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BEYOND FOSSIL FUELS

Portugal Gives Itself a Clean-Energy Makeover

Rupert Eden for The New York Times

A wind farm at Barão de São João, south of Lisbon.

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LISBON — Five years ago, the leaders of this sun-scorched, wind-swept nation made a bet: To reduce Portugal's dependence on imported fossil fuels, they embarked on an array of ambitious renewable energy projects — primarily harnessing the country's wind and hydropower, but also its sunlight and ocean waves.

Today, Lisbon's trendy bars, Porto's factories and the Algarve's glamorous resorts are powered substantially by clean energy. Nearly 45 percent of the electricity in Portugal's grid will come from renewable sources this year, up from 17 percent just five years ago.

Land-based wind power — this year deemed "potentially competitive" with fossil fuels by the International Energy Agency in Paris — has expanded sevenfold in that time. And Portugal expects in 2011 to become the first country to inaugurate a national network of charging stations for electric cars.

"I've seen all the smiles — you know: It's a good dream. It can't compete. It's too expensive," said Prime Minister José Sócrates, recalling the way Silvio Berlusconi, the Italian prime minister, mockingly offered to build him an electric Ferrari. Mr. Sócrates added, "The experience of Portugal shows that it is possible to make these changes in a very short time."

The oil spill in the Gulf of Mexico has renewed questions about the risks and unpredictable costs of America's unremitting dependence on fossil fuels. President Obama has seized on the opportunity to promote his goal of having 20 to 25 percent of America's electricity produced from renewable sources by 2025.

While Portugal's experience shows that rapid progress is achievable, it also highlights the price of such a transition. Portuguese households have long paid about twice what Americans pay for electricity, and prices have risen 15 percent in the last five years, probably partly because of the renewable energy program, the International Energy Agency says.

Although a 2009 report by the agency called Portugal's renewable energy transition a "remarkable success," it added, "It is not fully clear that their costs, both financial and economic, as well as their impact on final consumer energy prices, are well understood and appreciated."

Indeed, complaints about rising electricity rates are a mainstay of pensioners' gossip here. Mr. Sócrates, who after a landslide victory in 2005 pushed through the major elements of the energy makeover over the objections of the country's fossil fuel industry, survived last year's election only as the leader of a weak coalition.

"You cannot imagine the pressure we suffered that first year," said Manuel Pinho, Portugal's minister of economy and innovation from 2005 until last year, who largely masterminded the transition, adding, "Politicians must take tough decisions."

Still, aggressive national policies to accelerate renewable energy use are succeeding in Portugal and some other countries, according to a recent report by IHS Emerging Energy Research of Cambridge, Mass., a leading energy consulting firm. By 2025, the report projected, Ireland, Denmark and Britain will also get 40 percent or more of their electricity from renewable sources; if power from large-scale hydroelectric dams, an older type of renewable energy, is included, countries like Canada and Brazil join the list.

The United States, which last year generated less than 5 percent of its power from newer forms of renewable energy, will lag behind at 16 percent (or just over 20 percent, including hydroelectric power), according to IHS.

To force Portugal's energy transition, Mr. Sócrates's government restructured and privatized former state energy utilities to create a grid better suited to renewable power sources. To lure private companies into Portugal's new market, the government gave them contracts locking in a stable price for 15 years — a subsidy that varied by technology and was initially high but decreased with each new contract round.

Compared with the United States, European countries have powerful incentives to pursue renewable energy. Many, like Portugal, have little fossil fuel of their own, and the European Union's emissions trading system discourages fossil fuel use by requiring industry to essentially pay for excessive carbon dioxide emissions.

Portugal was well poised to be a guinea pig because it has large untapped resources of wind and river power, the two most cost-effective renewable sources. Government officials say the energy transformation required no increase in taxes or public debt, precisely because the new sources of electricity, which require no fuel and produce no emissions, replaced electricity previously produced by buying and burning

imported natural gas, coal and oil. By 2014 the renewable energy program will allow Portugal to fully close at least two conventional power plants and reduce the operation of others.

“So far the program has placed no stress on the national budget” and has not created government debt, said Shinji Fujino, head of the International Energy Agency’s country study division.

If the United States is to catch up to countries like Portugal, energy experts say, it must overcome obstacles like a fragmented, outdated energy grid poorly suited to renewable energy; a historic reliance on plentiful and cheap supplies of fossil fuels, especially coal; powerful oil and coal industries that often oppose incentives for renewable development; and energy policy that is heavily influenced by individual states.

The relative costs of an energy transition would inevitably be higher in the United States than in Portugal. But as the expense of renewable power drops, an increasing number of countries see such a shift as worthwhile, said Alex Klein, research director, clean and renewable power generation, at IHS.

“The cost gap will close in the next decade, but what you get right away is an energy supply that is domestically controlled and safer,” Mr. Klein said.

Necessity Drives Change

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Portugal’s venture was driven by necessity. With a rising standard of living and no fossil fuel of its own, the cost of energy imports — principally oil and gas — doubled in the last decade, accounting for 50 percent of the country’s trade deficit, and was highly volatile. The oil went to fuel cars, the gas mainly to electricity. Unlike the United States, Portugal never depended heavily on coal for electricity generation because close and reliable sources of natural gas were available in North Africa, and Europe’s carbon trading system could make coal costly.

Portugal is now on track to reach its goal of using domestically produced renewable energy, including large-scale hydropower, for 60 percent of its electricity and 31 percent of its total energy needs by 2020. (Total energy needs include purposes other than generating electricity, like heating homes and powering cars.)

In making the shift, Portugal has overcome longstanding concerns about reliability and high cost. The lights go on in Lisbon even when the wind dies down at the vast two-year-old Alto Minho wind farm. The country’s electricity production costs and consumer electricity rates — including the premium prices paid for power from renewable sources — are about average for Europe, but still higher than those in China or the United States, countries that rely on cheap coal.

Portugal says it has kept costs down by focusing heavily on the cheapest forms of renewable energy — wind and hydropower — and ratcheting down the premium prices it pays to lure companies to build new plants.

While the government estimates that the total investment in revamping Portugal's energy structure will be about 16.3 billion euros, or $22 billion, that cost is borne by the private companies that operate the grid and the renewable plants and is reflected in consumers' electricity rates. The companies' payback comes from the 15 years of guaranteed wholesale electricity rates promised by the government. Once the new infrastructure is completed, Mr. Pinho said, the system will cost about 1.7 billion euros ($2.3 billion) a year less to run than it formerly did, primarily by avoiding natural gas imports.

A smaller savings will come from carbon credits Portugal can sell under the European Union's carbon trading system: countries and industries that produce fewer emissions than allotted can sell permits to those that exceed their limits.

Mr. Fujino of the International Energy Agency said Portugal's calculations might be optimistic. But he noted that the country's transition had also created a valuable new industry: Last year, for the first time, it became a net power exporter, sending a small amount of electricity to Spain. Tens of thousands of Portuguese work in the field. Energias de Portugal, the country's largest energy company, owns wind farms in Iowa and Texas, through its American subsidiary, Horizon Wind Energy.

Redesigning the System

A nationwide supply of renewable power requires a grid that can move electricity from windy, sunny places to the cities.

But a decade ago in Portugal, as in many places in the United States today, power companies owned not only power generating plants, but also transmission lines. Those companies have little incentive to welcome new sources of renewable energy, which compete with their investment in fossil fuels. So in 2000, Portugal's first step was to separate making electricity from transporting it, through a mandatory purchase by the government of all transmission lines for electricity and gas at what were deemed fair market prices.

Those lines were then used to create the skeleton of what since 2007 has been a regulated and publicly traded company that operates the national electricity and natural gas networks.

Next, the government auctioned off contracts to private companies to build and operate wind and hydropower plants. Bidders were granted rights based on the government-guaranteed price they would accept for the energy they produced, as well as on their willingness to invest in Portugal's renewable economy, including jobs and other venture capital funds. Some of the winners were foreign companies. In the latest round of bidding, the price guaranteed for wind energy was in the range of the price paid for electricity generated by natural gas.

Such a drastic reorganization might be extremely difficult in the United States, where power companies have strong political sway and states decide whether to promote renewable energy. Colorado recently legislated that 30 percent of its energy must come from renewable sources by 2020, but neighboring Utah

has only weak voluntary goals. Coal states, like Kentucky and West Virginia, have relatively few policies to encourage alternative energies.

In Portugal, said Mr. Pinho, the former economy minister, who will join Columbia University's faculty, "the prime minister had an absolute majority."

"He was very strong, and everyone knew we would not step back," Mr. Pinho said.

A Flexible Network

Running a country using electricity derived from nature's highly unpredictable forces requires new technology and the juggling skills of a plate spinner. A wind farm that produces 200 megawatts one hour may produce only 5 megawatts a few hours later; the sun shines intermittently in many places; hydropower is plentiful in the rainy winter, but may be limited in summer.

Portugal's national energy transmission company, Redes Energéticas Nacionais or R.E.N., uses sophisticated modeling to predict weather, especially wind patterns, and computer programs to calculate energy from the various renewable-energy plants. Since the country's energy transition, the network has doubled the number of dispatchers who route energy to where it is needed.

"You need a lot of new skills. It's a real-time operation, and there are far more decisions to be made — every hour, every second," said Victor Baptista, director general of R.E.N. "The objective is to keep the system alive and avoid blackouts."

Like some American states, Portugal has for decades generated electricity from hydropower plants on its raging rivers. But new programs combine wind and water: Wind-driven turbines pump water uphill at night, the most blustery period; then the water flows downhill by day, generating electricity, when consumer demand is highest.

Denmark, another country that relies heavily on wind power, frequently imports electricity from its energy-rich neighbor Norway when the wind dies down; by comparison, Portugal's grid is relatively isolated, although R.E.N. has greatly increased its connection with Spain to allow for energy sharing.

Portugal's distribution system is also now a two-way street. Instead of just delivering electricity, it draws electricity from even the smallest generators, like rooftop solar panels. The government aggressively encourages such contributions by setting a premium price for those who buy rooftop-generated solar electricity. "To make this kind of system work, you have to make a lot of different kinds of deals at the same time," said Carlos Zorrinho, the secretary of state for energy and innovation.

To ensure a stable power base when the forces of nature shut down, the system needs to maintain a base of fossil fuel that can be fired up at will. Although Portugal's traditional power plants now operate many fewer hours than before, the country is also building some highly efficient natural gas plants.

To accommodate all this, Portugal needed new transmission lines from remote windy regions to urban centers. Portugal began modernizing its grid a decade ago. Accommodating a greater share of renewable power cost an additional 480 million euros, or about $637 million, an expense folded into electricity rates, according to R.E.N.

Last year, President Obama offered billions of dollars in grants to modernize the grid in the United States, but it is not clear that such a piecemeal effort will be adequate for renewable power. Widely diverse permitting procedures in different states and the fact that many private companies control local fragments of the grid make it hard to move power over long distances, for example, from windy Iowa to users in Atlanta. The American Society of Civil Engineers gave the United States' grid a "D+," commenting that it is "in urgent need of modernization."

"A real smart national grid would radically change our technology profile," said John Juech, vice president for policy analysis at Garten Rothkopf, a Washington consulting firm that focuses on energy. "But it will be very costly, and the political will may not be there."

A 2009 report commissioned by the Pew Center on Global Climate Change estimated that the United States would have to spend $3 billion to $4 billion a year for the next two decades to create a grid that could accommodate deriving 20 percent of electricity from wind power by 2030 — a 40 percent to 50 percent increase over current spending.

The Drawbacks

Energy experts consider Portugal's experiment a success. But there have been losers. Many environmentalists object to the government plans to double the amount of wind energy, saying lights and noise from turbines will interfere with birds' behavior. Conservation groups worry that new dams will destroy Portugal's cork-oak habitats.

Local companies complain that the government allowed large multinationals to displace them.

Until it became the site of the largest wind farm south of Lisbon, Barão de São João was a sleepy village on the blustery Alentejo Coast, home to farmers who tilled its roller coaster hills and holiday homeowners drawn to cheap land and idyllic views. Renewable energy has brought conflict.

"I know it's good for the country because it's clean energy and it's good for the landowners who got money, but it hasn't brought me any good," said José Cristino, 48, a burly farmer harvesting grain with a wind turbine's thrap-thrap-thrap in the background. "I look at these things day and night." He said 90 percent of the town's population had been opposed.

In Portugal, as in the United States, politicians have sold green energy programs to communities with promises of job creation. Locally, the effect has often proved limited. For example, more than five years ago, the isolated city of Moura became the site of Portugal's largest solar plant because it "gets the most

sun of anywhere in Europe and has lots of useless space," said José Maria Prazeres Pós-de-Mina, the mayor.

But while 400 people built the Moura plant, only 20 to 25 work there now, since gathering sunlight requires little human labor. Unemployment remains at 15 percent, the mayor said — though researchers, engineers and foreign delegations frequently visit the town's new solar research center.

Indeed, Portugal's engineers and companies are now global players. Portugal's EDP Renováveis, first listed on stock exchanges in 2008, is the third largest company in the world in wind-generated electricity output. This year, its Portuguese chief executive, Ana Maria Fernandes, signed contracts to sell electricity from its wind farm in Iowa to the Tennessee Valley Authority.

"Broadly, Europe has had great success in this area," said Mr. Juech, the analyst at Garten Rothkopf. "But that is the result of huge government support and intervention, and that raises questions about what happens when you have an economic crisis or political change; will these technologies still be sustainable?"

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