sustain under the administration's latest budget. A variety of technological improvements, in part benefiting from such support, might bring about a substantially expanded volume of wind-generated power. Possibilities include continuing advances in the aerodynamics of wind turbines, electricity storage systems to provide power availability during poor wind-speed periods,

and cost-reducing breakthroughs to reduce line losses in long-distance electricity transmission.

What's in Store for Renewables?

Although technological advances and unexpected steep price increases for conventional energy can contribute to expanded use of renewables, their prospective growth—as projected in the just-released *Annual Energy Outlook 2005* by DOE's Energy Information Administration (EIA)—remains modest. Absent major energy policy departures, non-hydropower renewables are projected to increase their share of total electricity generation only to about 3.2 percent by 2025, compared to 2.2 percent in 2003. This is in spite of the fact that the *absolute volume* of renewables, mostly in the form of wind, will likely grow substantially over that period.

A strategy for a stronger renewables role would have to be embedded in a broader national energy policy. Dealing with the problem of greenhouse gas emissions from fossil-fuel combustion is one component of such a policy. Well-designed R&D funding for both renewable and other innovative energy systems is another. To stimulate renewables more directly, one of the most cost-effective approaches would be a national RPS, providing for an efficient nationwide trading system and a mechanism to protect against high costs. It will be very challenging to integrate a federal renewables policy with the variety of existing state-level RPS policies. Nevertheless, the RPS provision of the Energy Policy Act of 2002 provides a feasible approach. Complementary to other elements of a more rational energy policy than either political party or its leaders have given us in recent years, the RPS would represent one creative step forward. ■

Fuel Type	Capacity		Generation		U.S. Electricity Capacity and Generation, 2003
	1,000 MEGAWATTS	PERCENTAGE	BILLION KWH	PERCENTAGE	
Fossil/nuclear	823	89.4 %	3,493	90.7 %	
All renewables	98	10.6	359	9.3	
Hydropower	79	8.6	275	7.1	
Non-hydropower	19	2.0	84	2.2	
Wind	7	0.7	11	0.3	
Geothermal	2	0.2	13	0.3	
Solar	0.5	0.1	1	0.0	
Wood/MSW	9	1.0	59	1.5	
Total	920	100 %	3,852	100 %	

Notes: Capacity refers to summer availability. Because of rounding, numbers may not add to totals.
MSW=municipal solid waste.

SOURCE: U.S. ENERGY INFORMATION ADMINISTRATION, 2005.