

Germany's unique subsidies **have rapidly**
and the number of green jobs, to make it

Let the Solar Shine In

■ Fossil Fuels Beware

15.3%

of Germany's electricity in
2008 came from renewables.

increased the use of solar panels and wind power,
the world's leader in renewable energy.

■ **By Bruce Stokes**

FRANKFURT (ODER), Germany—The amber brick walls of the Gothic church of St. Mary's soar above the skyline of this city founded in 1253. Gutted by fire in the waning days of World War II, the empty hulk of St. Mary's basilica stood for decades as a bleak reminder of this community's lost status. ■ The Oder River today serves as the border between Germany and Poland and as the namesake of this town, which sits on its banks, to distinguish it from the much larger German industrial city of Frankfurt am Main some 380 miles to the southwest. For hundreds of years,



■ **FIELD POWER:** A 1.4-megawatt installation using First Solar panels sits amid farm fields in Dimbach, Germany.

Frankfurt (Oder) hosted trade fairs that made the town a vital commercial link between Eastern and Western Europe. But the Cold War rearranged national frontiers, robbing this city of its entrepôt role and putting it into Communist East Germany. German reunification in 1990 led to the swift collapse of uncompetitive local industries and the flight of the community's best and brightest young people to the West.

Today the restoration of St. Mary's is nearing completion, a symbol of the city's drive to reinvent itself, this time as the gateway between Germany's past and its future. "We knew we had to make a new start," said Peter Edelmann, the city's deputy mayor for economic affairs.

"The question we faced," said Martin Wilke, managing director of the local Investor Center, "was how to rebuild the economy for tomorrow." Facing double-digit unemployment and few other prospects, city leaders decided to promote renewable-energy technologies such as wind power and photovoltaics.

It was a serendipitous marriage of economic necessity and environmental responsibility.

Germany accounts for about one-fifth of all greenhouse-gas emissions in the European Union, so Europe's chances of limiting climate change hinge on Germany's success in tackling the source of the problem. One of the best ways to cut emissions is to shift to more renewable-energy technologies to produce power.

Three major photovoltaic makers have set up shop in Frankfurt (Oder): First Solar, Conergy, and Odersun. Brandenburg, the German state that is home to Frankfurt (Oder), has more photovoltaic-production capacity than any other region in Germany, more than a third of the nation's total. The producers and installers of solar energy technologies are now the fastest-growing employers in the area.

Germany is the world's largest producer of renewable energy. Fully 280,000 Germans make a living in the renewable-energy sector, a ninefold increase in the past decade.

The environmental and economic development lessons learned here—especially the importance of generating a supply of renewable energy, not simply the demand for it—have much to teach the Obama administration as it attempts to recast American energy policy and to foster environmental technology and green jobs in the United States.

Solar Capital

First Solar, the largest thin-film solar panel maker in Frankfurt (Oder)—and in the country—sits in an industrial park along the autobahn on the outskirts of town. It builds utility-

East Meets West



scale commercial and industrial photovoltaic systems that convert sunlight into electricity. With 600 workers, First Solar is the second-largest local employer. It is an American-owned company that came here because it saw a market.

The First Solar plant is a prototypical high-tech facility, a nondescript, warehouse-like structure the size of about eight soccer fields. The only hint that this factory is in Germany, and not a U.S. suburb, are the giant windmills silhouetted against the horizon beyond its bordering tree line, an ever-present reminder of the region's commitment to all forms of renewable power.

The factory produces a solar module every two hours or so. Machines coat sheets of glass with a film of cadmium telluride half the thickness of a human hair, inscribe perpendicular lines on the coated surface to create 116 solar cells, and then cover that surface with another sheet of glass to seal it. The resulting 4-by-2-foot panel, or "module," can produce about 75 watts of



BRUCE STOKES

The Oder River divides Poland (background) from Germany (foreground). The town here, Frankfurt (Oder), made a decision after German reunification to promote renewable-energy manufacturing when other local industries had collapsed.

began manufacturing solar panels in Toledo, Ohio. But its focus soon shifted to the German market, and it opened a plant here in 2004. The motivation was simple: Demand for photovoltaic panels was rising rapidly because of Germany's innovative electricity-rate structure, known as a "feed-in tariff." (See sidebar, p. 36.)

A law enacted in 2000 gives any German the right to feed unlimited electricity into the country's grid. For 20 years, the utilities must then buy the energy at a fixed price that covers the cost of the power's production plus a small profit for the supplier. As a result, German homeowners can become energy entrepreneurs, borrowing money to build windmills in their backyards or to put solar collectors on their roofs.

"Investments and the meaningful jobs go where the markets are," Ahearn said. The Germans understood that plant construction, manufacturing, and research-and-development subsidies—long favored by many nations to nurture infant industries—would not be sufficient to create a viable renewable-energy sector. They also needed a market.

"A factory is not built because of research money," said Hans-Josef Fell, energy spokesman for the German Green Party in the Bundestag. "Create a market, and the factories will follow."

First Solar and its competitors benefit from traditional state subsidies. But what brought the company here was a solar panel market sufficient to justify scaling up production enough to lower manufacturing costs. Germany has fueled that demand not with taxpayer money but through a small increase in each consumer's electricity bill, which is the feed-in tariff.

"We put in place the macro framework," said David Wortmann, director of renewable energies and resources at Germany Trade & Invest, a government agency. "And that created micro opportunities."

The Payoff

The payoff has been striking. Germany now has about 20,000 wind turbines and this year will have the world's second-largest installed capacity for wind power, trailing only the United States, which has more than three times the population and an economy five times as large. More than a fifth of the world's installed solar power is also in Germany, even though the country is blessed with only half the sunlight of the Sahara. In 2007, Germany's peak electricity-production capacity from renewable-energy sources was four times that of the United States.

Reliance on renewable energy is growing faster in Germany

electricity from sunlight. First Solar manufactures 7,800 modules a day. In this highly automated process, the firm's skilled workers largely spend their time servicing the machinery, calibrating dials, and checking quality.

Manufacturing capacity has nearly doubled in less than five years, and the variable production cost per watt has fallen from about \$3 to 98 cents. "As we scaled up," First Solar President and CEO Mike Ahearn said, "the cost came down dramatically. In the outyears we think we can bring it down even more." The target is 65 to 70 cents per watt by 2012.

"Reaching this milestone will show the world that we can be competitive with other sources of energy," said the plant's managing director, Burghard von Westerholt. "We will one day be cheaper than wind power."

Ahearn added, "First Solar's success story is, to a large extent, also a German success story." Founded in 1999, the company

■ Popular Panels



■ One of the leading solar panel makers in Germany is a **U.S. company**.

■ Germany has **more than a fifth** of the world's installed solar power.

■ The increase in renewable-energy sources may put the country's conventional utilities in a **financial bind**.

than anywhere else in the world. In 2000, only 6.2 percent of the country's electricity came from renewable sources, mostly hydropower. By 2008, renewables were providing 15.3 percent, already exceeding the country's 2010 goal of 12.5 percent.

Wind generates about half of this electricity, and another quarter comes from hydropower. But this mix may soon change. Since 2000, installed capacity for hydro has increased just 3.2 percent, while capacity for wind power has grown 264 percent and for photovoltaics an eye-popping 3,711 percent, albeit from a very small base.

The country's use of renewable energy still has room to grow. An energy road map that the German Environment Ministry issued this year has set a goal of renewables producing 30 percent of the country's electricity by 2020. This target is ambitious but necessary. By 2020, Germany intends to phase out its 17 nuclear power plants, which now supply about a quarter of the nation's electricity.

To ensure that future energy demand does not outstrip what renewables can supply, Germany has also set an ambitious conservation goal. By 2030, the government hopes to reduce primary energy consumption by 28 percent through a variety of efficiency measures, including construction of a smart grid designed to cope with surges in supply and demand. The feed-in tariff's encouragement of decentralized, rather than centralized, electricity production will bolster conservation by limiting the need to transmit power over long distances, which also consumes energy.

The environmental benefits are significant, too. The German government estimates that reliance on renewable energy reduced the country's annual CO₂ emissions by 11 percent, or 117 million tons, in 2007, with half of that attributable to the feed-in tariff.

Jobs, Jobs, Jobs

Reduction in carbon emissions is a gift to the next generation, but the current generation needs jobs. In the late 1980s, Frankfurt (Oder) had a population of 87,000. Today it has shrunk to 64,000. Unemployment is 14.5 percent. "We need to create jobs to have people stay in this region," Edelmann said.

Initially, community leaders saw computer chips as their salvation. The region had been the center of the East German semi-

conductor industry, which collapsed after reunification because its products were woefully uncompetitive by global standards. The area was left with 8,000 workers with chip-making skills. Unfortunately, a deal to bring Intel to the city fell through.

"That was a huge setback for us," Edelmann said. Intel "would have created 1,000 jobs. So it was tough times afterwards."

But the city still had advantages. It had the roads and the power and water lines that it had installed to entice Intel. The European Union and the German government offered subsidies to cover half the capital costs of new plants and equipment, plus government backing for low-interest loans and wage subsidies for training, because the region was so economically disadvantaged. And, thanks to Germany's feed-in tariff, demand for solar energy was rising.

Enter First Solar, looking for a market and interested in building a factory close to it. The company received more than 3,000 applications for its first 400 job openings. Other solar makers soon followed. Local officials estimate that 1,500 people now work in the renewable-energy sector in the region. Wilke's goal is to double that number. To that end, the city is courting solar manufacturing investors from China and India.

The effort to create green jobs is part of a national strategy. "It didn't make sense just to create a market," said Wortmann, who worked for First Solar before moving to Germany Trade & Invest. "We needed an industry as well. Our main objective was to create sustainable manufacturing jobs."

It is working. In 1998, 30,000 Germans were employed in the renewable-energy sector. Today, that workforce has grown to 280,000. Of these, in 2007, 84,300 worked in the wind sector; 96,100 in biomass; and 50,700 in solar energy, which is the fastest-growing segment, having doubled its employment in just three years. By comparison, direct employment in coal mining in Germany has fallen from 80,000 in 1998 to 30,000.

Utilities Fight Back

Not surprisingly, given the sorry state of the Frankfurt (Oder) economy in the early 1990s, promotion of job-creating renewable-energy technology attracted local support across the political spectrum, according to Edelmann.

The rest of Germany, however, hasn't always embraced renew-

able energy so warmly. Nor is such popular support assured in the future. Germany's experience with renewables is a reminder of the competing interests that are likely to shape the American debate over energy.

In the mid-1990s, recalls Miranda Schreurs, director of the Environmental Policy Research Center at the Free University of Berlin, public opposition to renewable energy in Germany was significant, driven by concern about the impact of windmills on migratory birds and about noise pollution from wind turbines.

The four powerful German utility companies largely ignored decentralized renewable-electricity production, assuming that it would prove too insignificant to pose a competitive threat. Accustomed to high returns on their investments in centralized power generation, the utilities also shunned the lower returns promised by the feed-in tariff.

As renewable energy's contribution to the overall German energy mix has grown, however, utilities have taken note and set up their own renewable-energy subsidiaries. They are also using their learning experience to offer renewable energy in other European countries.

At the same time, utilities with large investments in coal-fired power generation have started pushing back as wind and solar energy increasingly eat into their German market share. "They are calling for government support for carbon sequestration to make it possible for them to remain competitive," said Schreurs, referring to the as-yet-uneconomical technology that would capture the CO₂ emitted from burning fossil fuel and store it underground.

There is also talk of extending the operating life of Germa-

ny's nuclear reactors. "The nuclear renaissance discussion is a phantom discussion," asserted Fell, the Green Party member in the Bundestag, "but it discourages investment in renewables."

The utilities backed a proposed 2008 European Commission directive that would have outlawed feed-in tariffs. They lost that fight, but the debate over the feed-in tariffs will continue. Biogas producers, for example, do not have privileged access to German natural-gas pipelines like solar producers have to the electrical grid. If, as the German government hopes, bioenergy can produce 8 percent of the country's electricity by 2020, up from 3.7 percent in 2008, adjustments to the feed-in tariff may be necessary to put biogas on par with solar and wind power.

Even more problems loom. A great deal of renewable-energy-generating capacity—the product of multiple small investments spurred by the feed-in tariff—will be coming on line in the next few years, and that will pose challenges for the traditional energy sector.

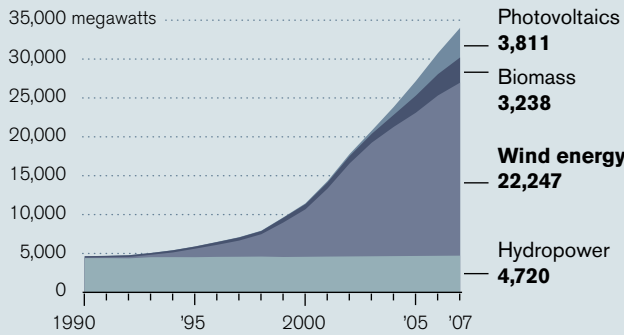
A coal-fired electricity-generating plant has to run about 8,000 hours a year to be profitable. Green politicians in Germany speculate that at a certain point, as renewable sources provide more and more electricity, some traditional power facilities won't be able to run at full capacity and thus will be less profitable. Utilities may also begin to clamor for caps on renewable-energy production.

In response, Green politicians are talking about changing the mix of nonrenewable-energy sources, switching to natural-gas-fired generating plants from coal-fired ones. Gas plants cost less up front and can run at lower capacities while remaining profitable. Thus, they are a more flexible component of an energy sys-

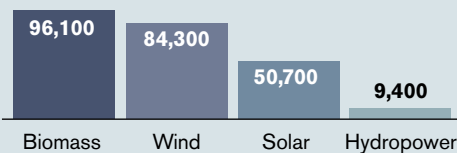
Germany Going Green

Germany has the largest installed wind energy capacity in the European Union and is second in the world only to the United States. Wind energy accounts for the largest share of the country's renewable-electricity generation.

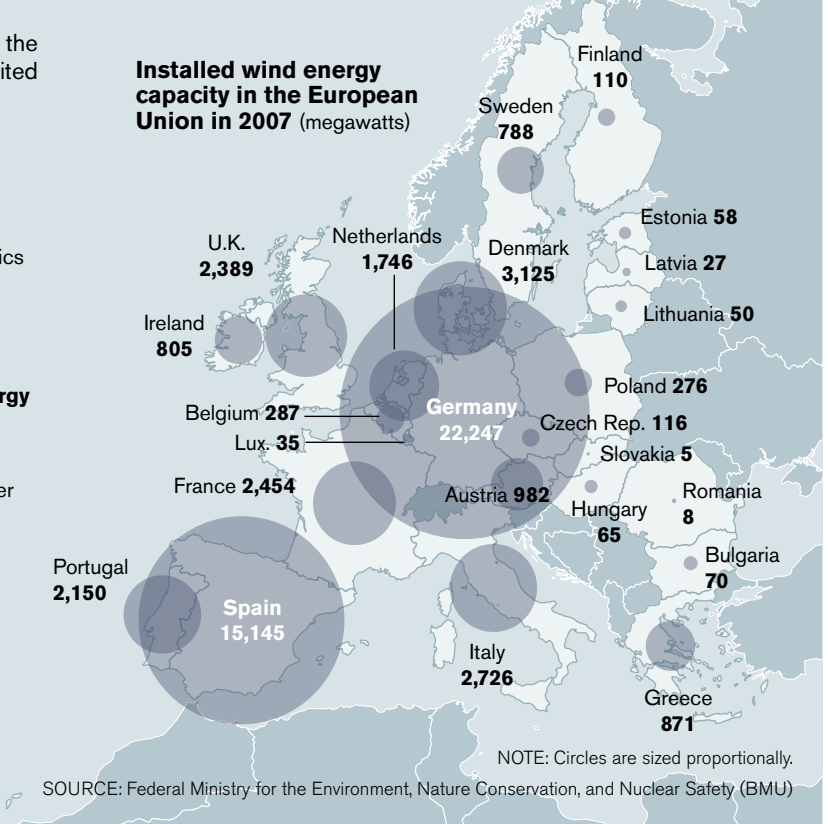
Installed capacity for electricity generation from renewable-energy sources in Germany



Renewable-energy jobs in Germany (2007)



Installed wind energy capacity in the European Union in 2007 (megawatts)



tem with both renewable- and nonrenewable-energy sources.

And the electrical grid could still prove a choke point. The German grid is not as antiquated as that in the U.S., Schreurs said, but it is not designed for the surges that renewable energy feeds into the system. More important, complained Reinhard Butikofer, the former head of the German Green Party, the electricity grid is owned by the coal and nuclear power producers, which have no incentive to invest in a “smart grid” that is more compatible with renewable-energy sources.

Fell said, “Achieving a competitive market in the power sector must start by bringing in new actors in order to break the anti-competitive dominance of the market by the major groups.”

Renewables' Limitations

Notwithstanding the explosive growth in renewable-energy production here, Germany's experience with green power holds some sobering lessons about the limits of this resource.

Renewables account for only about a tenth of Germany's energy consumption, including transportation, heating, and cooling. Petroleum still provides a third of the country's energy use; coal, a quarter. By 2020, analysts expect that renewables will be only about 20 percent of the total. Wind, solar, and biogas can be an important supplement to traditional power sources, but in the short run, they will not replace them.

Photovoltaics are emblematic of these limitations. Solar panels are particularly inefficient in converting sunlight into electricity and are still quite costly compared with other sources of energy. Thus, for the foreseeable future, solar is likely to remain a niche producer of peak power.

A single First Solar module can provide enough electricity, at high noon on a sunny day, to power only one 75-watt lightbulb. Thus, a vast array of panels is needed to provide significant power. Moreover, a First Solar panel converts into electricity only 11 percent of the sunlight that strikes it. Company executives think they can increase that efficiency by several percentage points. Still, conventional power-generating facilities that convert the energy in coal and natural gas into usable power attain up to 40 percent efficiency.

There is also danger in a nation's becoming too reliant on any single form of power. Renewable energy comes in spurts on windy and sunny days, and no efficient way has been found to store it for later use. “Eventually, we will have to manage the renewable side,” Butikofer admitted. “The naive idea that if you build more windmills that is all you need is wrong.”



The surge in interest in green power here has mostly ignored the challenge of generating energy to heat and cool commercial and residential structures or to power the transportation sector, both of which are huge energy consumers. A recent law requires new German homes to meet 10 percent of their heating needs with renewable energy. But the requirement does not apply to the much larger number of buildings that are renovated each year. And after initially encouraging biofuels production, in 2006 the German government increased taxes on biodiesel, making it uncompetitive with traditional diesel. Sales have collapsed.

How Germany ultimately copes with these challenges will be shaped by its national elections in September. Most of the major parties now champion renewable energy in general and the feed-in tariff in particular. This has not always been the case, however.

The Christian Democrats, now led by Chancellor Angela Merkel, were originally against the tariff but came to support it because it created jobs for workers who build windmills and install photovoltaics; these are largely CDU voters. Similarly, the conservative Christian Social Union came aboard because the Bavarian farmers who are the party's backbone found they could make a tidy income by selling wind power.

The Free Democrats still oppose the feed-in tariff as too costly and as unnecessary regulatory interference in the market. As the third-largest party in Germany, with 16 percent of the vote in recent public opinion polls (triple its showing in the last national election), the FDP could hold the balance of power after the election. If it demands curtailing the feed-in tariff as the price of joining a governing coalition, Germany's renewable-energy future will be clouded.

No other major economy has responded to the threat of global warming more rapidly than Germany's. The country has curtailed its carbon footprint by dramatically increasing its reliance on renewable energy. In the process, it has created hundreds of thousands of green jobs.

This renewable-energy transformation is the product of policy choices. Foremost among them was the decision to subsidize the market for green energy by charging consumers more for electricity and then paying them something if they produce their own. The benefits of taking that approach, instead of simply using tax dollars to subsidize research, development, and the production of renewable technologies offer an invaluable lesson for the Obama administration as it pushes legislation to stimulate renewable-energy production and the creation of green jobs. ■

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