RE-ENERGIZING THE BORDER: RENEWABLE ENERGY, GREEN JOBS AND BORDER INFRASTRUCTURE PROJECT

Wind Energy Potential

in Mexico's Northern Border States

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Wind energy on the border — a model for maximum benefit

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INTRODUCTION

Since the early 1990s, Mexico's wind energy sector has gone through a dramatic transformation. From a few experimental wind energy projects designed to either show the potential for electricity generation or to provide very small-scale production for off-grid communities, by 2012 large-scale generation projects were either in development or operation in a number of states in the country, with over 1,000 MW installed capacity throughout the country and a further 2,000 MW in construction.

The change in the wind energy sector since 2006 has been remarkable, with a more than 600% rise in installed capacity during the presidential mandate of Felipe Calderón. 2012 witnessed Mexican installed wind capacity exceeding 1,000 MW for the first time, and it is predicted that in 2012 alone, according to Secretary of Energy Jordy Herrera, around 650 MW of capacity are due to come online, with four Oaxacan projects (La Venta III and Oaxaca I, II, III & IV) leading the way.

In addition to the development of wind parks in Oaxaca, the *Comisión Reguladora de Energía* (CRE) has issued permits for wind plants in Baja California, Tamaulipas, Nuevo León, San Luis Potosí, Veracruz, and Chiapas, bringing the total number of wind power generation permits issued to 30 across the country.

The Mexican Federal Electricity Commission (*Comisión Federal de Electricidad* or CFE) has published its strategic infrastructure investment plan (the *Programa de Obras e Inversiones del Sector Eléctrico* or POISE), which posits the construction of as much as 1,500 megawatts of wind power for public service. All of these developments place Mexico firmly in the forefront of wind generation in Latin America (although at the moment it is second to Brazil in terms of installed capacity), and wind power has been seen by both the government and the private sector as a lucrative economic sector.

Most electricity experts are familiar with wind energy projects that have been developed in the southern state of Oaxaca. There, the wind currents that cross the Isthmus of Tehuantepec were mapped in the 1990s and 2000s (with financial and technical assistance from USAID), encouraging the private sector to invest in the construction of wind farms that generate electricity for sale to private clients or to the CFE. The development of the wind industry in Oaxaca began in the 1990s but is only now approaching its real potential. By the end of 2012, wind-based installed capacity in the state will reach around 1,500 MW. This is only a small percentage, however, of the nation's potential in wind energy. A recent Mexican government study estimated that around 71 thousand megawatts of wind energy could be produced nation-wide, exceeding current national demand by 40%.[1]

Although the Oaxacan experience has been highly successful in terms of rapidly developing the resource, it has become a source of significant criticism on the

grounds of unfair and unequal treatment of local landholders, a failure to share benefits with the local communities, and for causing social conflict. For example, wind companies typically share only 1% of their profits with local communities in Oaxaca, compared with around 5% in developed countries. Increasingly, Oaxaca is seen as a textbook case for how not to develop wind power in politically and socially fragile areas.

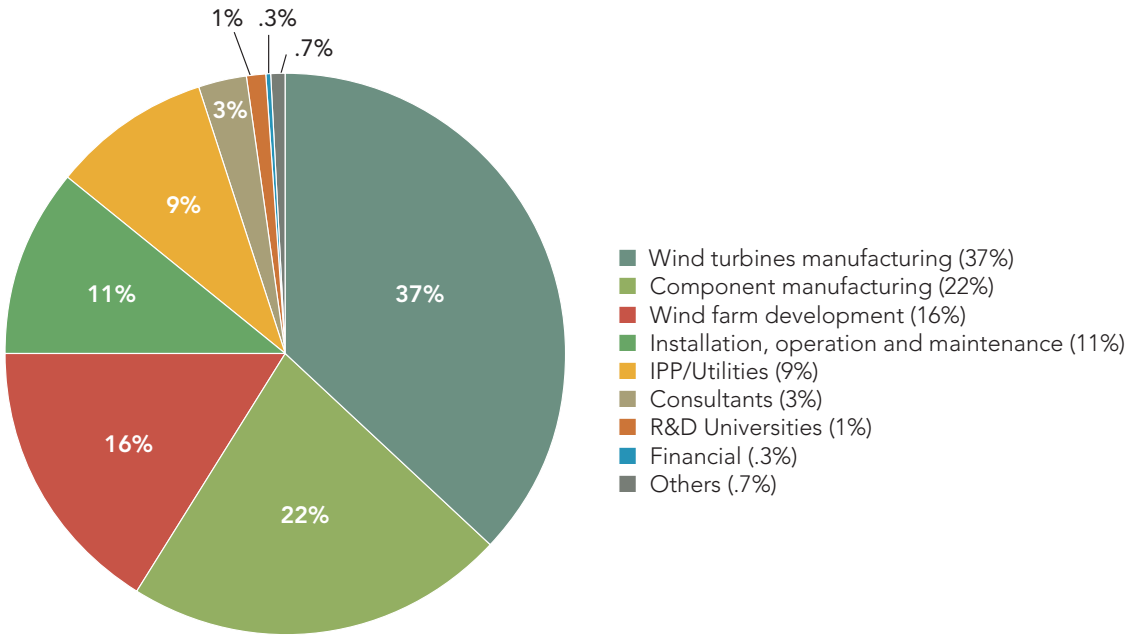
This paper evaluates the potential for developing wind power on Mexico's northern border, and in so doing examines ways to avoid such mistakes as have plagued the Oaxacan wind sector. The paper looks at the prospects for wind energy development across the border region, with a particular emphasis on the states of Baja California and Tamaulipas, and argues that a model is emerging whereby wind power generation involves both public and private sector partners who are harnessing the potential of wind to maximize benefits for government, business and society.

Our analysis focuses on three main axes. First, we examine the potential for creating economic benefits in border states from wind energy development, with particular attention paid to employment and infrastructure. Second, we examine the potential for the creation of clusters and the development of human capital. Last, we look at the implications for social participation and the distribution of benefits.

HOW WIND GENERATES JOBS

The wind energy sector has led the recent worldwide revolution in renewable energies. With massive investment in the sector in China, the United States and Europe, global installed capacity in wind energy has grown from just over 24,000 MW in 2001 to 239,000 MW by the end of 2011, an

Figure 1: Distribution of job creation from wind energy



Source: EWEA, "Wind and Work: Wind Energy and Job Creation in the EU," Euopean Wind Energy Association, 2009, http://www.ewea.org/fileadmin/ewea_documents/documents/publications/Wind_at_work_FINAL.pdf.

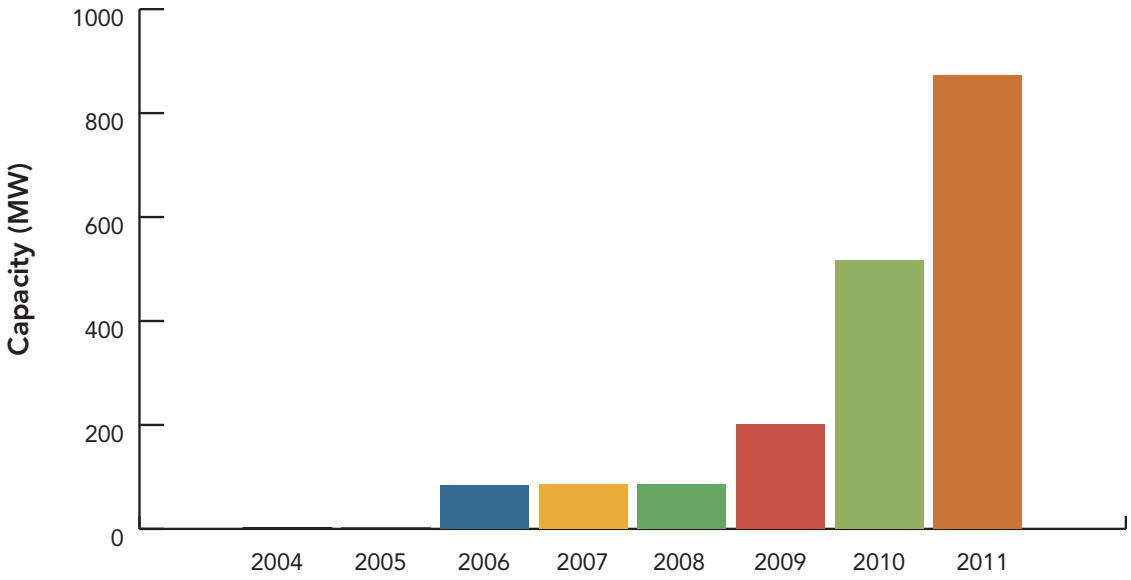
almost ten-fold increase in a decade. In part, this has been driven by fears over climate change, but the most significant factors have been declining costs and the prospect of subsidies from governments anxious to promote the use of renewable energies.

This prodigious rise in installed capacity in wind has created benefits beyond just reduction in greenhouse gas emissions. Wind power has been hailed as a major source of so-called "green jobs," and has been credited with creating more jobs per unit of energy than traditional hydrocarbon-based electricity generation industries. Employment is created not only in the construction, operation and management of wind facilities, but, more importantly, in the manufacturing of wind turbines. All of the world's major wind markets have been attracted by the prospect of this kind of employment creation, as manufacturing jobs are seen as being high quality, well-paid positions. Estimates of the importance of wind sector employment point to the creation of 6 jobs per year per MW of installed capacity in the manufacturing of turbines. This would suggest that well over a million job years have been created worldwide by the wind boom, just in manufacturing. Another estimate of the importance of wind energy, from the European Wind Energy Association, also highlights the importance of the turbine manufacturing industry in wind energy job creation, but goes further and shows the full distribution of employment in the sector. Component manufacturing is the second highest factor in job creation, suggesting that societies can derive long-term employment benefits from wind, far beyond the initial phase of construction.

WIND ENERGY IN MEXICO

During the administration of President Felipe Calderón, the installed capacity of wind power in Mexico has expanded by

Figure 2: Installed wind capacity in Mexico



Source: The Wind Power: wind turbines and wind farms database, http://www.thewindpower.net/country_en_36_mexico.php.

over 600%. As noted above, the growth of the wind sector during the Calderón administration reflects the high quality of the resource as well as the interest of the private sector to invest in renewable energy sources. But it has also been made possible thanks to the existence of a legal framework that has encouraged the private sector to become involved in electricity generation, traditionally an area reserved for the state in Mexico.

Under the Mexican Constitution, the State has exclusivity over generation, transmission, transformation, distribution, and supply of electricity whenever it is intended for public service. The Constitution states: "It corresponds exclusively to the Nation to generate, conduct, transform, distribute, and supply electric energy which has for [its] objective the provision of [a] public service." However, private participation in generation is allowed thanks to a legislative innovation passed in the early 1990s. The 1992 *Ley del Servicio Público de Energía Eléctrica* (LSPEE) is generally seen as being the most important factor in driving private participation in Mexico's electricity system, and in facilitating a greater role for wind energy in the nation's energy matrix. Under the LSPEE, the CFE's Constitutional monopoly on electricity generation for public service is interpreted to exclude five areas:

- Electricity generation for self-supply purposes, cogeneration or small scale production (<30 MW)
- Independent Power Production for CFE
- Back up or emergency generation
- Electricity imports
- Electricity generation for export purposes

The passing of the 1992 LSPEE resulted in a dramatic expansion of private sector involvement in the electricity industry (see

Table 1: Installed electricity generating capacity in Mexico 1987–1997 (Mega-Watts)

Installed Capacity	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
National Total	25,755	26,428	27,402	28,21	30,068	30,448	32,533	38,550	39,939	41,693	41,716
Public Sector	25,145	23,954	24,439	25,293	26,979	27,068	29,204	31,648	33,037	34,791	34,815
Thermoelectric	13,749	14,305	14,779	14,914	16,271	16,532	17,718	19,199	19,394	20,102	20,120
Hydroelectric	7,546	7,749	7,760	7,804	7,931	7,931	8,171	9,121	9,329	10,034	10,034
Carbon Electric	1,200	1,200	1,200	1,200	1,200	1,200	1,900	1,900	2,250	2,600	2,600
Geo-thermoelectric	650	700	700	700	720	730	740	753	753	744	750
Nuclear Electric	-	-	-	675	675	675	675	675	1,309	1,309	1,309
Wind Electric	-	-	-	-	-	-	-	-	2	2	2
Private	2,610	2,874	2,963	2,968	3,271	3,380	3,329	6,901	6,902	6,902	6,902

Notes: All 1997 data is estimated; data on private generators is estimated beginning in 1994. Dashes refer to periods in which data was unavailable.
Source: CEPAL, "Impacto de la reforma económica sobre las inversiones de la industria eléctrica en México: el regreso del capital privado como palanca de desarrollo," http://www.cepal.org/publicaciones/xml/0/4540/lcl1175e.pdf.

Table 1). Between 1992 and 1997, installed electricity generation capacity in the hands of private enterprise more than doubled from 3,380 MW to 6,902 MW.

The LSPEE authorizes co-generation for private companies with authorization for connection to the national grid coming from the *Comisión Reguladora de Energía* (CRE). The regulation considers various modalities in this regard:

- Interconnection contracts for intermittent renewable energy sources (CIEI)
- Interconnection contracts for small-scale solar projects
- Interconnection contracts for self-supply arrangements for governmental entities
- Purchasing contracts for small producers (CCPP)
- Purchasing agreements for electricity surpluses

TRANSMISSION SERVICE AGREEMENTS

Self-supply contracts involving local and state governments are given a lower transmission charge for energy from renewable, rather than traditional, sources. This helps to greatly improve the economics of self-supply for municipalities and state-level governments in particular.

Of more direct relevance to renewable energies, Mexico implemented the *Proyecto de Energías Renovables a Gran Escala* (PERGE) in 2007, which provided limited economic incentives for renewable energy projects over 100 MW. Mexico further improved the legal environment for renewable energy with the 2008 *Ley para el Aprovechamiento de las Energías Renovables y el Financiamiento de la Transición Energética* (LAERFTE). Despite the fact that this new law once again established the dominance of the state in the electricity sector, the LAERFTE promoted the use of renewable energies in Mexico through two main initiatives:

- A National Strategy for the Energy Transition and Sustainable Use of Energy (*Estrategia Nacional para la Transición Energética y el Aprovechamiento Sustentable de la Energía*), which aims at improving energy efficiency and diversifying the energy matrix; and,
- The Special Program for the Use of Renewable Energy (*El Programa Especial para el Aprovechamiento de las Energias Renovables*), which aims to produce new public policies in the areas and to provide means to promote renewables.

Within this package of policies was the creation of a new fund for the energy transition, the *Fondo para la Transición Energética y el Aprovechamiento Sustentable de la Energía*. Comprised of an annual total of 3 billion pesos, this fund attracted enormous interest when it was first announced. However, the Federal Government has used the fund for energy savings and energy efficiency programs rather than promoting renewable energy use, and has failed to meet its annual contribution since 2010.

In terms of economic incentives or subsidies for renewable energy development, Mexico lags far behind European countries or the United States. However, thanks to a modification of the tax laws made in 2004, companies that invest in renewable energies can deduct up to 100% of the money spent on machinery and equipment during the first year of operation. The law stipulates that the project remains in operation for at least five years.

These legislative developments, however, were not solely responsible for the rise in wind energy capacity. Instead, it was the conjunction of several factors that brought about Mexico's wind boom in the 2000s: improved technologies, falling costs, increased interest in renewable energies due to rising awareness of climate change as well as financing opportunities through international carbon credit schemes, and most importantly the mapping of Mexico's wind patterns in key areas of the country, such as Oaxaca. The 1995 *Mexico Wind Resource Mapping Project*, undertaken by the United States' National Renewable Energy Laboratory (NREL), led to a deeper and more detailed evaluation of the resource in 2002, in which USAID, NREL and a collection of U.S. and Mexican partners participated.

The resulting 135-page Wind Energy Resource Atlas of Oaxaca proved to be the trigger for major interest in Oaxacan wind. As large private consumers, such as WalMart, Bimbo, Cemex and Grupo Bal began to recognize both the cost advantages and environmental benefits of taking out self-supply contracts for wind power, investment flooded into the sector, led by foreign firms such as Gamesa and Acciona. In 2007, the Mexican government set a target of 2,500 MW of installed wind capacity by the end of 2012, a target that is now likely to be met by the end of 2013.

Interest in Mexican wind did not just stay in the southwest of the country. Working again with its partner NREL, USAID has funded mapping of the wind resource in a number of states:

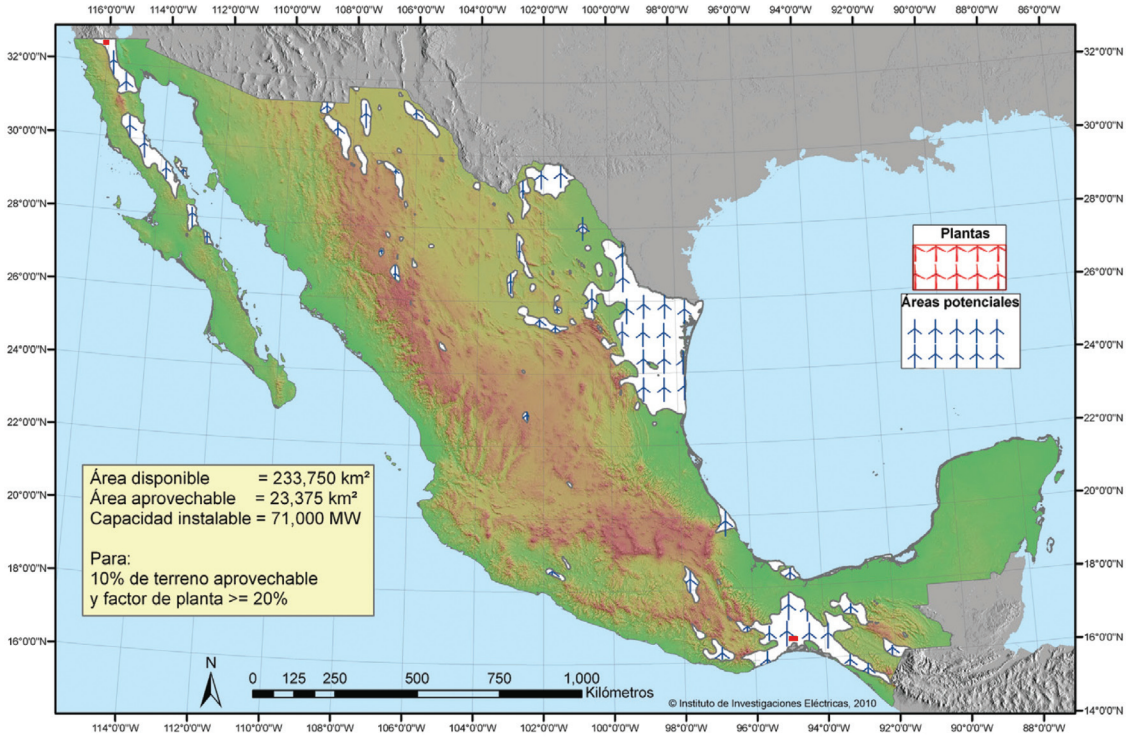
- Baja California Norte Border Region
- Western Chihuahua Border Region
- Northwestern Mexico Border Areas
- Eastern Sonora Border Region
- Western Sonora Border Region
- Baja California Sur
- Quintana Roo and Yucatán

As should be obvious from this list, there was a clear focus on the potential of northern Mexican border states in the new mapping exercise. This reflected the growing awareness in the United States (and, to a lesser extent, in Mexico) that there was an emerging market for exporting wind power to the Californian electricity market as that state moved toward a renewable portfolio standard (RPS), requiring a minimum level of renewables in the state's electricity mix. The importance of this development has been discussed at length elsewhere, most recently in another Wilson Center publication.[2]

What is also clear, however, from a Mexican government map showing areas with wind energy potential in the country, is that the areas that have thus far been examined and evaluated constitute a tiny percentage of the total. Mexico has a truly world-class wind resource and holds the prospect of significant expansion of capacity throughout the country if the right conditions are met.

Before moving on to focus on the question of transmission, it is worth emphasizing the problems that have come out of the development of wind projects in Oaxaca. In 2009 USAID published a report titled "Elementos para la Promoción de la Energía Eólica en México," which focused heavily on Oaxaca but also covered northern Baja California and the southeast of the country.[3] The report recognized the continuing obstacles to the development of the wind industry in Mexico, emphasizing transmission, the lack of incentives or subsidies and social and environmental factors. The social dimension is of particular importance here. Between 2007 and 2010, more than 180 lawsuits have been filed in

Map 1: Areas with potential for wind energy generation in Mexico



Red areas are actual plants. Blue areas have potential for development.
Source: Secretaria de Energía website, http://sener.gob.mx/webSener/res/1803/Eolico.pdf.

Oaxaca against wind energy companies, seeking to nullify contracts that are seen as unfair.[4] In one high profile case involving the EURUS consortium, the construction of the wind farm was held up when 170 *campesinos* blocked the entrance to the site, demanding a three hundred percent increase in the payments made by the wind company. The 2009 USAID report recommended broadening the policy process to incorporate civil society and universities in a more comprehensive fashion. Furthermore, it insisted on the need to address the concerns of local landowners relating to land use and compensation.

TRANSMISSION: THE CRUCIAL ELEMENT

Around the world, the development of the wind energy sector has depended on the availability and close proximity of transmission lines. Unlike conventional sources of generating electricity, which can be located close to population centers and existing transmission lines, wind (as well as solar and geothermal) plants must have transmission lines built to allow them to get their electrons to market.

Surveys of wind producers around the world have shown that development is hindered more by transmission challenges

than any other single factor. In Mexico this problem is made more severe by the fact that the CFE has a constitutional monopoly over transmission and therefore there are no other outlets for wind Independent Power Producers (IPPs) if CFE refuses to provide capacity. Moreover, CFE is prohibited from using public funds to build new transmission capacity if the energy generators cannot prove that they are willing and ready to pay for the electrictity transmission service. On the other hand, many electricity generators who want to build plants cannot get the financing they need unless they can prove that transmission capacity will exist by the time they come online.

In the case of Oaxaca, this problem has been resolved through close cooperation between IPPs, the CFE and the CRE, which have developed an effective method of estimating future transmission demand through the use of open seasons. In an open season system, a period of time is determined (often one year) during which electricity companies can indicate their intention to build new plants and their need for transmission capacity. At the end of this time, the transmission authority (in this case the CFE) uses the results to justify its investment in constructing new lines.

For the state of Baja California, this problem is made even more acute because there is no interconnection between the state and the national grid, making export of electricity to private consumers in other states impossible at the present time. Mexico's national grid is in fact three grids, with Baja California Norte and Baja California Sur each having their own independent system.

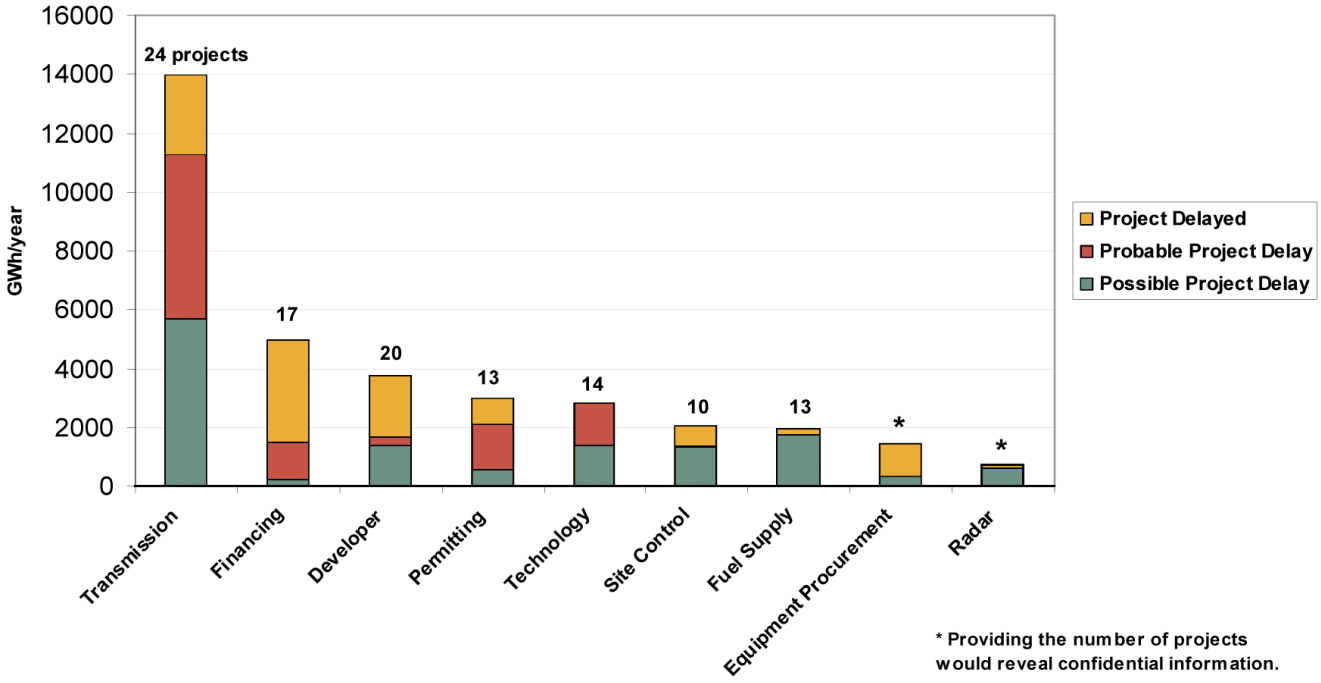
A further level of difficulty is found with cross-border transmission. A quick survey of the above map shows that there are only a limited number of interconnections across the border. Furthermore, only 5 of these connections are bi-directional. In Baja California, the Miguel-Tijuana and the Imperial Valley-Rosarita interconnections (both 230kV AC) have a combined capacity of 800 MW, in Coahuila the Eagle Pass-Piedras Negras interconnection (138kV HVDC) has a capacity of only 38 MW, and in Tamaulipas the Laredo-Nuevo Laredo (138kV VFT) and McAllen-Reynosa (138kV HVDC) interconnections have a combined capacity of 250 MW. These interconnections are maxed out and therefore cannot be considered for future cross-border electricity trade. In addition to these lines operated by CFE, there are two privately owned transmission lines of 310 MW (owned by Intergen) and 1200 MW (owned by Sempra).

The problem of cross-border transmission has been identified in a number of previous reports on wind and renewable energy in Mexico,[5] and in 2010 the two countries set up a task-force to address the issue.[6] Although this group has met a number of times, there appears to be little momentum behind the initiative, with each side blaming the other for lack of progress.

WIND AT THE BORDER

Since the mid-2000s, the governments of northern Mexican border states have begun to develop an awareness of the potential for wind energy development in the region. This has been driven by a number of factors. First, the high level of investment in wind energy projects in Oaxaca has demonstrated to governments that the sector is a source of considerable wealth and economic benefits. Second, the growing awareness and detailed knowledge of the potential for wind energy in the northern states has shown them that they have a resource that has thus far remained untapped. Third, developments at the national level in terms of energy planning and the emphasis by the Calderón

Figure 3: Barriers to renewable energy development



Source: USAID, "Estudio del Potencial de Exportación de Energía Eólica de México a los Estados Unidos," 2009.

Map 2: Mexico's national grids

Blue: 400 kV, Orange: 230 kV, Red: 116 kV, Green: 161 kV, 138 kV, and 34.6 kV
Source: CFE, www.cfe.gob.mx.

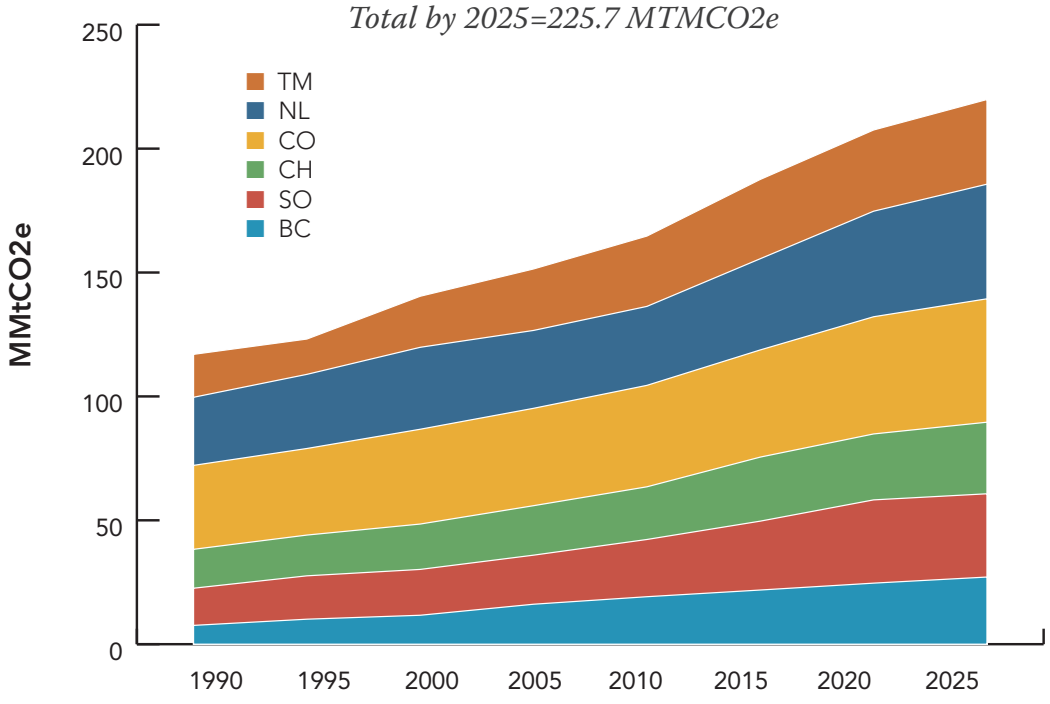
administration on climate change and the question of mitigation have raised an awareness of the environmental benefits of renewable energy.

The northern states, as other studies in this project have shown, are particularly well-endowed when it comes to renewable energy, and wind is no exception. Of the six border states, there are exploitable wind resources in Baja California, Chihuahua, Nuevo León and Tamaulipas. The first and the last of these stand out, with huge potential in the mountainous regions of the Sierra Juárez in Baja California, and in the coastal and inland plains of Tamaulipas.

Graphic 1 shows this clearly. Although Oaxaca has been the first beneficiary of the wind boom in Mexico, the future development of the sector will likely be in the northwest and northeast of the country. The north of the country offers an intriguing prospect for two reasons: first, the geographic proximity to the United States, and second, its proximity to areas that have traditionally been seen as the industrial heartland of Mexico. Both of these factors offer the potential for customers for electricity produced from wind.

One last point that merits mention here is that the border states show not only some of the highest economic growth rates in the country, but also the highest rates of growth of carbon gas emissions. A recent study by the BECC/COCEF (Border Environment Cooperation Commission/Comisión de Cooperación Ecológica Fronteriza) showed that the border states show a steady rise in emissions and are responsible for 25% of national emissions.

Figure 4: Carbon gas emissions in Mexican border states (BECC/COCEF study)



Source: BECC/COCEF, "Emisiones de gases de efecto invernadero en los seis estados fronterizos y proyecciones de casos de referencia 1990–2025," http://www.becc.org/espanol/index.html.

Chihuahua:

NREL produced its first wind map of the state in 2004, which highlighted a number of areas showing potential for wind energy development. However, it is only since 2008 that the private sector has begun to show interest in the resource. The area surrounding the city of Cuauhtémoc, 110km to the west of Ciudad Chihuahua, has been identified as a potential site for wind farm development by the state and has attracted interest from Spanish, American and Korean firms. The potential at the site is considerable, and the Chihuahua Ministry of Communications and Public Works announced that the state was recently in talks with a firm to install 10 MW of wind turbine capacity to generate electricity for public lighting. The rate at which the electricity would be sold to the municipality would be lower than that charged by the CFE, and excess electricity would be sold to the public utility.[7]

At the same time, the Spanish company Preneal Energías Alternativas has been exploring the possibilities of developing the wind resource in the desert of Samalayuca, where it has signed agreements with local landowners to rent 6,000 hectares of land with an eye to installing wind turbines. The long-term goal is to install over 850 turbines that will ultimately have a total installed capacity of over 2,000 MW. As part of the land rental agreements, Preneal has committed to sharing 1.5% of the profits from wind generation with the ejidatarios. It is worth noting that this is significantly less than the norm in the United States and similar to the rate paid to Oaxacan land owners.

To date neither of these projects has been brought to fruition, and Chihuahua lags behind states such as Baja California and Tamaulipas. However, the state has been successful in taking advantage of the wind boom in the United States by attracting investment into the wind turbine manufacturing sector. Vientek, a joint venture between TPI Composites Inc. and Mitsubishi Power Systems (MPS), manufactures blades for wind power units at its assembly plant in Ciudad Juárez. From there it ships blades for the North American and Japanese markets. The plant opened in 2002 and has been highly successful. In 2007, a second plant was opened in the city. The firm now employs 900 people in the two plants and continues to experience high levels of demand as MPS has increased its wind turbine manufacturing to 1200 MW/year.

Coahuila:

Although the state of Coahuila has no working wind energy projects, like Chihuahua it has benefited from the wind energy boom in the form of manufacturing jobs. In November 2009, Speco Wind Power, a Korean producer of towers for wind turbines, opened a plant in the city of Monclova, employing 450 people, with plans to double that number in following years. The investment totaled US$30 million.[8] Since 2009, however, the plant has diversified its manufacturing away from just wind towers to other heavy machinery, as demand has been slack for its product.

Nuevo León:

The eastern area of Nuevo León shares the same wind resource as Tamaulipas, and the state government has begun to recognize the potential therein. As early as 2002, the private sector showed interest in the wind patterns in Santa Catarina and Guadalupe municipalities with the creation of Eólica Santa Catarina. The venture includes the municipal authorities of Santa Catarina

and Guadalupe and the Mexican-U.S. firm Energy and Water Service Multinational (ESM), which agreed to provide financing. To date, this project has not been realized, but interest was revived in June 2011 with the announcement that the firm Next Energy Mexico was preparing a $48 million investment to install eight 2.6 MW turbines (for a total of 22MW capacity) in the Santa Catarina area. The goal of this project is to provide electricity to the municipal authorities in Monterrey, Apodaca, Santa Catarina, Escobedo, García and Los Ramones.[9]

In January 2011, the state government announced the launch of a wind energy atlas, *El Atlas de Potencial Eólico de Nuevo León*, which identified the areas with biggest potential for development and put the overall potential of the state at around 11,000 MW. The two areas with biggest potential in the state were identified as the municipalities of Hidalgo and Linares.[10] Based on this study, the state's director of sustainable development, Fernando Gutiérrez Moreno, announced that the government would begin a program to drive the development of the wind sector in Nuevo León, hoping to install as many as 250 turbines in the next few years. Fernández Moreno predicted that investments totaling over US$2 billion would be required to bring this potential to market.[11]

Nuevo León is particularly intriguing because of the potential for cooperation in wind energy between the government and the industrial elites that dominate the economy in the region. Major Mexican firms from Monterrey, such as Cemex, are already heavily invested in wind energy self-supply contracts from Oaxaca, and would be strong promoters of the resource in the center of Nuevo León.

Tamaulipas:

As can be seen from the Mexican government's wind map, Tamaulipas has enormous potential for wind power development. However, it is only in recent years that the state government has

Table 2: Wind energy projects in Tamaulipas

Los Vergeles, San Fernando (2012)	El Porvenir wind park, Reynosa, (2013)	Wind turnbine manufacturing (Matamoros)
■ 161 MW ■ Financing: US$ 328 million ■ Eployment: 500 jobs in construction phase (2 yrs) plus 60 permanent jobs ■ 25% reduction in GG ■ Low cost electricty for municipal authorities (5–10% savings) — used for hospitals, schools, public lighting, public buildings.	■ 54 MW, 156.4 GWh/yr. (72 MW in 2nd stage) ■ Financing: US $51 million ■ 15 yr self-supply contracts ■ According to the COCEF, El Porvenir will reduce carbon emissions by 0,976 metric tons of CO_2 in first year ■ 20 km of new roads will be built to service the wind park ■ Construction will begin in March 2012, come into operation in March 2013.	■ CS Wind Corporation, investing US $60 million in production plant ■ For export to the U.S. market ■ 700 new jobs in the next 4 yrs: skilled labor — engineers and technicians

Source: Duncan Wood, ""Re-Energizing the Border," presentation made to the Woodrow Wilson International Center for Scholars, Washington, DC, December 14, 2011.

recognized this potential and has begun to encourage investment in wind capacity. At present, the center of the state's wind sector is to be found at Los Vergeles, a site in the municipality of San Fernando (a region notorious in recent years for high levels of drug violence), but there is cause for optimism in other areas.

Three projects stand out in the state. The first, at Los Vergeles, involves the construction of a 70 turbine, 161 MW wind facility that will provide electricity to 43 municipalities. The electricity will be used to power public lighting, schools and hospitals.[12] The savings for public authorities will be substantial, and the sale of carbon bonds will further lower the cost of the electricity. It is estimated that the wind farm will employ 500 people for 2 years during the construction phase and will provide 60 permanent jobs in the management and operation of the facility. Though the project has been talked about for a number of years, groundbreaking took place in November 2010 and the first turbines are expected to come online by the end of 2013.

The second project of importance in Tamaulipas that is already in the construction phase is a smaller wind park in the north of the state, on the border with the United States. Construction began at the El Porvenir wind park in March 2012 on communal farmland known as Ejido El Porvenir, just southeast of Reynosa, Tamaulipas. 54 MW of turbine capacity will be installed. The facility is being run by Mexican company Compañía Eólica de Tamaulipas, S.A. de C.V. (CETSA), which received a peso loan equivalent to US$51 million from the North American Development Bank (NADBank) and the Border Environment Cooperation Commission (BECC). This is the first wind facility financed by the NADBank in Mexico. The electricity from the plant will be sold through 15 self-supply contracts to Soriana, a major Mexican supermarket chain.[13]

The third major wind-related development in the state involves the opening of a $60 million manufacturing plant for towers and components for wind turbines, run by the CS Wind Corporation. Once again, as in both Chihuahua and Coahuila, these turbines are for export to the United States market, showing that Mexico is benefitting from the wind energy boom in its northern neighbor while also highlighting the fact that Mexico has the capacity to produce turbines for its own national market. The plant in Matamoros will employ up to 700 people as production increases.[14]

Beyond these existing projects, the government of the state has announced that there are now 40 projects and businesses interested in investing in wind power in the state. This claim is backed up by the recent success of the CRE's *Temporada abierta*, or open season, for firms interested in reserving transmission capacity from the CFE in Tamaulipas. The season, launched in August of 2011, closed in March 2012 with a total interest amounting to 1900 MW. Even if only a percentage of this interest comes to fruition, the state's electricity sector will be transformed.

BAJA CALIFORNIA: WIND WORKING FOR THE COMMUNITY

Because Baja California has yet to be connected to the national electricity grid (the CFE claims that the interconnection, with a capacity of 300MW, will be completed in 2014), the state has an intriguing history in terms of power generation. Geothermal power has been used to produce electricity at the CFE's Cerro Prieto plant for decades, in sufficient quantities to make the state independent in power generation and to allow for exports to California.[15] The long-

Table 3: Potential areas for electricity generation from wind in Baja California

Station	Mean (knots)	Mean m/s	Standard Deviation	Energy (W * M²)
La Puerta	11.5	6.2	2.5	238.2
La Rumorosa	14.9	8	4.0	516.4
El Centinela	17.2	9.3	4.9	793.7
El Hongo	12	6.5	2.6	274
El Pinal	11.7	6.3	2.9	254.7
Jacume	15.5	8.3	3.7	518.6
Pino Suárez	20.2	10.9	4.5	1299.6

Source: Centro de Investigación Científica y de Educación Superior de Ensenada. (2003), "Zonas Potencialmente Productoras de Energía Eólica, en Baja California." http://www.bajacalifornia.gob.mx/energia/estudios.html.

term importance of this renewable and clean source of energy is that it has helped to shape a way of thinking about energy policy (with an emphasis on innovation and renewables) in the state that is unique in the country.

The history of wind energy in the state of Baja California can be traced back to a study carried out in 2003 by the Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE), titled "*Zonas potencialmente productoras de energía eléctrica eólica en Baja California*." This study, based on information from meteorological stations across the state, identified a number of locations as being particularly well-suited for wind energy development. Combined with the studies carried out by USAID and NREL, the CICESE report provided a boost for wind promoters in Baja, and helped to alert the state government to the potential.

In 2008, the BC government of Governor José Guadalupe Osuna Millán (2007–2013) decided to use the development of the wind resource at La Rumorosa, only a few kilometers from the U.S.-Mexico border, as a showcase of what could be possible for the rest of the state. At the time, wind power was still a novelty in the Mexican energy sector, and the Baja California government's decision was seen as a brave new departure. The state's energy commissioner, David Muñoz Andrade, is now recognized throughout Mexico as being a champion of wind energy, and his efforts were crucial in pushing forward the development. In order to attract private investors into the region to build wind farms, the state energy commission took the initiative to build a small, 10 MW wind project at La Rumorosa. The plant was designed to provide electricity for the city of Mexicali's public lighting needs.

La Rumorosa is a small town in the municipality of Tecate, bordering the United States to the north, the municipalities of Mexicali and Ensenada to the east, Tijuana and Ensenada to the south, and Tijuana to the west. It has a semi-desert climate, mountainous and dry, wholly unfit for farming. The town lies on the Sierra Juárez, and the winds that gave the town its name are very strong, to the point of making

it difficult to walk for long distances. La Rumorosa has a reputation as a place for the middle classes of Mexicali to escape to in the heat of the summer, but has few other economic opportunities.

The building of the La Rumorosa I wind plant was undertaken in 2009, and involved a total investment of U.S. $26,191,715. The project had a strong local component, with the principal contractor and a number of subcontractors from the areas of Mexicali, Tecate and Tijuana. The administration of the entire project was awarded to Turbo Power Services, S.A. de C.V., a Mexicali-based firm. A total of 90% of the human resources employed in the planning and construction phases of the project came from the local area. The project employed 270 people directly over a six-month period in the construction phase, including 7 engineers. Furthermore, the local community benefitted in other ways, with rising demand for services (food, lodging, etc.) during the construction phase, as well as employment opportunities in local mechanical and welding workshops thanks to the maintenance needs of on-site equipment. In total, we can estimate that the project led to the creation of around 500 temporary jobs in the area. Three full-time permanent jobs were created in the management and running of the plant. In a town the size of La Rumorosa (its population is under 2,000 people), the temporary and permanent employment footprint has had a discernible impact on local welfare.

The use of local contractors and employees was a conscious decision of the state government and Turbo Power Services. A representative of the firm has stated that "the economic impact is much stronger, localized, and permanent in the locality, in comparison with the use of subcontractors and businesses located, or whose headquarters are located, in other regions of the country or abroad."[16] It is also claimed that the training received by the local population will provide long-term benefits for the community. Of greater importance is the fact that the employment of large numbers of local people, as well as the creation of diverse business opportunities, helped to convert the local community into an important stakeholder in the project.

This aspect of the project, of ensuring that the local population accepted and welcomed the building of the wind farm, was also assisted by a clear and open communication strategy on the part of the state government. By sharing data about the project, establishing a transparent procurement policy, and by involving the local community at every stage of the process, the project met with minimal resistance and is a source of local pride.

One opportunity to create local economic benefits was missed, however. The wind turbines that generate the electricity had to be imported from the United States as Mexico did not have a viable option. Five 2 MW Gamesa G87/2000 wind turbines (power 850 kW, diameter 52 m) were used in the project to produce a total installed capacity of 10 MW. As we have already explained, the major employment benefits from wind power (in terms of permanent jobs) are to be found in the manufacturing of the turbines, and Mexico has thus far failed to attract significant investment into this sector, thereby missing out on high-quality, permanent employment opportunities.

Nonetheless, the long term benefits of La Rumorosa I have been significant since the construction was completed and the plant began generating electricity. The electricity produced is transmitted to the city of Mexicali, where it is bought by the municipal authority and used to power 80% of the public lighting in the city. Because of the low cost of the electricity (thanks in part to the excellent resource at La Rumorosa, and in part because

of the effective management of the project), the Mexicali government is able to save between 5–10% on what it would have had to pay to CFE for the same electricity. These savings mean that the local authority, and therefore the tax payer, saves money, which can then be used for other public services.

The fees paid to the state government for the provision of the service suffice to cover the costs of generation and the financing of the project, and still result in a surplus. This surplus is taken by the state government and invested in a program called "Tu Energía." In this program, local families in Mexicali receive a subsidy on their electricity bills through deposits to a discount card which can be used to pay the CFE. 35,000 families in the city were selected based upon income levels and financial need. Approximately one third of the beneficiaries are households with a single mother, one third senior citizens, and third persons with disabilities. Recipients are subject to a means test and the subsidies are transferred to the discount card in installments: in May of each year the amount deposited to the card is 100 pesos; in June, 150 pesos; in July and August, 250 pesos; in September, 150 pesos; and in October, 100 pesos. These subsidies can be accumulated and can be used to pay off earlier debts with the CFE.

The logic behind the scheduling of these payments is that, during the summer months, electricity use in Mexicali rises dramatically due to the need for air conditioning in homes. Because of the CFE's pricing system, whereby low level consumption is subsidized but higher levels of electricity use result in much higher costs per unit of energy consumed, this higher consumption in the summer months has traditionally resulted in a major financial burden for low-income Mexicali families.

There is a long history of social discontent in Mexicali over electricity bills. Given the extreme temperatures in the summer months, local families face the dilemma every year of whether to use their air conditioning system or to save the money for other necessities. The "Tu Energía" program is a "smart subsidy" that helps 35,000 families to cover their costs without sacrificing comfort in their homes. What's more, its focus on disadvantaged families is a highly progressive aspect that has attracted positive publicity for the program.

KNOWLEDGE SPILLOVERS

In addition to the development of human capital on-site at La Rumorosa, the government of the state has a vision of building networks of expertise in wind power at the local and state levels. The government plans to work alongside universities and other institutes of higher education to take advantage of the wind farm at La Rumorosa to develop undergraduate, graduate and diploma level courses on renewable energies. In 2010, the Universidad Tecnológica de Tijuana (UTT) and the Universidad Politécnica de Baja California (UPBC) signed a collaboration agreement with the state energy commission, aimed at exchanging knowledge and experience, promoting academic course offerings and conferences, the publishing of text books and other didactic materials, and the financing of research and training activities. Through this agreement courses on renewable energy will be jointly designed and taught, involving the exchange of teaching staff and researchers. A key component of these courses will be practical experience for the students.

In addition, in 2009 the Universidad Autónoma de Baja California (UABC) announced the creation of a Center for Renewable Energy Research (CIER). This project seeks to bring together businesses, government and universities to produce

applied research, technological development and innovation aimed at improving the international competitiveness of Mexican renewable energy firms. A central goal of the CIER is to produce highly qualified human resources and technology transfer for small and medium-sized enterprises involved in the renewable energy sector.[17]

In 2012, the government of Baja California also announced the creation of a small training and public information center at the site of La Rumorosa I. This facility will allow university students to spend a day on-site and observe first-hand how a wind plant is managed. Technical data from the plant will be available for analysis, and students will be able to interact with staff at the facility.

It is hoped that the combination of these three initiatives, along with more that will come in the future, will lead to the development of knowledge clusters in renewable energies in the state. By encouraging collaboration between universities and the private sector, and by offering the prospect of well-trained graduates to satisfy the demand for skilled labor in the sector, the state hopes to build a reputation as a renewable energy hub.

FURTHER DEVELOPMENTS AT LA RUMOROSA

The other long term benefits of the La Rumorosa I project are to be found in its status as an example of what can be achieved through wind power. The Baja California government has consistently argued that the success of the project will inspire private investors to take the leap and build wind farms in the region that will result in the generation of clean electricity, green jobs, infrastructure and positive economic spillovers for the local community.

By 2011, Sempra had announced that it would build a 156 MW wind plant, named Energía Sierra Juárez, at La Rumorosa, to generate electricity for export to the United States. This plant will involve the installation of 52 turbines, bringing further employment and income in the form of rents for land use. Sempra has a 20-year agreement to provide Southern California Edison with up to 250 MW of wind power from La Rumorosa[18] that is expected to generate enough energy to power 65,000 homes in California. The firm has long-term plans to expand the capacity of its plant and has acquired access to almost half a million acres in the region (mainly through leasing arrangements), that will allow it to reach a maximum capacity of 1,200 MW if the firm decides to fully develop the resource.[19] Sempra will get the electricity to market via a cross-border transmission line built by the company that will connect with the San Diego grid.

The other major development that has been announced at La Rumorosa involves Mexico Wind Power, a subsidiary of Cannon Wind Power, a United States firm. Cannon has announced that it will begin with a first phase of the project installing 72 MW capacity on 7.5sq km. However, the company has declared that it has the potential to generate up to 1000 MW in the area. Thus far, the firm has signed a series of 60-year contracts with the local *ejidos*, guaranteeing access to prime land.[20] Interestingly, the company has commented on the fact that it is much easier to deal with the *ejidos* in Baja California than their counterparts in Oaxaca, suggesting that the attention has been paid to the lessons of the Oaxacan experience. It also suggests that the local community has been convinced of the benefits from wind energy through the experience of the La Rumorosa I.

Other companies that have registered interest in the region include Fuerza Eólica and Unión Fenosa, both of which have

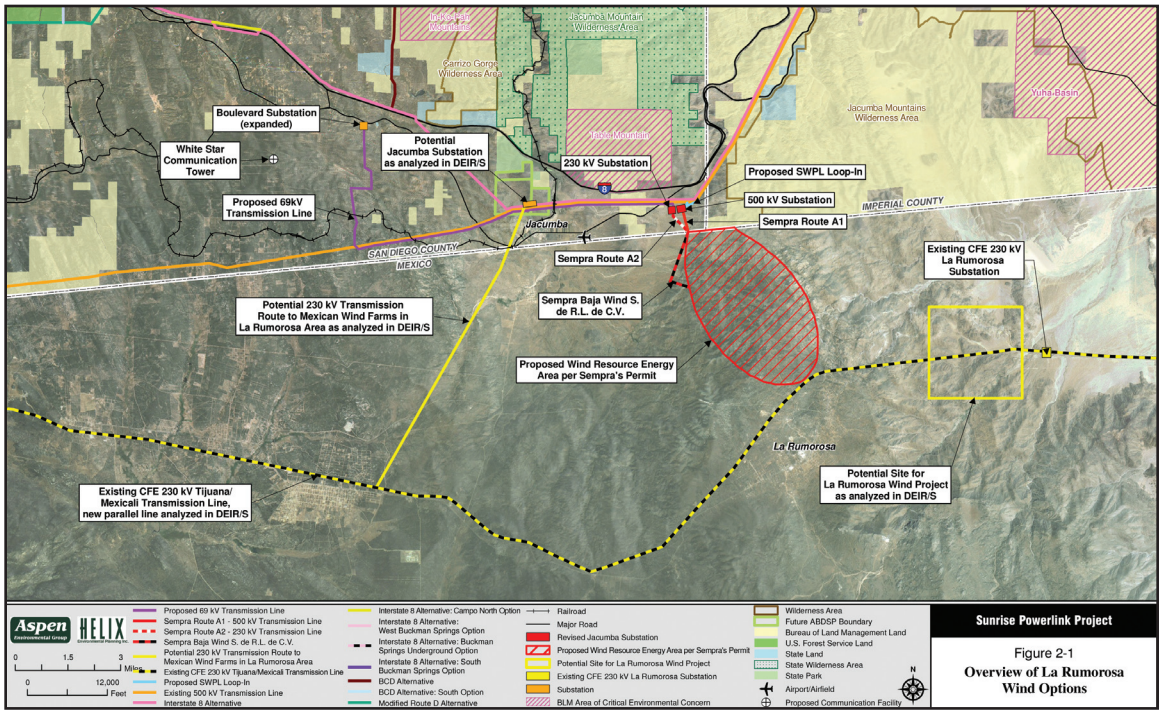
received approval from the CRE to develop wind projects in La Rumorosa. It is estimated that there is potential for up to 5,000 MW of installed capacity in the vicinity of La Rumorosa alone, with even greater possibilities for development throughout the Sierra Juárez mountain range.

THE TRANSMISSION OBSTACLE

A major difference between the Cannon and Sempra projects is that Cannon's goal is to produce wind power for domestic consumption within Mexico. The focus on self-supply contracts suggests that the prospect of Baja California's interconnection with the rest of the Mexican grid will prove a boon for wind power in the area. However, the existence of a connection between the state and the rest of the country may prove insufficient, as there is still the question of how to move electrons generated at La Rumorosa to the existing grid in the state. Sempra's Energía Sierra Juárez has circumvented this issue by proposing to build its own cross-border transmission line to connect with the California grid. However, Cannon is currently struggling to find off-takers for its electricity because the transmission question within the state has not been resolved.

When the La Rumorosa I project was completed, the plant hooked into a small, low-capacity local transmission line that runs beside the project. The line looks alarmingly unstable and does not have the capacity to take anymore electrons. Also running near the project is a 230kv line that connects Mexicali and Tijuana, but CFE did not give permission to Turbo Power Services

Map 3: Transmission options for Sempra Energía Sierra Juárez project



Source: California Public Utilities Commission, "Overview of La Rumorosa Wind Options," http://www.cpuc.ca.gov/environment/info/aspen/sunrise/rdeir/figs/fig_2-1_overview_larumorosa_wind_option.pdf.

to link into that line, as it is already running at capacity.

This lack of transmission options is a major obstacle for both domestic and export-oriented projects, but the CRE has recently announced that it will attempt to overcome the problem through the launching of an "open season" for transmission requests that will spur the CFE into the construction of new lines. This approach has worked well in the United States and has already been used in Oaxaca (and is also being applied in Tamaulipas). It will, however, only solve the problem of transmission of electricity for domestic consumption. The problem of large-scale cross-border transmission remains a highly tricky and political one, as the bilateral working group on the issue has thus far failed to make any significant progress.[21]

CONCLUSIONS AND POLICY RECOMMENDATIONS

There can be little doubt that, as with multiple areas of renewable energy, there is enormous potential for wind energy in Mexico's northern border states. Both Baja California and Tamaulipas have begun to exploit the resource on a large scale, and Nuevo León has taken the first step in this direction by mapping the state's wind patterns. The construction, operation and management of wind farms hold the prospect of significant employment opportunities for the local population, and land owners (individually or collectively) will benefit from rents and profit sharing schemes. However, the examples of Chihuahua, Coahuila and Tamaulipas show that there is also the potential for building a Mexican wind turbine industry to provide equipment and components for the coming wind boom in the border region. The building and consolidation of such an industry would provide thousands of skilled jobs on a permanent basis for workers in the border states, and would enable equipment and component manufacturers to develop economies of scale and greater levels of efficiency that would enable them to export to the rest of North America and beyond.

State governments must take the lead in efforts to build the wind energy generation business in the north. The governments of Nuevo León and Tamaulipas highlight this, but it is Baja California that must be considered to be a model for effective policy implementation. There the construction and operation of the La Rumorosa I plant has shown how wind energy can be exploited in such a way as to provide employment and opportunities for local interests, improve the lives of inhabitants of the community, incorporate the local population into the planning process, and share benefits on an ongoing basis with socially vulnerable groups. The potential for knowledge spillovers and the creation of government-business-university clusters should also be examined more closely, as the government of Baja California is attempting with the creation of university-level programs for renewable energy.

However, state governments will not be able to move the process forward on their own. Due to the need to build new transmission capacity to move the newly-generated electrons to market, the CFE and the federal government (through the Secretaría de Energía) will need to engage with state governments and the private sector. The current move towards open seasons for transmission is a welcome development, and has worked well in the United States and in Oaxaca. Another important lesson to learn from the United States would be for state governments to work together through the concept of inter-

state compacts to push CFE to address their needs.[22]

Cross-border transmission continues to be a major challenge. Although the two countries have the institutional mechanism in place to address the problem, there has been little progress to date in the bilateral task force. State governments in Mexico and the United States should seek ways to pressure their federal governments to inject new impetus into the process. The elections of 2012 provide an intriguing opportunity for this to happen.

The maximization of benefit from wind energy development in Mexico's northern states can only be achieved if a holistic approach is adopted. First, state governments must collaborate with each other and with the federal government to develop a strategy for both generation and transmission. Second, governments must work with local communities to guarantee the creation of stakeholders at at the local level who at the very least will not block projects and at a maximum will lobby to make sure that they come to fruition. Governments must also take full advantage of wind energy in the long-term by both building knowledge-based networks and clusters and by attracting wind turbine manufacturers into their territories.

Mexico's wind potential is huge. The northern border states are home to much of this potential and must develop a strategic vision of how to best exploit the resource. What is at stake is a long-term payoff in terms of employment, investment and social welfare that is probably more important than the potential impact in terms of climate change mitigation.

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