FALL 2015

ReVista

HARVARD REVIEW OF LATIN AMERICA

ENERGY

OIL, GAS AND BEYOND

Oil, Gas and Beyond

I was waiting for the ship to come in. In fact, so was everyone else in Nicaragua. Gas lines stretched around the block. The supermarket shelves were nearly bare. Lights went out again and again, plunging the country into frequent darkness. Telex machines couldn't work, and we reporters had to depend on the few places with generators to file our stories (for younger readers, this was pre-computer and smart phones). U.S. President Ronald Reagan had imposed a trade blockade on Nicaragua in May 1985. The Soviets were sending oil, dodging the blockade.

We reporters did what we always do: we reported on the ship's arrival. But we also breathed a collective sigh of relief. The arrival of the Soviet ship meant hot showers and light to read by.

Energy is intensely political. It shapes nations and trade and fuels wars and blockades. Energy, I discovered then, is also intensely personal. It shapes our lives on a daily basis. It's not only a matter of how we get around or whether we have enough food to eat; energy production affects the communities that receive it and those that produce it. It shapes attitudes toward gender and race and nationalism and identity. It pollutes the air and the rivers. It offers immense economic opportunities. Or it does both.

You might not think of Latin America and the Caribbean right away as a big energy producer or consumer. But Venezuela stands ninth in global oil production with gas reserves almost triple those of Canada. Three countries—Venezuela, Brazil, and Mexico—account for about 90 percent of the region's oil production. And Latin America and the Caribbean also have the capability to provide abundant alternative and renewable energy sources: wind, solar, geothermal and biomass, among others.

Perhaps because of my experience in Nicaragua, I started to conceive this issue in terms of meta-politics. And there is certainly a lot of politics related to energy in the region: the political upheaval of Brazil as a result of corruption scandals in the national oil company; the turmoil in oil-rich Venezuela; the impact of the semi-privatization of Mexico's oil industry; the targeting of Colombia's energy installations by guerrilla forces in a show of strength in the context of the ongoing peace process.

But then I thought back on how the arrival of oil had been experienced on a very local and personal level. I began to hear stories about the production of energy: what it felt like to grow up in an oil camp, how energy production affects indigenous women in one particular region, how local communities involve themselves in deciding what is done with oil.

And just recently Alvaro Jiménez, Nieman Affiliate at Harvard '09, happened to mention to me that he was starting a website "Crudo Transparente," a site that monitors the Colombian oil industry. Out of curiosity—and as a quick break from proofreading this issue—I took a peek. The site focuses on five areas: local economy, contracts and royalties, environment, security and human rights and ethnic conflicts. I was pleased to see how much overlap there was with the themes I had chosen for this issue of ReVista.

Although the website deals with only one country—Colombia—it felt like an affirmation of the focus I had chosen for this wide-ranging topic. Energy is political. Energy is personal. Energy matters.

June C. Erlick

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ReVista

Editor-in-Chief
June Carolyn Erlick

Copy Editor
Anita Safran

Publication Interns
Isabel Espinosa
Gabriela Farrell
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Design
Jane Simon Design

Printer
P+R Publications

Contact Us
1730 Cambridge Street
Cambridge, MA 02138
Telephone: 617-495-5428

Subscriptions, Back Copies and Comments
jerlick@fas.harvard.edu

Website
revista.drclas.harvard.edu

Facebook
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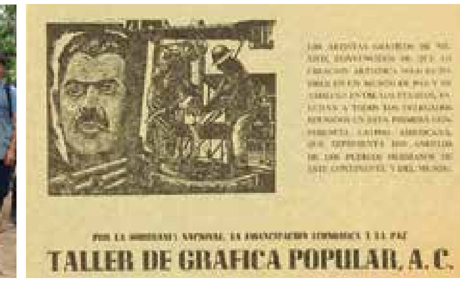

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The Power of the Brazilian Wind

How Wind Energy Became a Competitive Source

BY MAURICIO B. C. SALLES

BACK IN 1992, THE FIRST WIND TURBINE IN BRAzil was about to be installed. The chosen place was also one of the most beautiful places in the country (or even on earth). At that time, the archipelago of Fernando de Noronha had only diesel generators to power its electricity demand, due to the distance between the main island and the continent — 545 kilometers from Recife, the state capital of Pernambuco. The Brazilian electricity generation in that year relied about 92% on hydropower alone.

Almost a decade later, in 2001, a shortage of rain caused the water of the hydropower plant reservoirs to drop to very low levels. Brazil experienced an electricity crisis. As a result, the government recognized it needed to find a more flexible electricity generation model considering different primary sources of energy. Academic researchers had long recognized this fact, but it took a crisis to make the government see the importance of the possibilities they envisaged.

Wind power in the Valley of the Winds (Vale dos Ventos), Brazil.

PHOTO COURTESY OF ABEEólica

To cope with the problem, the use of other energy sources such as coal (3.4%), gas (3.2%), oil (4.9%), and nuclear (4.3%) increased, lowering the hydropower sources to 82%. Between 2000 and 2001, electricity use dropped almost 8% because of energy rationing. Nevertheless, in 2002 the demand started to grow again, as in any other developing country. Brazil needed new electricity generation capacity and was waiting for the first governmental action towards developing wind energy.

In 2004, the federal government began to encourage the use of other renewable sources such as wind, biomass and small hydroelectric plants (SHP) through the Program of Incentives for Alternative Electricity Sources (PRO INFA). By coincidence, that was the year that I defended a Master's Degree at the University of Campinas (UNICAMP) centered on Wind Power in Power Systems (and subsequently wrote one of the first theses on the subject in Brazil). Although PROINFA was not a very successful governmental program, it was certainly an important starting point to begin the new development of wind power in Brazil.

The first governmental auction that included wind power took place in 2009, just after my Ph.D. thesis defense at the University of São Paulo (USP). During the two previous years I spent at a research institute at RWTH Aachen University in Germany, I learned how far behind Brazilian wind power was: the discussions in Germany were about massive constructions of offshore wind farms located at the North and Baltic seas and many manufacturers competed to sell wind turbines in the market.

A few years later, a government agency (the Growth Acceleration Program-PAC) began to focus on the implementation of a wind industry in Brazil, offering incentives to launch new enterprises and produce domestic equipment. Due to high competition in bids for energy production, prices of wind energy have been gradually reduced, positively contributing to the diversification of energy sources. Almost 300 megawatts of wind power capacity were offered at the lowest price ever at a 2012 auction. The Brazilian federal government contracted all the energy that will be produced by those wind farms for a 20 years period. The megawatt per hour (MWh) of wind energy was purchased for less than US$48 (converted from Brazilian currency on 12/14/2012).

These wind-power projects started during a period of major technological evolution of wind turbines, which improved performance through better aerodynamics of the blades, advanced mechanical transmission speed systems (gearbox) and new control and operation strategies for turbines. As a result, wind power has become a very competitive source, generating energy at the same price or lower than hydropower plants. In the first semester of 2015, the use of wind power compared to hydropower was 4.2% and 62%, respectively. The production of wind power energy does not reach its maximum capacity on a constant basis because the wind does not blow all the time—it fluctuates according to the wind patterns. Nevertheless, these numbers show a considerable improvement.

Installed wind power grew from almost zero in 2004 to around 6.2 gigawatts (GW) in the first half of 2015. The Global Wind Energy Council's (GWEC) last reported ranking indicates that Brazil was in 10th place for worldwide installed capacity by December 2014. The expectation is that the country will move to 7th place by December 2015.

POTENTIAL OF INSTALLED CAPACITY

Brazil recently became one of the top five global investors in wind energy and renewable energy. The National Bank for Economic and Social Development (BNDES) ended the year 2014 with an equivalent of 2585 MW of installed capacity investment approvals for new wind power projects. According to the *Atlas of the Brazilian Wind Potential* (preliminary studies for turbine heights above 246 and 328 feet—73 and 100 meters, respectively), the Brazilian territory could have around 350 GW of installed capacity. The potential for offshore installations is not yet exactly known, but the National Institute for Space Research (INPE) concludes in a recent study that the offshore wind capacity potential for the Brazilian coast in water depth up to 328 feet (100 meters) is 600 GW. If you consider the current power capacity of the entire Brazilian energy system to be almost 137 GW, the wind potential is huge. Onshore and offshore together account for almost seven times the installed capacity of all sources and 154 times the already installed wind power capacity.

In this sense, the investments in the Northeast and southern regions are changing these areas of Brazil. More recently, new studies have pointed out a great wind potential also in the southeast in states such as São Paulo, Minas Gerais and Espírito Santo. With the current growth rate and a coastline of 5,600 miles, the country is among the world leaders in installed capacity. Because of the Northeast's strong and constant winds, several companies have been especially attracted to the region for both energy production and installation of the transmission lines. Rio Grande do Norte, for example, is the first Brazilian state to have more than two gigawatts of installed capacity with 80 wind farms: it has become Brazil's main producer of this type of electricity generation. However, the Northeast state of Bahia is constructing many wind power plants and will very soon reach first place.

WIND POWER GENERATION POTENTIAL

Wind power generation potential depends strongly on the wind speed and the efficiency of the turbines. Wind power installed capacity, however, is directly connected to job creation, as well as the selling and buying of equipment (we will get back to that). Brazil is said to have better geographic conditions than Europe and the United States, because the rate of change in wind speed and direction, as well as the turbulence levels, are lower. Wind farm revenue is strongly dependent on this issue and new R&D policies need to create incentives for the adaptation of the European and American designs to Brazilian wind characteristics.

Besides promoting sustainable energy development, the installation of wind farms brings several benefits to the population in areas around the power plants. As most of the farms are built in areas with a poor standard of living as measured by the Human Development Index (HDI), the entry of large business groups has brought new investments to these small cities. Compensatory measures (included in the permit) and social responsibility policies have been carried out to a large degree. Current social projects include free community courses, construction of recycling plants, advice to farmers, modernization of fishing boats and construction of tanks for water storage, among other initiatives that vary according to local needs.

The wind power sector creates many jobs (temporarily or permanently); how many depends directly on the installed capacity. Rural residents have been trained to work in the sector, and local demand for services and products has grown. According to the Brazilian Association of Wind Energy (ABEEólica), 120,000 directly related jobs had been created in Brazil by 2013. In 2014, 37,000 jobs were created and investments were expected to reach more than US$60 billion by 2018. Recently, Presidents Barack Obama and Dilma Roussef announced a joint agreement to generate 20% of electricity power through renewable resources by 2030 (excluding hydropower plants).

These jobs are mainly temporary during the construction of the wind farms, although some permanent jobs remain, mainly in the areas of management and maintenance. The projects also serve as a source of income for smallholders because a portion of their land is leased to house the wind farm, usually with 20-year contracts. In these areas, agricultural and livestock activities still can be carried out at the same time.

Beyond Brazil, the integration of renewable energy into the electric grid is facing many challenges. Germany sets a good example of high penetration of renewable energy. In order to cope with the pre-defined levels of reliability, other sources of energy must be connected to the grid, ready to begin generating electricity in case of a sudden lack of wind. In the case of Germany, the backup source of energy is gas or coal. One of the best alternatives to increase the penetration of renewable is probably energy storage systems, but those are still very expensive and the most promising technologies are only in the infancy stage of development for large amounts of energy. My research as a visiting scholar at Harvard University is about advanced energy storage systems that might allow more renewable energies in power systems.

What is going to be unique in Brazil and will be even more interesting than the seasonal complementarity (between hydro and wind) is the fact that we could use the flexibility of existing hydropower plants to back up the fast changes in wind speeds (because sometimes the wind can stop blowing in an entire region). The large hydropower plants reservoirs in Brazil can be considered great storage systems. This combination would enable high levels of wind energy penetration and would turn the Brazilian electric power generation into one of the most successful sustainable electricity matrices in the world. That will happen if the wind does not stop blowing, the rain keeps falling on the right places and the rivers continue to flow (not considering the negative impact of big reservoirs, which is another long and interesting discussion).

Mauricio Salles *is a Visiting Scholar at Harvard and Assistant Professor of the Department of Electric Energy and Automation Engineering (PEA) at the Polytechnic School of the University of São Paulo.*

Ana Maria Peres, *a Brazilian journalist and former resident of Cambridge (MA), collaborated with this article.*

Solar Energy in Chile

Development and Challenges

BY CLAUDIO A. AGOSTINI, CARLOS SILVA AND SHAHRIYAR NASIROV

FOR SEVERAL DECADES, CHILE HAS STRUGGLED to have a stable and reliable mix of energy sources to satisfy its growing needs. In the 1980s, the country relied heavily on hydroelectricity, considered almost the sole solution to its growing energy requirements. As a result, every time the country faced a drought, there were even periods of blackouts and rationing because not enough energy was being produced.

In the mid-1990s, a combination of continued rapid growth in energy demand, increasing environmental concerns regarding large hydro projects, and the unreliability of hydropower prompted the Chilean government to diversify energy sources by encouraging the use of low-price natural gas from Argentina. The low-cost energy from the imported natural gas made it more attractive to build combined-cycle power plants instead of relying on large hydro plants and coal. Thus the energy sector invested heavily in this source, building four pipelines from Argentina, setting up new gas distribution networks and constructing a half a dozen new combined-cycle power plants. In 2004, natural gas accounted for 26% of Chile's total energy consumption, of which 80-90% came from gas supplied from Argentina. As a result, in 2004 the Argentine government restricted the volume of gas exports to Chile in order to relieve its own domestic gas shortages. In just a few years, the gas supply to Chile stopped. This brought about another energy crisis in which generators were forced to replace gas-fired electricity with expensive and more polluting diesel generation, and the government promoted the construction of liquefied natural gas (LNG) terminals to compensate for these changes and have another alternative to Argentine gas.

The successive energy crises have taught us a valuable lesson. The country is now more concerned with energy diversification, understanding its important role for the security of the system. The country has learned that short-term gains come at a high long-term cost. In addition, the economy's dynamism over the last decades, including the significant improvement in the welfare of the population (poverty, for example, has decreased from 40% to 13% in two decades), has doubled electricity demand. Chile is now the country with the highest energy consumption per capita in Latin America, well ahead of larger countries like Argentina, Brazil and Colombia.

Chile is also considered one of the most attractive countries for the development and deployment of renewable energy technologies (RET), mostly because its geographic location and diversity provide abundant renewable energy resources (RES). Significant potential exists in the use of biomass, hydropower, geothermal, solar, wave and wind energy. In particular, Chile has one of the largest solar potentials in the world. With almost 356 days of clear skies, high solar radiation and low humidity, the Atacama Desert in northern Chile offers excellent conditions for generating solar energy. Therefore, adding solar energy to the energy mix can be an important opportunity to contribute to the country's energy diversification strategy.

To attract renewable energy investment, several new regulatory incentives have been introduced. In 2008, the Chilean government took a significant first

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