



WHARTON *on* Going Green



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Going Green

THE WORLDWIDE HUNGER FOR ENERGY, combined with the environmental threat from carbon-based energy sources, is creating an interesting—and finally profitable—intersection where investors and innovators could link up, particularly as energy prices headed into the stratosphere. With energy prices settling down, and the global financial crisis crippling economic growth, some believe that the push towards greener, renewable-energy projects is losing steam. But not all is doom and gloom, and a number of players big and small see a positive side to the energy scene today. A big challenge for investors, however, is separating truth from exaggeration regarding the benefits of alternative energy ideas. One place to look for solutions to all of these challenges is in Germany, which is quietly emerging as the worldwide leader in many green energy technologies and may become the epicenter of the world's next industrial revolution.



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A Trickle in the Pipeline:



Renewable-energy Ventures Scramble for Renewed Financing

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But it's not all doom and gloom. From Big Oil to renewable-energy startups, energy industry players at a recent Wharton Energy Conference reported that they were hustling to find a silver lining in today's challenging conditions.

Experts in renewable-energy sources, following the 2008 run-up in energy prices and the subsequent credit crisis, pointed out that tight credit conditions were making financing for new ventures scarce. Obtainable loans carried very restrictive covenants. Public companies were finding it nearly impossible to raise money by selling bonds or new shares of stock, and private-capital sources had shriveled as well.

According to Jason Hicks, managing director of Washington, DC-based Persimmon Tree Capital Management—which makes private investments in companies that develop renewable fuels, energy conservation systems and environmentally friendly technology—the values of privately held firms tend to adjust more slowly than those of public ones. With price drops lagging the falling market, his firm became very conservative about new investments in private companies. “It’s just going to take a while for the pricing to come down to where we feel comfortable making those investments,” said Hicks, who sat on a panel titled “Opportunities in the Global Power Industry.”

‘Volatility Is Our Friend’

Despite the difficulties, a number of conference speakers noted that energy volatility has underscored one of the chief benefits of wind, solar and geothermal energy: The fuel is free, making it easier for producers to plan, and it attracts customers who want steady prices. “Price security is valuable,” said Hicks. Because of this, investment in renewable energy, especially wind, will continue even if traditional fuels like oil and coal remain cheap, he predicted.

“Volatility is our friend,” argued Stephen Chazen, president and chief financial officer of Los Angeles-based Occidental Petroleum, the fourth-largest U.S. oil and gas company. Chazen said that oil firms try to acquire resources like oil fields when prices are low, and exploit them when prices are high. “When [the market] is volatile, people are forced to sell out. That’s where you get these better deals ... I had no idea what to do with \$145 oil,”

he added, referring to oil's peak per-barrel price last summer. At that price, owners of oil reserves will not sell, at least not at affordable prices, he noted, but good opportunities are easier to come by with prices at \$40 to \$50. "If it were \$145 per barrel forever, it would be a crummy business."

But falling oil prices are not as damaging to the oil producers as many outsiders assume, Chazen said, since the single biggest production cost is the energy used for pumping and other purposes. With the "lifting cost" down to around \$10 a barrel, oil could be profitable at \$20 a barrel, although that price would be too low to encourage much new investment in the industry, he noted.

In the summer of 2008, high prices for fossil fuels spurred interest in renewable energy, such as electricity produced from wind, solar panels and geothermal sources. Wind is growing fastest, since turbines require less government subsidy than other renewables to be financially viable. But most renewable sources need some subsidy, which typically comes via tax benefits, and renewable-energy providers generally need large amounts of outside capital, since many firms are not mature or profitable enough to generate cash to fund expansion on their own.

Amid the financial and economic crisis, financing is tougher to get, according to Jacob Susman, founder of OwnEnergy, a wind farm developer headquartered in Brooklyn, NY. "Entrepreneurship in energy is ... always going to be a little different than in some other sectors" because of this need to link with big sources of capital.

Solar and wind firms that do not earn

enough to use all the tax benefits they qualify for can sell the excess "tax equity" to investors. But because of the financial crisis, many of the big buyers—such as investment banks—have pulled back or withdrawn from this market. Other funding sources have tightened as well.

In recent years, 18 or 19 well-capitalized players have dominated this market; now

Still, several speakers saw an upside to the financing downturn.

"There's a potentially very positive outcome, which is recalibrating the industry's growth," Susman said, adding that the federal government may step in to help with financing as it looks for ways to stimulate the economy. Washington could expand financing options for

renewable energy by modifying the tax-equity legislation to make it easier for ordinary investors to participate, he said.

Carson agreed that the energy market downturn has spurred some valuable rethinking. Energy experts are now taking a more rigorous look at purported energy and environmental savings from renewables, trying to include all the costs and pollution that go into production, transportation and use. It is no longer a given, for example, that America's oil-dependence and pollution problems can be solved by making ethanol from corn, Carson pointed out. "We're all doing a collective, 'What were we thinking?' on that." In another example, he pointed to a project in The Netherlands to make electricity from renewable wood pellets. While it sounded environmentally responsible, the wood came from pine trees in the U.S. state of

Georgia, and the pellets traveled by train, ship and truck, each burning fossil fuels. "That was five or six steps too complicated for me."

A period of rethinking also could help dispel some of the myths about renewables, clearing the way for smarter investment, Susman said. "There's somewhat of a perception that investing in technology is ... going to drive all the

"Price security is valuable. Because of this, investment in renewable energy, especially wind, will continue even if traditional fuels like oil and coal remain cheap."

Jason Hicks, Managing Director,
Persimmon Tree Capital Management



there are just five, according to John A. Carson, senior vice president in finance at Terra-Gen Power, a developer of geothermal, wind and solar power with offices in Reno, NV., and New York. "That market has broken up over the past few months," he noted, citing withdrawals by Wachovia Bank, Morgan Stanley and other firms.

changes that we see toward renewables in coming years. In fact, consumers will be the driving force, as they demand renewables and legislation to support these energy sources.” Unfortunately, he added, economic worries are now cutting into consumers’ willingness to pay a premium to go green.

A second myth: Startup firms will lead the charge to renewable energy. Such firms will indeed play a key role, “but we also need people sitting at Morgan Stanley, at Chevron and at the Department of Energy,” Susman suggested. Without these players, the industry will not get the regulatory and financial support it will need.

Finally, he noted, many people mistakenly believe money has been falling off the trees to support development of renewable energy sources. This wasn’t true even before the economic crisis. Since most renewable energy cannot currently be produced as cheaply as fossil fuels, the industry’s growth will depend on consumers paying higher prices. Susman said he prefers a system, such as a carbon tax that would raise the cost of coal, oil and other environmentally damaging fuels, so renewables would be more competitive. “We, as consumers, need to start stepping up and paying for the environmental degradation that those forms of energy caused.”

Spare Room in the Bowling Alley

While public attention tends to dwell on the big stories—such as the collapse in oil prices or the shriveling of financing—conference speakers noted that energy firms are extremely diverse, and firms that specialize in energy investing continue to find opportunities that look promising even in tough times.

Paul Holland, managing director of Foundation Capital, a venture capital firm in Menlo Park, CA., that has backed numerous clean-technology firms, said Foundation was an early investor in Silver Spring Networks, which has products such as smart electric meters that use the Internet to allow utilities and their customers to consume electricity more efficiently. In its early days, Silver Spring operated in space rented from a bowling alley. Foundation, unable to find other investors, wrote a string of million-dollar checks on faith in the firm’s long-term future. Now, Silver Spring, based in Redwood City, CA., boasts major customers such as Florida Power & Light. “If there’s a message in this, it’s that you never know,” says Holland.

Experienced energy investors can also nudge young firms into new, potentially more profitable directions, said William D. Lese, managing director of Braemar Energy Ventures, a New York venture capital company that invests in energy technology firms. Braemar is working with a firm that aims to improve capacitors (devices that store energy). Because the company had trouble getting funding, it wanted to move quickly to produce small capacitors for sale in the Far East. But with Braemar’s help, it refocused on developing large devices that could be of far greater value even if they took longer to bring to market.

Holland and Lese participated in the conference’s “Investing in Clean Technology” panel, which covered diverse approaches that investment firms use to decide which startups to back. Raj Pai, managing director of Global Environment Fund (GEF), a private equity firm in Chevy Chase, MD., which invests in environmental and clean energy

companies, said GEF tends to focus less on game-changing technology than on solid business prospects. “We tend not to make technology bets so much as market bets,” he noted. GEF likes firms that are within a few years of surviving without borrowing.

Advanced Technology Ventures, which invests in Internet technology, healthcare and clean technology, focuses on firms that will soon be able to survive without government subsidy. Vice president Dharmesh Thakker said the firm, which has offices in Palo Alto, CA., and Waltham, MA., seeks to moderate risk by investing in firms with products or services that have a variety of applications for multiple markets.

According to several panelists, it is unwise for anyone in the energy industry to pin their hopes on high fuel prices. They do not use the derivatives markets to hedge against fuel price changes, but use other strategies to counter that risk. Lese’s firm invested in a company with a new technology useful in the cosmetics industry as well as the oil industry, giving it a kind of diversification. Utilities are on a “jihad of efficiency,” Holland said, so that products like smart electric meters should continue to sell even if fuel prices fall.

What will fuel prices do? Pai predicted oil could climb to \$80 a barrel this year; Holland said \$45, with other panelists predicting a similar range between \$45 and \$80 but none confident that any prediction would hold. “It’s a commodity,” Holland said. “It goes up and it goes down. Don’t base your career on the price of a commodity.” 💡

Green Technology Offers Opportunities for Discerning Investors and Entrepreneurs



Most energy experts agree that global warming is a serious threat, and they also agree that green technology has the power to fundamentally reshape how business gets done. But at this early stage, these experts—including investors—are finding it hard to separate truth from exaggeration when it comes to the benefits that green technology can offer. That was the consensus of industry speakers at the recent Wharton Energy Conference who participated in panels on renewable energy, oil and gas, energy finance and power.

At the moment, an aura of uncertainty surrounds the electric-power industry, according to several panelists who noted that old-line players, like the investor-owned utilities, are cautiously awaiting signals from politicians, regulators and even the public. Companies want to know whether the United States will adopt a so-called “cap-and-trade”

system to govern carbon emissions or a more straightforward carbon tax. In addition, they are wary of betting too heavily on any particular new technology, such as wind or solar, until they know that it will be broadly supported.

Yet at the same time, venture capitalists and new investors like Google are eagerly

pouring money into just about any startup that brands itself as pursuing “clean tech” or renewable energy. As a result, technologies that remain unproven on a massive scale are seeing huge run-ups in value. Stock in U.S.-based First Solar, for example, has returned nearly 600% over the last 12 months.

“We are not in a bubble [for renewables], but there are valuation issues,” said Michael Liebreich, chief executive of New Energy Finance, an energy consultancy. “There is \$100 billion of new money that has been invested in clean energy across all sectors and countries. What you have is enormous inflation of asset prices, which is driven by that liquidity, not by fundamentals. In the fear-and-greed balance of capitalism, we’re definitely in the greed phase.”

“People are so giddy over solar power’s potential that they are making investments that simply don’t add up,” Liebreich said. Germany, a country with

relatively weak sun, has committed to producing electricity via solar. But solar power, which remains costly compared with traditional sources, works best in places with abundant sunshine and a weak transmission infrastructure for electricity, like Africa and much of Asia. Germany is “is papering over agricultural land with solar,” he said. “It’s absurd. You have a situation where 90% of the capacity of rapidly growing solar-cell manufacturing is going into Germany.”

Some solar proponents prefer to see shortcomings in the resource as manageable. Solar, for example, is intermittent—it only works when the sun is shining—and in some parts of the world produces far more power during the summer than the winter. Only what Liebreich called a “portfolio approach” that includes several sources of power—such as solar, wind and nuclear—will cover all of the world’s power demand while also stemming carbon emissions.

The ‘Saudi Arabia of Wind’

Despite the importance of wind and nuclear power, both of those sectors face short-term obstacles, at least in the United States, conference panelists noted.

Consider wind, said Tim Rosenzweig, chief financial officer for UPC Wind in Boston. In many ways, it’s ideal for the United States, which has lots of open space and, in some regions, famously strong breezes. “The Dakotas have been called “The Saudi Arabia of Wind,” he noted.

The trouble is, the best areas for situating wind turbines—the big bladed towers that look like aircraft propellers without the plane—and thus producing power are far from big cities. And at present, adequate infrastructure doesn’t exist to move the wind-generated electricity to the millions of people in the Chicago region, much less to people on the East and West coasts.

Yet putting the turbines closer to crowded urban corridors has proved thorny, he pointed out. Companies face the classic NIMBY (“Not in My Backyard”) dilemma. Many people like the idea of wind power but don’t want to look out their windows and see the turbines. Cape Wind, a wind farm off Cape Cod that has been the subject of national media attention, is a prominent example of a project that has

dealt with NIMBY issues. In the case of Cape Wind, organized residents—including Senator Ted Kennedy—lobbied against it on aesthetic grounds, among others. In light of this reality, “we are now looking at Northern Maine, potato

“I’d be happy to get rid of every single subsidy for renewable energy if we had a carbon tax that priced emissions at appropriate levels and then let the markets decide.”

Barney Rush,
Chief Executive,
H2Gen Innovations



country,” Rosenzweig said. “We are seeking opportunities where communities will embrace wind, and it can create [needed] jobs.”

Placing turbines even farther offshore than the Cape Wind Project—that is, out of sight—could sidestep the sort of opposition Kennedy and others had voiced. But at the moment, that’s not practical. “The technology isn’t ready for

prime time,” Rosenzweig noted. “The cost to install offshore wind is very high; it’s much more expensive to maintain and the wind isn’t that much better.” The potential additional revenues simply don’t offset the costs.

In the short term, wind-power generators also face shortages of turbines. Most turbines are produced in Europe, which embraced wind power earlier than the U.S. With the current weakness of the U.S. dollar, they are too expensive to install here. “Turbine prices are up more than 60% over the last three years,” he said.

A \$350 Billion Investment

Nuclear, for its part, is a workhorse technology, already providing about 20% of America’s electricity. (Nuclear reactors produce about 80% of the electricity in France.) But a U.S. utility hasn’t built a new nuclear power plant in decades because of high construction costs and public opposition. People grew wary of nuclear in the wake of the accidents at Three Mile Island, near Harrisburg, PA., and Chernobyl in the Ukraine. No one was harmed when the core of the Three Mile Island reactor melted down in 1979, but hundreds died in 1986 after the Chernobyl plant exploded. The disaster spewed radiation throughout Europe and forced the resettlement of 400,000 people who lived nearby.

Today, a nuclear reactor still operates on Three Mile Island; it’s the sibling to the one that malfunctioned three decades ago. It is run by Chicago-based Exelon, the leading U.S. producer of nuclear power.

Because of the concerns about global warming, utilities are showing a renewed interest in constructing nuclear plants. They are beginning to submit applications for new facilities and seeking regulatory guidance on how to proceed. None of them wants to move too aggressively because of concerns about red tape, potential protests from the public, and thus escalating costs. “Cost overruns on nuclear plants almost bankrupted investor-owned utilities in the 1970s and 1980s,” pointed out Mac MacFarland, vice president for corporate development at Exelon.

Even so, companies are laying plans so that they will be ready to proceed with construction once they get the assurances they need. Exelon, for

example, is preparing to file an application for a reactor in Texas, MacFarland noted. Assuming that it moves ahead, it would be a huge financial commitment, so much so that MacFarland wondered how many other companies could afford to follow his firm's lead. "The equity component alone would be 6% of our market capitalization, and we're the biggest company in the industry. We are twice as big as the next largest."

Even without building new nuclear plants, the traditional power industry faces huge financial burdens. "There will need to be \$350 billion invested in [power] generation over the next decade," MacFarland said. "Transmission represents another \$150 billion of needed investment—the distribution infrastructure in our cities has really deteriorated. Environmental retrofits on existing plants are going to cost another \$50 billion, and that doesn't include carbon capture. Efficiency investments are going to be another \$50 billion." For companies to carry these costs, they are going to have to bulk up by merging. "A consolidation will happen in the industry," MacFarland predicted. "It has to."

For the moment, many utilities are reluctant to move forward on any sort of big investment because of the lack of clarity on whether they will face a carbon tax or a cap-and-trade system, several conference panelists pointed out.

A cap-and-trade system limits the total emissions of a pollutant and then gives companies permits to release a certain amount (say, in this case, one ton of carbon per permit). Regulators then gradually reduce the number of permits, forcing companies to cut overall pollution. Meanwhile, firms can trade their permits. Efficient operators—those that don't use up all of their emission permits—can sell their unused ones to less efficient firms. This creates an incentive for the efficient firms to keep pushing down their emissions (thus earning extra permits to sell) while allowing breathing room for less efficient outfits that can't reach

emissions targets. The less efficient players can weigh whether they should invest heavily in lowering their emissions or buy someone else's excess permits. That lets the market decide where pollution cuts get made.

NO_x and SO_x

In 1990, under the Clean Air Act, the United States adopted a cap-and-trade system for power-plant emissions like nitrogen and sulfur oxides (NO_x and SO_x). "NO_x and SO_x have been reduced by 40%," MacFarland said. "Market forces did that. You had a lot of low-hanging fruit, and we were able to address those with scrubbers and low-NO_x burners."

The practical effect of a carbon tax or a cap-and-trade system is the same: Both create a financial incentive to clean up pollution. Politicians tend to prefer the cap-and-trade approach because it doesn't involve levying a new tax, but, in either system, the costs will be passed on in the form of higher power prices. "A lot of people talk about cap-and-trade like it's a solution to the dilemma that we find ourselves in," said Jane Sadowsky of Evercore Partners, an investment banking firm. "But the costs of a cap-and-trade system will be borne by the consumer, too."

Whichever method politicians choose, they need to do so soon, said Parker Weil, managing director for the Americas power group at Merrill Lynch. "The government's mistake is that it's not providing clear-cut price signals. Gas should be more expensive, and coal should be more expensive."

Barney Rush, chief executive of H2Gen Innovations in Alexandria, VA., agreed, pointing out that, in some ways, a tax would level the playing field between dirty power sources, like coal and oil, and clean ones like solar, wind and—his company's specialty—hydrogen. At present, some commentators criticize clean technologies because they depend on government subsidies. "I'd be happy to get rid of every single subsidy for

renewable energy if we had a carbon tax that priced emissions at appropriate levels and then let the markets decide," he said. "A broad, across-the-board way to say that there are costs to carbon emissions would be with a tax."

That doesn't mean that all renewable technologies would succeed; some might remain impractical for widespread use. Hydrogen, which Rush's company is trying to exploit, has the advantage of being ubiquitous and usable in cars and trucks, he pointed out.

Rush noted the often-heard comment that "hydrogen has a reputation as being tomorrow's technology—and it always will be." A few years ago, it got a lot of buzz when U.S. automaker General Motors began to evangelize about its plans to make hydrogen-powered cars. But those plans have been slow to materialize, and that has soured some people on hydrogen's potential. "In the last couple of years, people [haven't wanted to] talk about hydrogen," he said. It is true that "developing fuel-cell technology takes a long time and a lot of effort," Rush noted, but the technology, in both transportation and industrial applications, continues to advance. Honda, for example, will begin leasing hydrogen-powered cars in California this year for \$600 a month. And hydrogen-powered forklift trucks are already operating in some warehouses.

Rush argued that hydrogen cars must succeed. International trends—like the rapid development of India and China, with their combined populations of more than two billion people—leave little choice. "Within 20 or 30 years, the number of cars in China and India will be no different than what we expect here in America," he added. "If you look ahead to that kind of demand, the fuel isn't going to come from oil. It's going to have to come from other sources.

"We aren't going to transfer overnight to a carbon-free world," Rush said, "but there will be a transformation over the next 20 to 30 years. There's going to be a gradual lightening of carbon in the mix." 💡

Going Green:

Why Germany Has the Inside Track to Lead a New Industrial Revolution



This article looks at how the German government and individuals helped such companies as Enercon, the world's third-largest producer of wind generators, and Q-Cells, the world's largest producer of photovoltaic cells, reach their present position, and what their gains might mean for the country and the world.

Back in 2008, even as Americans argued over whether renewable energy is a fantasy, Germany generated 14.2% of its electrical power from renewable resources. Already a leading player in so-called clean technology—the mix of environmentally benign power generation and environmentally friendly technologies—Germany may become the epicenter of the world's next industrial revolution: the triumph of clean, cheap, sustainable electricity.

Bigger than Cars

At a time when most countries have hardly begun installing power-generating windmills, Germany has already installed 23,900 megawatts, making it the world's largest home of windmills per capita. Germany also has an installed base of 3,830 megawatts of photovoltaic cells,

making the country a world leader in solar power as well, despite its famously wet climate.

Already, renewable technologies provide some 170,000 jobs to the German economy. By 2020, some analysts estimate that clean technology, or “clean tech,” will be an even bigger industry in

Germany—and globally, an industry rivaling or exceeding IT in historical importance. Products are good enough already that the installed base of solar panels and windmills keeps climbing rapidly, and technological advances seem likely to accelerate that process.

Würth Solar of Marbech, for instance, is now at work on thin-film photovoltaic cells that can convert up to 12% of the sunlight they receive into energy, a technology that may prove to be lighter and cheaper to mass-produce than traditional photovoltaic cells. Nanotechnology researchers at the Fraunhofer Institute for Solar Energy Systems have invented a new kind of cell that has a much lower efficiency rate but, on the other hand, is simply a layer of dye which—in combination with some nano particles printed on the circuit—produces electricity.

The home market may be only the beginning. The European Union has challenged itself to generate 20% of its electricity from renewable sources by 2020. Solar itself may be just three or four years away from being truly cost-

competitive with other forms of power. According to a Piper Jaffray analyst, when solar power becomes competitive with conventional power, “demand becomes infinite.”

Origins of Clean Tech

Although parts of Germany have long been extremely industrial, more than 85% of the country is forested or farmed, and Germans have long cared about the environment. The country’s leadership in eco-friendly technologies stems from tough air and water pollution laws passed in the 1970s, which encouraged the development of advanced treatment systems and other “end of pipe” solutions, according to Klaus Rennings, senior researcher in environmental resource economics and environmental management for the Mannheim-based Centre for European Economic Research.

More recently, some trace the growth of Germany’s environmental conscience to an event that happened beyond its borders: the meltdown at Chernobyl, Ukraine, in 1986. The disaster reportedly had a profound effect on Germans’ environmental consciousness. Living downwind from Chernobyl, Germany received some of the wide plume of radioactive fall-out that fanned out all over northern Europe. Direct health effects have apparently been minimal in Europe, but the incident led many Germans to feel that the environment was not only in a precarious condition, but that it mattered.

The question of a clean environment was not merely aesthetic: many Germans began to feel that permitting the environment to degrade any further might lead to problems that could directly affect their own health and safety. One measure of this: both large corporations, such as Siemens, and unions favor strong conservation and alternative energy measures, according to Wharton management professor Mauro Guillen.

Germany’s Green Party benefited from the new level of concern and began to win more state elections. Between 1998 and 2005, the party shared power at the federal level with the Social Democratic Party in a so-called red/green alliance. With their new clout, the Green Party pushed through major changes to the government’s energy and recycling policies. The Greens lobbied for the

creation of a number of incentives to drive environmentally friendly industrial development and alternative energy. Today, many of these companies are coming of age. Some foreign policymakers are looking at the way the governmental mandates were implemented for some clues about how to jumpstart their own clean-tech sector.

Nor has that pressure ever gone away. Just as the hyperinflation of the Weimar Republic left many Germans suspicious of credit for generations, so the experience of being downwind from a large nuclear accident seems to have made them nervous about their environment. Susanne Shields, director of the German culture and language program of Wharton’s Lauder Institute, says that in their tours of German companies, her students are struck by the stress so many companies place on their own green agenda. “That’s something they are usually impressed by,” she says.

“Many firms have made a major commitment to develop alternative energy sources,” agrees Jerry Wind, a professor of marketing at Wharton. “Other companies who are primarily energy consumers have a similar commitment.” Berlin alone, he notes, now has more than 30 research institutes and 1,000 companies dedicated to alternative energy production or green development.

The biggest reason the alternative energy sector has grown so quickly, in the view of some experts, is that the government created some simple but generous incentives for companies to produce electricity through means such as solar power or wind. By requiring electric utilities to buy power produced by the alternative producers at a set price, the government effectively guarantees a long-term set return for alternative energy production.

Setting a Floor Price

The advantage of this approach, as opposed to the tax credit style of incentives more familiar to U.S. business, is that it gives a free energy producer the ability to project business growth outwards over a number of years. Rather than suffer the slings and arrows of outrageous commodity prices—profiting when fuel prices are high and losing revenues when they fall—the German

approach provides a floor price that makes it possible for alternative energy businesses to plan for the future. This is especially true in the case of wind power, according to Guillen. The reason: There is no cost for the “fuel,” a fixed price for power makes it easy for planners to project the profitability of a plant—a task almost impossible in a highly price-volatile market.

This approach also ensures that developers of wind farms are companies that are genuinely interested in power development, which is not always the case in the U.S. “The wind farms in the U.S. get sold to companies not necessarily in the energy sector but companies that have large profits,” Guillen notes. He argues that while subsidies always lead to economic distortions, the tax credit approach leads to even greater distortions in this area.

Government regulation has helped the industry in other ways as well, according to Rennings, the environmental economics researcher. Rennings argues that Germany’s leading-edge regulations against pollution have led German companies to develop expertise and technology that they can sell to businesses in countries that are just adopting tougher regulations. First, Europe as a whole began emulating Germany, and now China is emulating Europe.

A third reason clean tech is succeeding in Germany, experts say, is because it plays into the country’s traditional strengths in engineering and physical technologies. Unlike, for example, information technology, clean tech depends on Germany’s traditional command of chemistry, physics and precision instruments.

The success may also be due to the fact that saving energy appeals to Germans’ traditionally thrifty nature. The idea that wind, for example, is just there for the taking is somehow especially appealing to Germans. “It’s not the land of plenty,” says Saikat Chaudhuri, a professor of management at Wharton. “You don’t have lots of space. You use what you have in the most efficient form.”

Guillen notes, for instance, that Germans have been told that if they are going to be stopped in traffic for more than a minute and a half, they should turn off their car

engines in order to save fuel. “They actually do it,” he says. “Just imagine!”

This thriftiness has been an important part of public support for environmental measures in Germany. Scholars say that even in the early 1970s, Germans saw higher automobile exhaust standards not as an added cost, but as a way to save fuel. They also considered pollution as a general burden on the land, a dirtying of the land (*Verschmutzung*) rather than an observed damage, as the British, for example, tended to see it.

problems remain, for one thing. It’s easy for legislators to mandate that utilities accept energy produced, say, from a windmill, but more difficult for engineers to design electrical systems that can accommodate the wide swings in power produced by some alternative sources of energy.

Wind turbines, for example, generate much more power in a high wind. While overall, clean energy provides about 9% of the total energy in Germany, according to various sources, wind speed can vary

executive education programs, contends that what is going on in Germany and other places in Europe right now is not just the creation of cleaner ways to generate electricity, but the foundation of a third industrial revolution.

Rifkin claims that just as in the 19th century, when the invention of the internal combustion engine combined with electrical communications to create an entirely new world of production and transportation, so now the birth of satellite communications and the Internet

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In other respects too, the clean tech sector seems to owe something to the market in which it has grown. One of the most notable qualities is the absence of a stock mania around it. Although for at least the last 40 years, Germans have felt optimistic that environmental protection, technical progress and economic growth aren’t mutually exclusive goals, there also seems to be a sense that this is the work not of months or years, as sometimes felt the case during the Internet bubble, but of decades.

And it will remain a get-rich-slow business, predicts Jürgen Habichler, head of Mountain Cleantech, a firm that specializes in ecological investments—not quite the outcome most venture capitalists seek. “Clean tech—it’s a different market. We deal with different people, a different mindset compared to the Googles and Microsofts of this world,” he says.

The truth is that as promising as clean tech seems, a lot of hard work lies ahead, both technical and economic. Logistical

a great deal. In Spain, for instance, the amount generated varies from 15% to 25% of the total electricity generated, depending on the wind. For a utility, this can pose a problem, since it’s not always easy to shut down a coal-fired power plant and then restart it a day later when the wind dies down, Guillen says.

For another, there are economic concerns. First, and most immediately, the price of hydrocarbons has fallen by about two thirds since last summer. Second, as long as renewable energy depends on government subsidies, the industry is vulnerable to political reversal. How—and when—the industry should be weaned is a cause for ongoing debate among economists, according to experts.

When Green Grows Up

Despite the technical challenges, some business scholars believe that the green boom is only beginning and will eventually be one of the great technological shifts of our age. Jeremy Rifkin, a futurist and teacher in Wharton’s

has prepared the way for new power generation technologies based on distributed rather than centralized power generation.

In contrast to many forecasters, Rifkin argues that these new technologies won’t mean getting along with less power, just producing it in different and more efficient ways. “Just as second-generation information systems grid technologies allow businesses to connect thousands of desktop computers, creating far more distributed computing power than even the most powerful centralized computers that exist, millions of local producers of renewable energy ... can potentially produce far more distributed power than the older centralized forms of energy—oil, coal, natural gas and nuclear—that we currently rely on,” he said in a lecture last year.

Wind agrees that something big is going on in Germany right now in terms of alternative energy and green development. “They’re doing it,” he says. “The reality is, they’re moving forward.” 💡