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WORKING FOR A SUSTAINABLE FUTURE

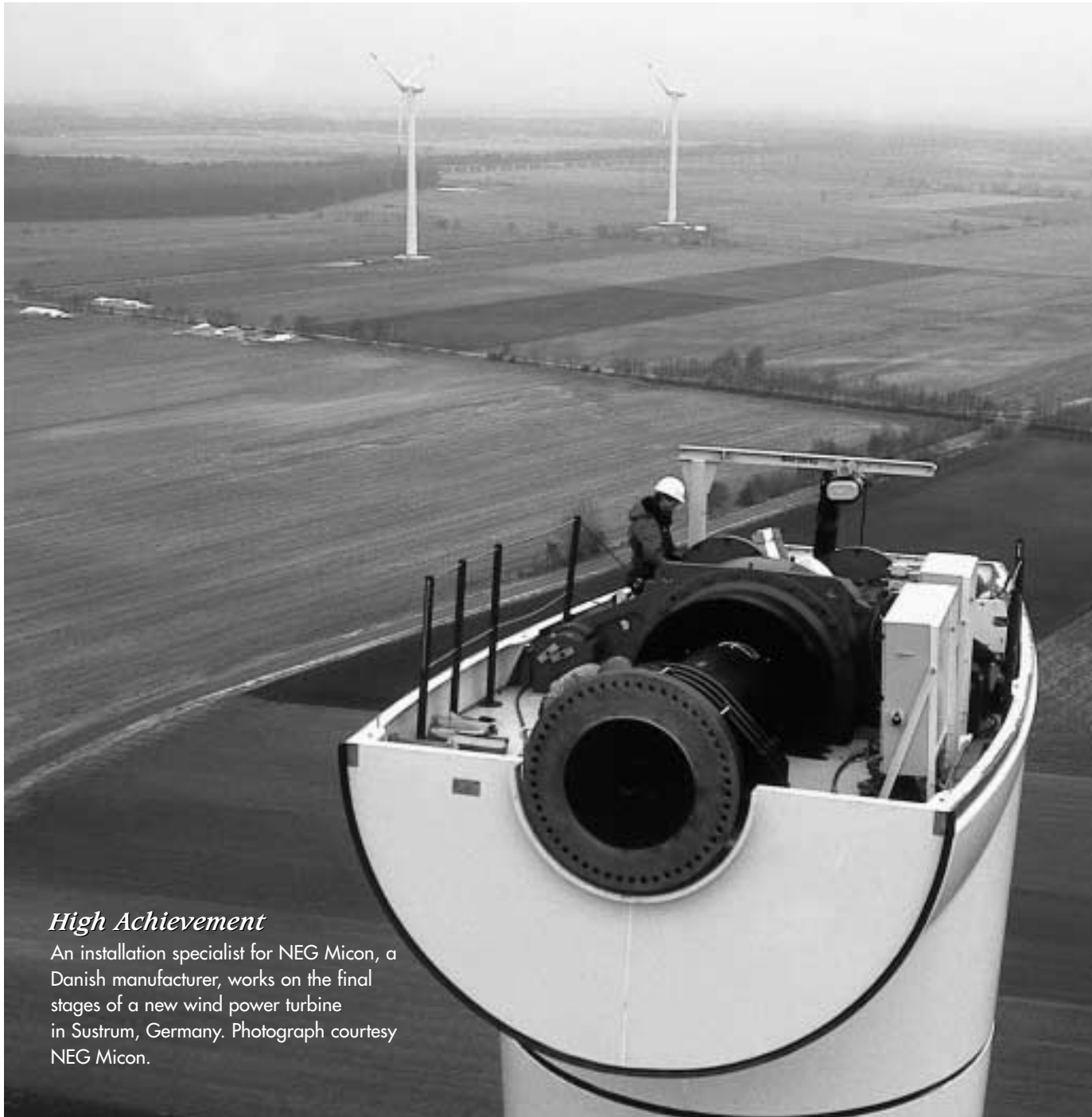
Going to Work for Wind Power

by Michael Renner

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High Achievement

An installation specialist for NEG Micon, a Danish manufacturer, works on the final stages of a new wind power turbine in Sustrum, Germany. Photograph courtesy NEG Micon.

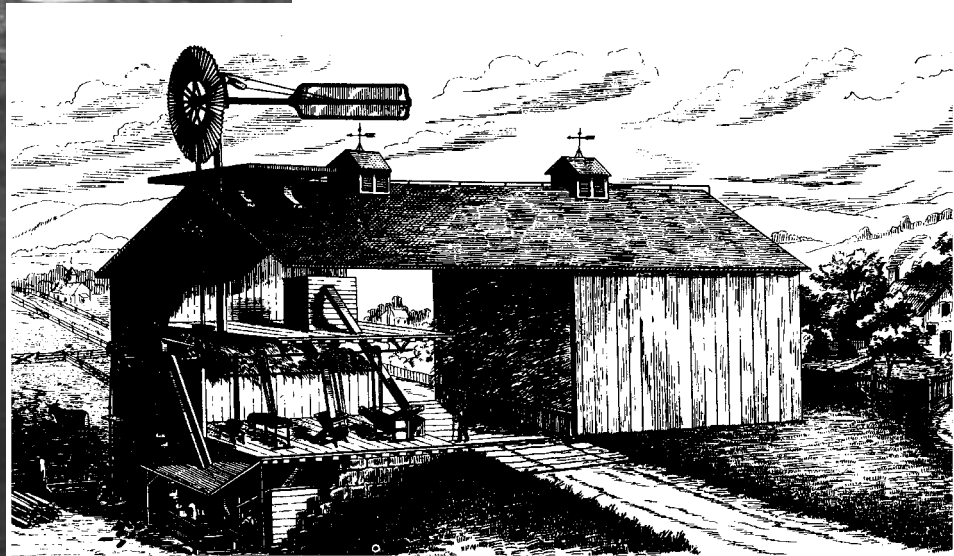
for Wind Power

The renewable energy of the future is already beginning to generate new jobs to replace the ones that are disappearing in the older energy sectors.

This is not your grandfather's windmill

Think of the Netherlands, and what may come to mind is a quaint countryside of historic canal houses, fields of tulips, and—of course—those ubiquitous windmills. Though the Netherlands today is a highly urban and technologically sophisticated nation, that image of the “old” country still plays a large role in the country’s economy—as a lure to millions of tourists. It’s fascinating to consider that these windmills were, for centuries, the main sources of mechanical energy before the dawn of the fossil fuel age—that such silent, pleasant-looking contraptions could have provided the power needed to pump water, grind grain, saw timber, and do a wide range of other tasks now done by loud, polluting machines. To the tourists, the relation between these quaint windmills and the modern diesel turbines or giant coal-burning power plants that have replaced them may seem as distant as that of schooners to speed-boats.

Enter the new high-tech wind generators of today, which began appearing two decades ago and have proliferated in the Netherlands and in some 40



other countries so far. Unlike their predecessors, the modern wind turbines do not directly operate pumps, sluice-gates, or grindstones, but generate the basic commodity—electricity—needed to run any modern industrial economy. These new wind turbines are as different from the old windmills in their use of wind as a telephone wire is different from a 19th-century church bell in its use of copper.

While providing a means of reducing global-warming gases and other air pollution in a way that is now becoming competitive with coal and oil in sheer cost per kilowatt-hour, the new wind-power also offers an advantage that has been largely ignored during the last few years of booming stock markets—but that will prove enormously important as the 21st century unfolds: it is not only a clean, competitive energy source but is a rich source of new employment. Whereas some defenders of the entrenched oil and coal interests predict that major efforts to stabilize climate change will spell economic doom, the evident capacity of wind power to deliver cost-effective power *and* new employment makes a compelling case that good environmental policy can also be good economic policy.

As far back as 200 B.C., windmills were used to pump water in China and to grind grain in Persia and the Middle East. In medieval Europe, merchants and crusaders returning from the Holy Land introduced this technology to their homelands, and windmills were erected in numerous places on the continent. By the early 15th century, in England alone, the use of animal power to grind grain—cattle pulling large stones in circles—had been supplanted by some 10,000 windmills. But it was in the Netherlands that windmill design evolved most over the ensuing centuries, producing incremental improvements in aerodynamic lift, rotor efficiency, and rotor speed. The Dutch relied on wind power to help drain the numerous lakes and marshes that made the Rhine river delta barely habitable and to hold their own against frequent and devastating floods. From the Netherlands, England, and elsewhere in Europe, wind technology reached the New World with the waves of settlers crossing the Atlantic. In the late 19th century, windmills were used on a massive scale to pump water for farms and ranches in the American West. Between 1850 and 1970, over 6 million mostly small units were installed in the United States.

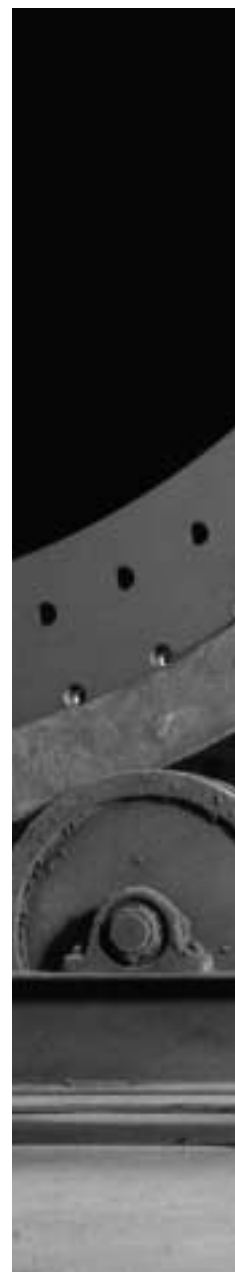
Predictably, when it became apparent that electricity would be the elixir of the new industrial economy, efforts were made to put wind energy to use in generating it. Wind-electric machines first appeared in Denmark and the United States around 1890. The development of a utility-scale system was first undertaken in Russia in 1931 with the 100 kilowatt Balaclava wind generator on the shore of the Caspian Sea. Operating for about two years, it generated a

cumulative 200,000 kWh of electricity. During the next few decades, experimental wind-power machines were built in the United States, Denmark, France, Netherlands, Germany, and Great Britain.

Despite these efforts to “modernize” wind energy use, wind mills were eventually retired from active service and preserved only as tourist sites. A principal reason for their demise was the invention of the steam engine, which had to be powered by heat—and which thus created a huge new market for coal. The steam engine was soon joined by a plethora of other coal- and oil-driven machines. Wind-powered machines went into a gradual decline, first in Europe and then in North America. In 1895, there were still some 30,000 windmills operating in Germany, providing the equivalent of 87 megawatts of power, but this amounted to only 1.8 percent of the country’s total power requirements—compared with 78 percent provided by steam engines.

Moving into the 20th century, the world’s industrial economies developed appetites for growing amounts of coal, oil, natural gas and, later, nuclear power. By then, it was clear that fossil fuels were simply too convenient to compete with; whereas wind could only be used on site—and only when the wind was blowing—coal or oil could be transported anywhere and used anytime. It took another half-century for the environmental costs of coal and oil to become a serious issue, but by then there was a new competitor on the horizon—nuclear power, which was initially expected to prove “too cheap to meter.” Substantial subsidies cemented these energy sources’ advantage.

It was only with the advent of the modern environmental movement that some economists began to reassess the economics of the prevailing energy system, and to recognize that the sizable environmental and health costs—the burdens of air pollution, acid rain, climate change, toxic mining and radioactive wastes, “black lung,” and respiratory diseases—were not being accounted for by conventional measures of cost per kilowatt-hour. Instead, they were “externalized”—not accounted for on any balance sheet. But at the same time that environmentalists were making this argument, defenders of the status quo were making a counter-argument: that industrial reforms made for environmental reasons would have pro-



hibitively damaging impacts on the economy because they would take away jobs. Restricting clearcutting of forests, for example, would take jobs away from loggers; restricting fishing of depleted species would take jobs away from fishermen; and so on. In the energy sector, it was said, cutting back on coal and oil would take jobs away from miners and refiners.

Since that argument was first promulgated, however, an ironic shift has occurred. In the coal and oil businesses, massive job losses—counted in the hundreds of thousands—have occurred in the past decade without their having been driven by environmental regulation and despite the continuing preferential subsidies they have received. Meanwhile, wind power is beginning to benefit from technological



Two Coats

A coating technician applies water-soluble paint to a section of tower being manufactured in Denmark. Photograph courtesy NEG Micon.

advances that will diminish its historic disadvantages of not being subject to transport and storage. Wind is now poised to compete economically with coal and oil on even terms in many places—and to do so not only with the advantage of being environmentally benign, but with the important added advantage of providing more jobs per unit of cost than the fossil-fuel industries it now challenges.

Wanted, To Run With the Wind

It was only in the wake of the oil crises of the 1970s that interest in wind turbines revived after more than half a century of dormancy, setting the stage for the emergence of a whole new, futuristic tech wind energy sector. It took a decade or so to take hold, but since the beginning of the 1990s, the new sector has been growing at a breathtaking rate. Worldwide installed generating capacity grew from about 2,000 megawatts in 1990 to 15,000 megawatts by mid-2000, an average growth rate of 24 percent per year. That's still tiny in absolute terms, but it's comparable to the position automobiles were in a century ago. And the prospects for continued expansion are good. Electricity from the wind is now rapidly closing the price gap with conventional power plants. In October 1999, the European Wind Energy Association, the Forum for Energy and Development, and Greenpeace International jointly released a study, *Windforce 10*, that contends that wind energy could meet 10 percent of the world's electricity demand by the year 2020. Under their scenario, installed capacity would grow to 1,200 gigawatts (1.2 million megawatts).

Windforce 10, in its assessment of the number of jobs that might be generated over the next two decades, concludes that 17 job-years of employment are being created for every megawatt of wind energy capacity manufactured and an additional five job-years for every megawatt installed, or a total of 22 job-years per megawatt. As labor productivity rises, the per-megawatt job figures are expected to gradually decrease to 15.5 by 2010 and 12.3 by 2020.

Assuming these ratios hold, the study projected that total wind power employment will climb from something under 100,000 jobs today to almost 2 million over the next two decades, with most of the growth occurring in Europe, North America, and China.

This growth includes the "direct" jobs of manufacturing and installing wind turbines, as well as the "indirect" jobs in supplier industries. It does not include any jobs that may be produced by the still embryonic off-shore wind industry. Nor, significantly, does it include the work of maintaining wind installations once they are built.

Offshore installations, which would be placed in

relatively shallow waters somewhat like offshore oil rigs, were not included in the *Windforce* study. But they are expected to play a growing role in coming years, particularly in Europe. A study released by the German Wind Energy Institute and Greenpeace in October 2000 ("North Sea Offshore Wind—A European Powerhouse") concludes that five North Sea countries—Germany, Britain, the Netherlands, Belgium and Denmark—have the potential to generate almost 2,000 terawatt hours of electricity per year from offshore wind, an amount that is more than triple their current combined demand for power. Tapping just one percent of this wind source in a year would provide electricity for 6.5 million homes and could employ 160,000 persons, according to Greenpeace.

Additional employment is generated through operating and maintaining wind turbines, though reliable numbers are unavailable. The European Wind Energy Association estimates that between 100 and 450 people are employed per year for every terawatt-hour of electricity produced, depending on the age and type of turbine used. In 1999, when about 29 terawatt-hours were generated, that would have meant anywhere from 3,000 to 13,000 additional jobs worldwide. As wind power capacity expands, obviously so will these numbers. Even at the lower end of this range, there may be some 3 million jobs in running and maintaining the world's wind energy turbines by the year 2020, if the *Windforce 10* projections hold up.

What Kinds of Jobs?

Wind power development opens up employment opportunities in a variety of fields. It requires meteorologists and surveyors to rate appropriate sites (to ensure that the areas with the greatest wind potential are selected); people trained in anemometry (measuring the force, speed, and direction of the wind); structural, electrical, and mechanical engineers to design turbines, generators, and other equipment and to supervise their assembly; workers to form advanced composite and metal parts; quality control personnel to monitor machining, casting, and forging processes; computer operators and software specialists to monitor the system, and mechanics and technicians to keep it in good working order. Many of these are highly skilled positions with good pay.

The lion's share of the world's wind power-generating capacity has been installed in Western Europe, and European companies are the leading manufacturers of wind turbines (accounting for about 90 percent of worldwide sales in 1997), so most of the world's wind power-related jobs are being generated there. In the United States, now the second-leading force in wind power, capacity is



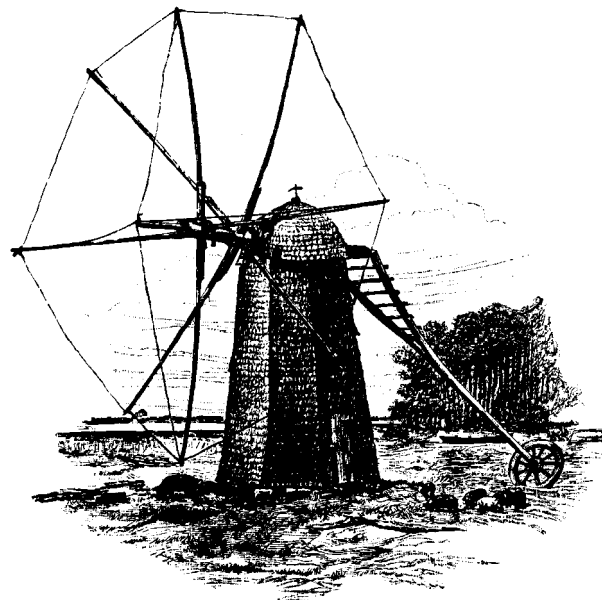
Light Footprint

Wind power is not a "heavy" industry of the traditional kind; its fuel is weightless, and its plants don't require the massive structures of coal or nuclear plants. Here, construction workers for Enron Wind lower a section of a wind tower into place. Enron has erected over 4,300 towers so far. Photograph by Lloyd Herziger/Enron.

expected to almost double by the end of 2001.

As other regions with high wind power potential gear up, the picture will gradually change. India and China, especially, have the meteorological potential to greatly increase wind power production and employment. With roughly 1,000 megawatts of capacity, India is already among the five leading wind power nations. It currently has 14 domestic turbine manufacturers, and spare parts production and turbine maintenance are helping some of its regions and villages to generate needed income and employment.

Other developing countries, too, are showing rising interest. Although they currently have little wind generating capacity installed, wind companies in Argentina hope to create 15,000 permanent jobs over the next decade. Latin American and East European nations are able to manufacture nearly all needed components within their own regions.



Imports will be needed for at least a portion of new installations in Asia, and for the bulk of installations in the Middle East and Africa.

Fossil Fuel Jobs—A Disappearing Act

The traditional energy sector, with its many millions of jobs once providing a large part of the industrial world's employment, is now a shrinking source of employment, even though the overall production of fossil fuels is still creeping upward. World coal output began stagnating in the mid-1980s, and the industry has become one of bigger and fewer companies, larger equipment, and less and less need for labor. In Europe, employment in this field has dropped particularly fast, since production is being driven down both by coal imports and by a shift to other sources of energy. During the past two decades, British coal employment has collapsed from 224,000 to just 10,000 miners, the result of mine closures and aggressive automation at remaining sites. About 50,000 jobs were lost in Germany during the 1990s. Even though the German coal industry continues to receive massive subsidies—with some \$20 billion allocated for the 2000–2005 period alone—its cuts in employment are expected to continue.

China, which produces more coal than any other nation, has undertaken to deliberately cut its coal output by 20 percent over the next several years, in order to bring production more in line with declining demand, reduce pollution, and bring down the human toll of mining. (At least 10,000 people die in Chinese coal mines each year—80 percent of the global number of victims—and increasingly, these jobs are scorned by all but the most desperate workers.) To this end, China has reduced its subsidies to coal production, with the result that some 870,000 coal industry jobs have been cut since 1994 and another 400,000 workers are expected to be laid off.

In the United States, coal production increased 32 percent between 1980 and 1999, but coal-mining employment nevertheless declined 66 percent, from 242,000 to 83,000 workers. One reason is that production has shifted from more labor-intensive underground mines in the eastern United States to surface mines in the West. Ton for ton, strip-mining employs only about one-third to one-half the number of workers required in underground mines. Environmental considerations played a role in this shift, insofar as efforts to combat acid rain have led to a greater preference for lower-sulfur coal, and western coal is lower in sulfur content than eastern coal. Employment is expected to fall by another 36,000 workers between 1995 and 2020, even in the absence of any measures to address the threat of climate change.

Similar trends can be seen in other parts of the

energy and utility industries, as increasing mechanization and automation have cut jobs even as output rises. In the United States, more than half of all oil and gas production jobs were lost between 1980 and 1999; during the same period of time, almost 40 percent of oil-refining jobs were cut. Today, petroleum refining and wholesale distribution accounts only for 0.3 percent of all U.S. employment. In EU countries, more than 150,000 utility and gas industry jobs have disappeared since the mid-1990s and another 200,000 jobs—one in five—are likely to be lost by 2004, as the new market liberalization program proceeds. In Germany alone, 60,000 utility sector jobs—one quarter of the total—were eliminated between 1990 and 1998.

The Labor Productivity Issue

Wind power is more labor-intensive than either coal- or nuclear-generated electricity. In Germany, currently the world leader with roughly 5,000 megawatts (roughly one-third of global capacity) installed, wind still contributes just 2 to 3 percent of the country's total electricity generation, while supporting about 35,000 jobs in manufacturing, installing, and operating wind machines. In comparison, nuclear power commands 33 percent of the electricity market, but supports a relatively meager 38,000 jobs; coal-fired power plants have a 26 percent market share and account for some 80,000 jobs.

Judging by the way the business press routinely describes companies that employ fewer people for a given level of output as “lean” or “efficient,” the high number of jobs in wind energy may seem to suggest that wind is a less economically efficient way of producing electricity. In today's globalizing economy, companies seem ever more intent on boosting labor productivity—the amount of goods and services produced per worker—and slashing labor costs as a means to stay competitive. Because wages and benefits are a major part of the cost of most businesses, the pursuit of greater labor productivity is an omnipresent concern.

In principle, however, a given industry—such as wind power—can become profitable while still remaining relatively more labor-intensive, by achieving superior efficiency in other major categories of cost—in its requirements for capital, materials, and energy. Unfortunately, in the calculus of most business executives, improving energy or materials productivity is given short shrift compared with improving labor productivity (or laying off employees). A key reason for this is that energy and materials appear to be cheaper than they really are, and therefore offer less incentive for pursuing increased efficiencies, because their production and use are subsidized and their environmental costs are “exter-

nalized”—meaning that those costs are not accounted for on a company’s balance sheet. One of the costs of coal power, for example, is the acid rain that drifts over the eastern United States from Midwestern power plants and kills countless trees along the Appalachian Mountains. Because the power plants don’t have to pay to restore those damaged forests, they have less incentive (than would be the case if the costs of restoration were included) to improve the efficiency of their fuel use than to cut the cost of their labor.

As industrial societies that pervasively allow such damage, not only to ecosystems but to human health and climate stability, we are deluding ourselves not only by not including the cost of such damage in assessing the overall productivity of a business, but also in thinking that by simply running the business with fewer workers we are truly being efficient in our ways. A society that widely exploits such accounting is not much different than those societies that wage repressive campaigns against workers and labor unions in order to keep wages low and the country’s products “competitive.”

The real news about wind-generated electricity is that it can be competitive—and can generate income that is not ill-gotten through overlooking human or environmental costs—even though it employs a comparatively larger number of people than a coal-fired plant. Unlike a conventional power plant, a wind turbine does not have to purchase fuel inputs, whether they be coal, oil, natural gas, or enriched uranium. At a wind power plant, the energy input comes for free. Wind



A High-Tech World

Enron Wind has job openings for airplane pilots, anemometrists, assemblers, construction cost estimators, contracts administrators, electrical and mechanical engineers, energy data analysts, financial analysts, investor analysts, mechanics, power systems engineers, and web programmers. Photograph by Lloyd Herziger/Enron.



Wind Power in the Year 2020

| Region | Installed Capacity (megawatts) | Electricity Generation Per Year (terawatt hours) | Share of Electricity Consumption (percent) | Employment (number) |
|----------------------------------|-----------------------------------|---|---|------------------------|
| North America | 300,000 | 735.8 | 12 | 325,000 |
| OECD Europe | 220,000 | 539.6 | 12 | 270,600 |
| China | 180,000 | 441.5 | 11 | 369,000 |
| Eastern Europe ¹ | 140,000 | 343.2 | 10 | 270,600 |
| Asia ² | 140,000 | 343.4 | 9 | 265,700 |
| Japan, Australia, New Zealand | 90,000 | 218.5 | 12 | 184,000 |
| Latin America | 90,000 | 218.5 | 11 | 184,500 |
| Middle East | 25,000 | 61.5 | 7 | 43,100 |
| Africa | 25,000 | 61.3 | 7 | 51,720 |
| World | 1,210,000 | 2,963.3 | 11 | 1,964,220 |

¹Including Russia. ²Excluding China and Japan.

Source: Adapted from European Wind Energy Association, Forum for Energy and Development, and Greenpeace International, *Windforce 10: A Blueprint to Achieve 10% of the World's Electricity from Wind Power by 2020* (London: 1999).

power plants are less capital-intensive, as well: they require less investment in buildings and machinery than conventional power plants do. And, there are no worries about toxic mine tailings, radioactive wastes, and other problems or costs associated with fossil and nuclear energy.

The Wider Picture

Some widely quoted critics of the Kyoto climate treaty—some of them working for think tanks quietly funded by fossil fuel industries (see “Matters of Scale,” page 21)—have declared that actions taken to substantially reduce carbon emissions would be terribly disruptive to the industrial economy. Their rhetoric echoes that of certain critics of U.S. policies aimed at saving Northwest rainforests, a decade ago, who displayed bumper stickers reading “Save a logger—kill an owl.” Yet, just as environmental protection in Oregon and Washington have not brought the feared ravages of unemployment, it is now clear that environmental policies pose little threat to jobs in general—and that, in fact, the wind industry is far from alone in demonstrating that moving toward a more sustainable economy will bring abundant new jobs to replace the old. Wind power has been the fastest growing among alternative sources of energy,

but others, such as solar photovoltaics and solar thermal energy, also have the potential to engage a growing portion of the public in meaningful and remunerative work. Additional opportunities will be found in the pursuit of such energy efficiency measures as retrofitting buildings to boost their thermal insulation.

The benefits to be gained by such shifts—the “double dividend” of a more protected environment and more jobs—will not just be one-to-one substitutions of beneficial investment dollars for destructive ones. The energy sector is a small employer relative to the

size of the overall economy, yet it exerts enormous leverage because such large quantities of capital—much of it in the form of public subsidies for nuclear, oil, and coal—are bound up in it. Withdrawing some of the hundreds of billions of dollars that have been propping up these obsolescent industries could free up capital to invest in a wide range of more sustainable industries—not only the wind industry discussed here, but a phalanx of new enterprises aimed at achieving greater materials/energy efficiency and pollution prevention. These enterprises might include greatly ramped-up recycling and remanufacturing, as well as designing and redesigning of products (and of buildings, communities, and whole economies) to put greater emphasis on durability, reparability, and reusability. Like wind power, many of these new industries are still quite small, but with the right kinds of subsidy, tax, and research policies—they can be scaled up significantly. It is becoming clear that making it possible for people to work productively does not have to depend on destabilizing the natural world.

Michael Renner is a senior researcher at the Worldwatch Institute and author of Worldwatch Paper 152, *Working for the Environment: A Growing Source of Jobs*.