Center for Clean Air Policy
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Mexico's Renewable Energy Program

A Step-by-Step Approach for Overcoming Barriers to Renewable Energy Deployment

Overview

Over the last ten years, policy-makers at the Ministry of Energy (SENER) and the Energy Regulatory Commission (CRE) worked together to overcome a number of significant barriers that impeded development of Mexico's plentiful wind energy resource. The main challenges were as follows:

- There was very little domestic experience with wind power or other forms of intermittent renewable energy.
- The authorities with substantial responsibility for electricity development and delivery were not supportive of wind power. The national utility companies (Comisión Federal de Electricidad, or CFE, and Luz y Fuerza del Centro) had constitutional authority over electricity generation, transmission, transformation, distribution and supply of public services. CFE was also responsible for planning, constructing and operating the national electric system, and it controlled the rates by which private companies could gain access to the electricity grid. However, CFE was resistant to changes that would support renewable energy development, including integration of intermittent power resources that are not subject to dispatch, concerns that contracts for renewable energy from IPPs would produce small amounts of power that would not justify the transmission infrastructure, and concerns about the costs of expanding transmission access.
- The rules and regulations (developed by CFE) were not supportive of wind power. CFE did not solicit bids for wind power, and self-supply companies[1] — particularly intermittent power projects — faced unfavorable terms to purchase, sell, and transmit power on the grid. As some of these barriers were overcome, additional issues, such as negotiations for capacity payments, had to be addressed.
- A federal law requires CFE to purchase electricity for public supply at the lowest possible cost. A narrow interpretation of this law meant that the diversification and environmental benefits of renewable energy were not recognized in cost determinations.
- The government did not offer incentives that would enable renewable energy to compete with the low-cost alternative.

[1] A self-supply company is generally a consortium of private parties that invests in an energy project that will supply electricity to at least one of the consortium members. Such projects require access to the power grid when the location of the energy is not adjacent to the demand.

- Transmission access to windy regions of the country was insufficient to support significant growth in wind energy.
- Negotiations with landowners (or their representatives) on compensation levels for loss of values associated with traditional land uses as well as for community benefits was challenging and time-consuming. This issue was sometimes complicated by poor records of land ownership.

As a result of efforts by SENER and CRE to systematically address these barriers, and with some initial financing from the World Bank and the Global Environmental Facility (GEF), Mexico's installed renewable energy capacity from wind grew from just over 2 MW at the end of 2000 to 524.5 MW at the beginning of 2011, with a pipeline of at least 3,400 MW of committed wind energy set to come on-line through 2016. This growth could be substantially higher, as there are a large number of potential self-supply projects being considered that have not yet received permits from CRE and are thus not included in this total). Today, Mexico has a thriving renewable energy program with active participation by both the private and public sectors.

This case study describes both the process and solutions used to overcome barriers to renewable energy development in Mexico. Mexico's approach could be replicated by other countries seeking to drive renewable energy development under the supported NAMA framework.

The Story

Context for renewable energy development

In 1937, Mexico's national power company, the Federal Electricity Commission (Comisión Federal de Electricidad, or CFE) was created. Prior to this, the Mexican electricity sector was made up of a number of largely foreign-owned private entities. The Electricity Public Service Act (EPSA) passed the following year, creating the rules under which CFE and private companies would generate, transmit and distribute electricity. Over the next decade, the low tariffs mandated for certain areas of the country led private investors to shy away from adding new capacity. In addition, CFE, at the behest of the Mexican government, began buying private utilities, which made other private sector interests even more nervous about investing further in Mexico. This inhibited the growth required in the sector and motivated additional government interventions, which led to a *de facto* nationalization of the system.

Article 27 of the Mexican Constitution was amended in 1960 to officially designate electricity generation, transmission, transformation, distribution and supply as public services. These were all deemed to be sovereign activities ("the exclusive responsibility of the Nation") and thus solely under the domain of the Federal government. Private-sector actors were not allowed to participate in electricity generation, except self-supply for use on their own premises. However, this exclusion had no real practical impact on the sector: by the time this Amendment was enacted, the Mexican government had already acquired all of the private utilities in the country.

In 1975, the Law of Public Service of Electricity (*Ley del Servicio Público de Energía Eléctrica, or LSPEE*) was established, replacing the EPSA and completing the nationalization of the electric industry in Mexico. This law officially proclaimed that two state-owned electric companies, Comisión Federal de Electricidad (CFE) and Compañía de Luz y Fuerza del Centro (LFC), were to be the sole public suppliers of electricity. (Due to financial difficulties, LFC was taken over by CFE in October of 2009.)

At this same time, it was becoming increasingly difficult for CFE to build enough new capacity to keep up with growing electricity demand. Through 1973, retail electricity prices (tariffs) – which are set by the Finance Ministry (Hacienda), not by CFE – largely reflected the associated costs. However, beginning the following year, Hacienda used oil revenues to lower tariffs, helping achieve broader public purposes (e.g., to control inflation and retain political support for the ruling party). For example, from 1974-1989, fuel oil was sold to the power sector at just 30% of its opportunity cost, resulting in an effective subsidy of about $1.5 billion per year (in 2001 dollars) to the power sector that was passed through to consumers (to meet the tariff requirements). Over this time, fluctuations in electricity prices largely tracked changes in the subsidy level (with a two-year delay).

On top of this, from 1982, when Mexico defaulted on its external debt, through the mid-1990s, the country experienced a number of economic crises, each of which was accompanied by strong restrictions on public debt. This culminated with the crisis of 1994-1995; in a deal with its creditors, the government agreed to prohibit publicly-owned enterprises from taking on additional debt. This limited CFE's ability to expand its capacity to keep up with rising demand. Its hands were tied because it couldn't raise revenues (tariffs were under the control of Hacienda, and residential and agricultural consumers were strongly opposed to increases in their highly subsidized electric rates), couldn't lower costs (due to strong labor unions), and couldn't borrow.

In response, the Mexican government began to promote private sector investment in capacity expansion. This was possible because, to comply with NAFTA, the *LSPEE* had been amended in 1992 to allow greater private sector participation in electricity generation in the form of:

- Self-supply (extended from persons "individually considered" to self-supply companies);
- Co-generation;
- Independent power producers (IPPs), who must sell their generated electricity to CFE;
- Small producers (less than 30 MW), who must also sell their generated electricity to CFE; and
- Generation for export.

Article 36-BIS of this amended LSPEE also requires CFE to purchase power for public supply at the lowest possible cost, generally interpreted as the least cost per kWh delivered.

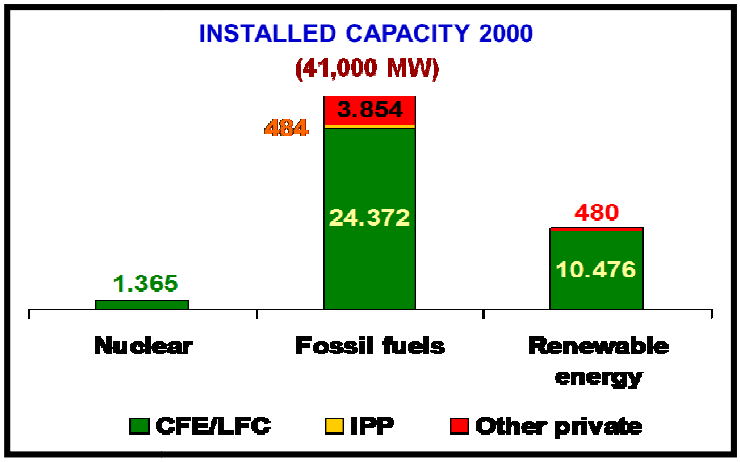
In 1993, the Energy Regulatory Commission (CRE) was formed as an advisory body to SENER. And in 1995, CRE was given the authority to regulate private-sector electricity generation in Mexico—duties previously performed by CFE.

The reforms in the early- to mid-1990s took a while to bear fruit, but were ultimately successful in driving growth in private sector electric capacity. The first independent power producer began operation in 2000, and the IPP program accelerated rapidly after that. Between 2000 and 2002, about half of new capacity came from IPPs, and a significant fraction resulted from self-suppliers seeking to lock-in long-term power contracts at a lower price than the rates charged by CFE. Only about one-third of the new capacity in these years was built directly by the public sector. The majority of this new capacity—both private and public—was fueled by natural gas.

Baseline capacity: The power mix in 2000

At the end of 2000, México had 41,000 MW of installed power capacity (see Figure 1). While nearly 11,000 MW of this capacity was based on renewable energy (RE), most of this was in the form of large hydro (see Figure 2). In addition, only 480 MW of renewable energy were due to private investments, and the great majority of these were in outdated sugar cane mills. CFE had a couple of small wind demonstration projects, La Venta and Guerrero Negro, which began operation in 1994 and 1999, respectively, with a total capacity of 2.3 MW. In addition, by year 2000, a couple of permits had been granted by CRE for self-supply generation using wind (all of these were proposed CDM projects), and private developers were seeking to undertake additional projects. The first phase of one of these wind farms, Fuerza Eólica del Istmo, was permitted in 1998 and is in operation (Phase II is under construction), while the other, Baja California 2000, was never built due to lack of power contracts[2] (and its CDM validation was terminated). However, due to economics and the purchasing requirements used in the bidding process for long-term contracts with CFE, IPPs built new NGCC facilities rather than renewable energy.

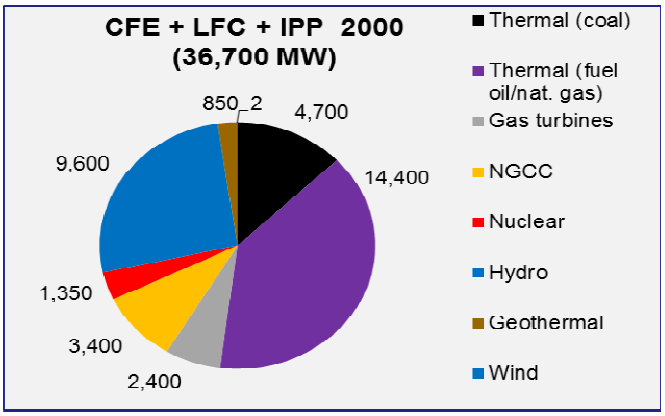
Figure 1. Mexico's Electricity Capacity by Generating Entity in 2000



Source: CRE.

[2] Because the grid in Baja California was not interconnected with the rest of the country, the project had to seek consumers within a limited area.

Figure 2. Mexico's Electricity Capacity by Fuel Type in 2000: Public Generators and IPPs only



Source: CRE.

In 2001, officials at the Ministry of Energy (SENER) wanted to develop policies to promote enhanced use of renewable energy and take advantage of the plentiful wind resources in southern Mexico. While this was partly due to a desire to reduce greenhouse gas emissions, the primary motivation was the need to diversify the fossil-dominated fuel mix of the electricity sector. CFE had recently experienced a large increase in generation costs due to rising natural gas and oil prices and wanted to make itself less vulnerable to such price swings in the future. However, there was still a reluctance to use national funds to subsidize renewable energy development, and the least cost purchase requirement still prohibited investments in renewable energy sources that cost more than the least-cost alternative. Further, beyond its two small demonstration projects, CFE was reluctant to invest in additional wind energy facilities due to concerns about the economics and intermittency of wind power. Other than large hydropower, the only RE power that CFE was willing to consider was geothermal, because it offered firm capacity and could be dispatched on demand.

Initial wind mandate: Overcoming CFE's reluctance to build wind

With CFE unwilling to invest in wind power voluntarily, and to initiate the development of Mexico's outstanding wind resources, in 2002, SENER issued a policy directive requiring CFE to finance its own wind power generation. This mandate from SENER allowed CFE to proceed without having to show least cost. This would be the first large-scale wind investment and first wind CDM project in Mexico, and the hope was that it would serve as a demonstration project that would spur further development of wind capacity in the country. The initial goal was 50 MW of wind capacity by 2006, but one year later this goal was incremented to 100 MW.

CFE was pushed by SENER into launching a competitive bidding process for construction of a wind farm and the necessary interconnection line to the Mexican grid. This bid included design and construction, insurance, and training of personnel. Preliminary work on the project began in 2005, and the next year, Mexico entered into an agreement with the World Bank to provide financial support for this project – a

loan of $113,865,000 for construction of the 83.3 MW "La Venta II" wind plant[3] and interconnection line and an agreement to purchase the verified emissions reductions (VERs) from the project on behalf of the Spanish Carbon Fund ($11,340,000 for an estimated 1.8 $MtCO_2e$ of VERs from 2007-2016) and the Bio-Carbon Fund ($945,000 for an estimated 0.54 $MtCO_2e$ of VERs from 2017-2019). Per the CDM Project Design Document, the income from the sale of VERs would reduce the levelized cost of energy production from $55.43 per MWh to $50.90 per MWh, which was still significantly higher than the $36.72 per MWh cost of the alternative, a natural gas combined cycle plant.

Another component of the La Venta II development was the provision of assistance to the local community, which was required to build support for the project from the local landowners. La Venta II was to be located on communal land – an ejido – and the Mexican government agreed to compensate the inhabitants through direct payments to landowners (approximately doubling their incomes on average); establishment of a trust fund (seven million pesos) to pay for public lighting, road paving, and computers for some schools; and establishment of an employment agency that would give local citizens priority in hiring for jobs associated with construction of the wind farm. These efforts were initially complicated by poor records on property ownership, as this information was not formally registered with the government. For this and subsequent projects, the government has recognized local property documents, and provided advice on reasonable accommodations. However, landowner negotiations remain a challenging and time-consuming part of wind energy projects in Mexico, particularly for the private sector, due to the complexity of the leasing rules and the lack of clear compensation guidelines.

On-site work at La Venta II was initiated in 2005, and the facility began operation in 2007.

Initial incentive program to support participation by IPPs

Feed-in Tariff and Revised Capacity Payment for IPPs

Whereas the initial SENER directive focused on overcoming reluctance by CFE to include wind in its generating portfolio, much of the new electric capacity in Mexico was being built by IPPs that were building natural gas combined cycle units and were inexperienced with wind farms. To build this experience, while also developing CFE's institutional capacity to value, acquire and manage renewable energy resources, and to make the costs more competitive with conventional power supply options, the government of Mexico issued additional instructions to CFE to contract for renewable energy capacity and obtained a $70 million grant from the Global Environment Facility (GEF) through the International Bank for Construction and Redevelopment. This grant was to be distributed in two phases. Phase I ($25 million) included $0.7 million for project management, $3.9 million for technical assistance[4], and $20.4 million to establish a "green fund" and develop an IPP program to generate renewable energy for CFE.[5]

[3] The size of the plant was reduced because the bids were higher than expected and the budget was not sufficient to build 100 MW of capacity.

[4] Development of methodologies for determining "least cost" when including diversification and environmental benefits of renewable energy; analysis and modeling of the incorporation of renewable energy into CFE's system; renewable energy project and business development; green power and export market development.

[5] The Government of Mexico also contributed $1.5 million of direct and in-kind support for the technical assistance work, $15 million of direct co-financing, and $6 million of foregone treasury revenues through an accelerated depreciation program for renewable energy investments.

Through that fund, CFE could pay each IPP an additional incentive of up to 1.1¢ per kWh delivered (a feed-in tariff) for the first five years of generation. Modeling by CFE and the World Bank indicated that this level of subsidy would lower the cost incurred by CFE for a 100 MW (350 GWh per year) wind farm to that of marginal generation sources in the system, satisfying the least cost purchase requirement. Large hydro and geothermal projects were excluded from this incentive, which effectively meant that it would be devoted to wind.

Phase II of the GEF grant (the remaining $45 million) was intended to be used to continue to incentivize renewable energy through a feed-in tariff that diminished over time. The corresponding program for accessing and using these funds (e.g., the size of the feed-in tariff and how rapidly it would decrease over time) was to be determined once the technical assistance tasks from Phase I were complete and in place. However, since the completion of these tasks has been delayed and CFE has now established a successful bidding program for IPPs that is not dependent upon a feed-in tariff, the second phase of the GEF grant has not been used.

A key challenge in fostering renewable energy through IPPs involved reaching agreement on the rules of payment; determining these rules took more than one year. Normally, IPPs would be paid not only for the energy delivered, but also for their generation capacity, any amount of which could be requested by CFE at any time. However, CFE was unwilling to pay for capacity for intermittent sources. The main problem with wind IPPs is that the IPPs cannot guarantee that the wind will blow when capacity is required by CFE, and therefore the capacity payment could not be treated in the same way as for an NGCC IPP (i.e., based upon the full capacity of the facility). Finally, the decision was taken to base the capacity payment for wind on the available capacity during peak periods (on average each month) and simply include it as part of CFE's total payment per kilowatt-hour delivered to the grid, recognizing that when the power was delivered, it was because the capacity was available. This capacity payment, , approved by CRE in 2005 and specified in modifications to the Interconnection Contract model, was important to make wind projects economically viable for IPPs.

The goal of the program negotiated with GEF was to encourage 101 MW of wind capacity in a first stage (a minimum of 70 MW had to be delivered to trigger the second phase of the project) and up to an additional 400 MW capacity in a second stage. However, only the first IPP plant, La Venta III, will receive the additional incentive of 1.1¢ per kWh from GEF funds for the first five years of generation under a 20-year long-term contract with CFE. Once the bidding process had concluded for the 100 MW La Venta III project (2008), CFE had gained experience working with IPPs to develop RE projects and was already convinced of the advantages of wind power. By 2008, four additional 100 MW plants had been included in CFE's expansion program (Oaxaca I-IV). While these plants will not receive the GEF-financed feed-in tariff, they are all CDM projects.

Government tax incentives: Accelerated depreciation

As an in-kind contribution to the GEF project, the Mexican government agreed to provide a tax advantage for renewable energy investments. While the Congress was supportive, the incentive faced resistance from Hacienda. Ultimately, Hacienda was convinced of the advantages of avoiding emissions

through cleaner new electricity generation resources rather than through reductions at existing industrial sources, where the costs might be higher. A modification of the Income Tax Law, the Accelerated Depreciation for Investments with Environmental Benefits (*Depreciación Acelerada para Inversiones que Reportan Beneficios Ambientales*), was approved by the Mexican Congress to favor new investments in RE. Under this new fiscal regime, which took effect in 2005, companies that invest in machinery and equipment for power generation using renewable sources may deduct up to 100% of the total investment in a single year. (If a company is unable to use the full amount of the tax rebate in the first year, they may use the remainder in subsequent years.) Based on influence from Hacienda, the law also establishes the obligation for the beneficiary to maintain the machinery and equipment in operation for a minimum of five years. The only fiscal incentive that Mexico provides for RE, the incentive is offered both to self-supply projects and IPPs.

Addressing the next barrier: Insufficient transmission

With the early successes in building wind through SENER's mandate to CFE and the IPP feed-in tariff pilot program, in combination with the initial permits issued to self-suppliers, the transmission capacity in the Isthmus of Tehuantepec—where high wind speeds could maintain capacity factors above 40 percent—was fully reserved and insufficient to handle further wind development. Self-supply plans are normally not available when CFE plans its own transmission infrastructure. CFE was also reluctant to build extra transmission capacity since public funds would have to be used unless self-suppliers could guarantee to reimburse CFE for its full payment. Furthermore, CFE did not believe that the proposed self-supply projects were economically viable and preferred to keep control of the generation.

To deal with this, CRE developed an open bid system in which IPPs and companies with self-supply projects would bid privately for capacity, including the cost of building new transmission lines. CFE could also reserve capacity for itself during this process. If the bids covered the cost of the new lines, then the lines would be built.

Under the proposed scheme, CFE would construct the required infrastructure with Congressional approval. However, the bidding companies would have to fully pay for the new transmission infrastructure (excepting the capacity reserved by CFE) once it came into operation and was ready to use. Once CRE allocated the new transmission capacity to the bidding companies, they had to place guarantees for 5% of the total estimated cost. The guarantees would then have to be incremented to cover 25% of the total cost before CFE went to Congress for approval and to 100% just before the transmission project was built by CFE.

In the first of these "open seasons," CFE was hoping to add 1000 MW of transmission capacity. CRE expected no more than 500 MW of self-supply and IPP capacity to be bid, but the bidding process ended with bids for 1,800 MW of transmission capacity. These bids covered the full cost of the new lines, indicating a higher level of profitability than expected. The installation was completed in November of 2010. CFE built a total of 2,300 MW of new transmission capacity operating at 440V, reserving the extra increment for use by future IPP projects.

CFE later decided to free up another 300 MW of transmission in the existing infrastructure to help fund necessary improvements, including reinforcing and modernizing the receiving substation and tending a second 220 kV transmission line on a system of existing towers. CRE held another small open round of bidding which led to an allocation of an additional 330 MW for self-supply projects that had initially reserved capacity on the still-to-be-built transmission lines but were willing to take advantage of this new opportunity because it allowed them to start their projects two years sooner.

At the present time, there are 524.5 MW of wind in operation (85.25 MW by CFE and 439.25 by self-suppliers and small producers), an additional 1,468.8 MW in different stages of construction that will come into operation between 2011 and 2013 (509.4 MW by IPP's under contract with CFE[6] and 959.4 MW for self-supply) and 461.5 MW that have reserved and paid capacity on the new transmission line but have not yet begun construction.

CFE´s latest expansion program, published this year, includes four new 300 MW wind IPP plants, Sureste I-IV, for a total of 1,216 MW, to be installed between 2013 and 2016. Rumorosa I-III, another 300 MW of wind power being built in Northern Mexico in part to serve the California market, are also part of the capacity addition plans for 2014.

In August of 2011, Mexico announced four additional "open seasons" for new transmission capacity that will provide access to renewable energy in Oaxaca, Tamaulipas, and Baja California for wind and in Puebla for small hydro (less than 30 MW). In response, CRE received bids for more than 22 GW of renewable energy, from which it will choose 4 GW for development. This significant excess of bidding illustrates the growth in interest in RE in Mexico by private-sector developers. It also suggests that the rate of transmission capacity expansion is not keeping up with demand for new self supply renewable energy capacity.

Changing the rules to encourage renewable energy use by self-suppliers

Alongside efforts to encourage renewable energy use by IPPs and CFE, the government sought to encourage renewable energy development by large and small self-suppliers. Several policy reforms (creation of an energy bank to support sales to and purchases from the grid, predictable wheeling fees, lower capacity back-up fees, and net metering for small self-suppliers) were implemented to support fair and predictable access to the grid, helping to jump-start interest in wind development by the private sector, particularly in high-wind areas of the country that support the highest capacity factors.

Energy Bank

Since wind self-suppliers cannot necessarily produce the electricity when it is needed to satisfy their associated load demand, in 2001 CRE established an "Energy Bank" to disengage energy supply from energy demand. Self-suppliers can "deposit" excess generation into this bank and "recover" it from the

[6] This includes La Venta III as well as Oaxaca I-IV, four 102 MW plants that were included in CFE's expansion program and are scheduled to begin operations in 2011. Developed by IPPs in response to CFE bids, these plants are all CDM projects, helping to ensure a sufficient return on investment.

bank when they are not producing enough power to satisfy their required demand. At the end of the year, if there is a net positive balance in the account (as should happen, since the charges are very high if the self-supplier ends up with a deficit), the self-supplier can choose to sell some portion of this balance to CFE at a discounted rate (85% of the marginal price) or carry over the balance to the next year. However, there is a limit on the total amount of energy that a self-supplier can carry over from one year to the next.

Predictable Wheeling Fees

Wheeling is the act of providing access to or transporting power over transmission lines, and CFE levies a wheeling fee on "off-site" self-supply projects (where the location of the generation is different from the site at which the self-supply power is consumed) for access to its high-tension transmission lines. CFE previously used its own simulation methodology for determining wheeling fees, based on the location of the power supply, the location of the power use, and whether the transmission went with the flow or was counter-flow. This method was not transparent, making it more difficult for private sector developers to estimate their costs. After negotiations with SENER and Hacienda, and over resistance from CFE, CRE developed a postage stamp tolling fee for RE and efficient co-generation, which was put in place in 2004 through the Wheeling Service Agreement for Electricity from Renewable Energy Sources (*Convenio para el Servicio de Transmisión de Energía Eléctrica para Fuente de Energía Renovable)*. This fee is based upon the variable costs of the transmission line, and varies based on the tension level used. For example, in March 2011, the rates were 0.03230 MX$/kWh for High and Medium tension lines, and 0.06459 MS$ for Low tension lines. The cost only changes with inflation, thereby providing cost certainty to project developers. This simplified wheeling fee has provided a significant benefit to the wind industry, as it provides more predictable and lower (by 40-50%) wheeling fees in a shorter timeframe (thus also reducing transaction costs) than the previous scheme.

Lower Capacity Back-up Fees

Self-supply generators pay CFE a capacity back-up fee to ensure that their electricity demand is met even when their self-supply is insufficient. Since wind is intermittent, the back-up capacity needed can be large and extremely variable, making the associated fee very dependent upon the methodology used to calculate the back-up capacity required.

Prior to 2006, the required back-up capacity was calculated based on the maximum difference (in 15 minute increments, over the course of a month) between the average demand from the associated loads and the average power delivered from self-supply. Since, even in the best of the locations, there is always at least one fifteen-minute period in any given month for which an intermittent source has no generation, self-suppliers with intermittent RE sources would always have to pay a capacity fee based upon 100% of the firm capacity required by the associated loads in some 15-minute period. Because the back-up capacity fee per kWh is high, this method of calculating required back-up capacity was prohibitively expensive and presented a significant barrier to RE projects by self suppliers.

In 2006, CRE approved a new method to calculate the back-up capacity needed for intermittent RE sources by redefining the "supply" and "demand" quantities in the equation described above. CFE now

calculates "supply" as the monthly average delivered capacity of the self-supplier plant, calculated as the average of peak energy delivered during working days (Monday through Friday). "Demand" is now considered to be the maximum demand of the associated loads at any time during the month. Thus, in any given month, if the self-supplier plant delivers an average capacity greater than or equal to the maximum capacity demanded at any moment by the associated loads, it would pay no capacity back-up fee. In those months when there is not enough intermittent resource during peak week-day hours to meet this condition, the back-up capacity required is calculated as the "demand" (maximum demand of the associated loads at any given time during that month) minus the "supply" (recognized average peak capacity delivered by the plant in that month). The self supplier must pay for this back-up capacity at a rate that varies monthly and also depends upon the self-supplier's contract, the geographic location of the renewable energy project, and the voltage level of the transmission line.[7]

Net Metering for Small Self-suppliers

CRE has approved a net-metering scheme for self-supply installations with a capacity less than 0.5 MW. This allows small installations to benefit from all the renewable power generated through sales of excess generation to the grid, not just that which is used at the self-supply location at the time of generation. However, this payment is just for the generation supplied, not the capacity. As a next step, CRE is working to design a system in which CFE would incorporate a capacity payment to small producers (less than 30 MW with all power supplied to grid) and efficient co-generators that will be included in the tariff paid by CFE for each kWh delivered to the grid.

Further enhancing government authority to support renewable energy

In 2008, The Law for the Use of Renewable Energy and Finance of the Energy Transition (Ley para el Aprovechamiento de Energías Renovables y el Financiamiento de la Transición Energética, or LAERFTE) further expanded CRE's responsibilities to include duties previously performed by CFE. These include, *inter alia*, issuing standards, guidelines, and methodologies related to the administration of renewable energy; working with SENER and Hacienda to establish the rules for the fees and other costs to be paid by CFE to private electricity producers; requesting review of dispatching rules; and developing methodologies for the determination of the contribution of renewable energy to the national electricity system.

In addition to expanding CRE's role, the LAERFTE also assigns specific responsibilities to SENER. The LAERFTE requires SENER to work with Hacienda, SEMARNAT, and the Ministry of Health to develop a methodology to value externalities and include these valuations, as well as international finance (such as carbon credits) and other criteria in assessing its purchase of electricity from private-sector generation projects (i.e., in determining "lowest cost"), both renewable energy and non-renewable energy. This methodology is expected to be completed in late 2011.

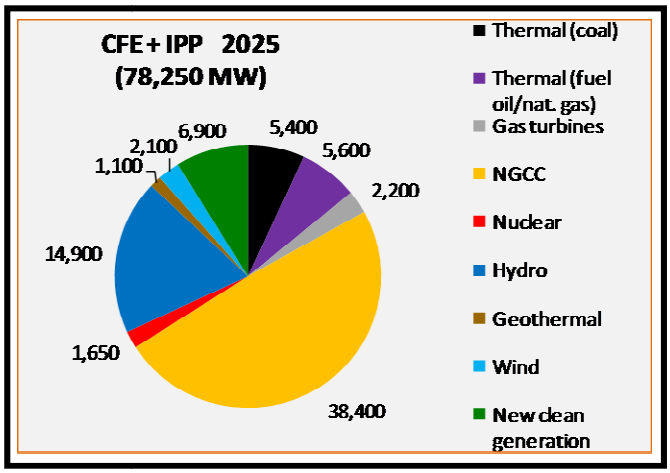
The LAERFTE also requires SENER to set gradually increasing goals for the use of renewable energies (minimum percentages for both installed capacity and power supply), to be updated every six months,

[7] See http://www.cfe.gob.mx/negocio/conocetarifa/depositosgarantia/Paginas/depositosengarantia.aspx.

and establish strategies to achieve these goals. Each year, SENER must update this strategy and prepare a progress report on achieving the country's renewable energy goals. In June of 2011, the LAERFTE was modified to require that the RE goals allow the following maximum participation rates for electricity generation from fossil fuels (subject to economic and technical feasibility): 65% in 2024, 60% in 2035 and 50% in 2050. Put another way, the target is to have 35% of electricity generation capacity in 2025 in the form of clean, non-fossil energy (nuclear, large hydro, CCS, RE), up from current clean energy capacity of roughly 29% of total electricity generation capacity.

CFE has developed a program that will allow the country to achieve this goal for 2025, either by installing its own generation plants or through IPP contracts. According to this program, 31,000 MW of new net capacity will be installed by CFE (potentially through IPPs) in the period from 2010-2025, including 3,600 MW of hydro power, 1,600 MW of wind power, 125 MW of geothermal energy and 6,900 MW in other new clean generation that is still to be defined (see Figure 3, below, for a breakdown of projected CFE/IPP capacity in 2025). It is likely that a substantial portion of the undefined clean electricity generation will come from wind power due to heavy constraints on nuclear power[8], limited availability of geothermal[9] and hydro power, and the still experimental state of solar energy.[10] CRE will have open bids oriented to small producers and efficient co-generators for any part of an annual target that cannot be met by CFE.

Figure 3. Mexico's Projected Electricity Capacity by Fuel Type in 2025: CFE and IPPs only



Source: CRE.

The LAERFTE also establishes a fund to finance initiatives related to the Energy Transition and Sustainable Use of Energy. It allocates three million pesos per year to this fund for fiscal years 2009-2011, to be spent on the promotion of renewable energy and energy efficiency projects. A technical

[8] Nuclear energy must be fully owned by the Mexican government and cannot be an IPP. This means the government must put up all the funds to support the project. In addition, following the Fukushima disaster in Japan, there is enhanced emphasis on nuclear safety and it may take a while before there is comfort to undertake a nuclear program that can meet heightened safety requirements.

[9] One expert estimates potential capacity at 1000 MW, at most.

[10] There is currently just 15 MW of grid-connected solar power in Mexico.

committee, chaired by SENER and made up of officials from a number of government ministries and agencies, has the responsibility for deciding where and how these funds are spent.

Finally, the LAERFTE also requires developers of renewable energy projects of more than 2.5 MW to (i) meet with local communities to agree upon social development projects to be implemented; (ii) compensate affected landowners with payments to be made no less frequently than twice a year; and (iii) promote social development in the community using international best practices related to sustainable rural development, environmental protection and land rights.

Results so far

Mexico now has the basic framework in place to promote large-scale RE development through 1) bidding by IPPs to fulfill CFE's renewable energy growth plans, where IPPs can take advantage of accelerated depreciation and have opportunities to purchase access to transmission infrastructure; and 2) market-based participation by the private sector to generate their own power supply, supported by fair rates to purchase and sell electricity to the grid and to transmit power on the grid, as well as programs to support new transmission construction, and accelerated depreciation for equipment purchases. Additional programs are being developed or are in place to support participation by small producers, including net metering for homes and businesses (less than 0.5 MW).

The policy changes and incentives for renewable energy that were established in the last decade resulted in a significant expansion of wind power, from just 2.3 MW in 2000 to 524.5 MW 2010. This included 85 MW installed by CFE, 435 MW by self-suppliers, and 5 MW by small suppliers. At a minimum, an additional 3,446 MW of wind energy is in the pipeline, set to be operational by 2016. The new incentives also led to significant growth in large hydro (1,675 MW), geothermal (110 MW), small hydro (90 MW) and biomass and biogas (45 MW). (The large hydro and geothermal power were established by CFE, and the small hydro and biomass/biogas were installed by small suppliers.)

However, even with all of the policies and programs that Mexico has put in place to spur the development of wind power, the Kyoto Protocol's Clean Development Mechanism (CDM) still plays a major role in most such projects. Tables A1 and A2 in Annex A lists all of the wind energy projects in Mexico that are in operation or under construction and have attained permits from CRE. Nearly all of these are also CDM projects. In fact, while private-sector developers have generally praised the Mexican government's initiatives to promote wind power, they have also indicated that the CDM is vital to their willingness to invest in wind projects in Mexico. This indicates that wind energy is still not cost-competitive in Mexico, and its continued growth may therefore depend upon the continuation of the CDM or a comparable funding source post-2012 and/or the adoption of the new methodology being developed by CFE to include environmental costs and benefits in its determination of the "least cost" electricity.

Next Steps

Going forward, additional steps to further enhance renewable energy development by the private sector in Mexico could include measures to reduce the time required for project development, including

permitting, negotiations for interconnection, and facilitating long-term leasing of land. More accurate wind resource assessments at both the regional and state levels would also support growth in the market.

Peer-to-Peer Learning

From an examination of Mexico's development of its renewable energy program, it is clear that wind power, in particular, faced numerous barriers—barriers that may be shared by other countries. It is also clear that these barriers can be overcome with government leadership employing a combination of mandates, regulatory changes and incentives that systematically address each impediment (financial, least cost purchase requirements, intermittency, grid access and sales, insufficient transmission, local resistance).

- A key factor in **overcoming resistance from the government utility** was new legislation that shifted power to regulators that were more supportive of wind power and private sector involvement. The legislature created a bigger role for the private sector in power markets, and also made changes to the entities responsible for overseeing the rates by which private companies could gain access to the electricity grid.
- Mexico's **lack of experience** and **resistance from the government utility** was overcome with a forced demonstration project coupled with international financial support. Government policy makers seeking greater electricity diversification issued a directive requiring a large-scale wind project, and financing from the World Bank in the form of a construction loan and an agreement to purchase the VERs made it possible from a financial and legal standpoint. This act required energy officials to exercise leadership and power to change the status quo. And the forced pilot project enabled CFE decision makers to better understand the operating characteristics and technical and financial viability of this resource within the larger power system.

  Inexperience with private sector (IPP) renewable energy production was overcome with a separate demonstration project that was facilitated with outside support in the form of a feed-in tariff. A key factor in making IPP renewable energy economically viable was a fair agreement on capacity payments.

  Over time, CFE learned they could balance intermittent wind plants with the country's flexible hydro power resource, ensuring sufficient supply during peak demand periods. During off-peak periods, the system had sufficient supply even when the wind was not blowing.
- Making renewable energy attractive for self-suppliers required changes to a series of **unfavorable rules for private developers of intermittent renewable energy** to purchase sell and transmit power on the grid.
  - **Depending on when the wind is blowing, at any given point of time, self suppliers may need to buy or sell power.** Previously, the price of the back-up capacity charged to self-suppliers was very high, essentially reflecting the maximum difference between supply and demand over the course of the month. And initially, self-suppliers were not compensated for excess power supplied to the grid. These issues were addressed with support of the regulator. CRE established a new methodology for calculating the required capacity payment, based on the difference between the average peak power

supply over the month and the maximum demand, and an Energy Bank was established to support sales of excess generation (at 85 percent of the marginal price).

- **Unpredictable fees paid by self suppliers to use the grid.** The fees paid by self-suppliers to wheel power from the location where renewable energy is produced to where it is used previously depended on the output of a simulation conducted by the national utility, which was difficult to predict. With intervention from the regulator, a new methodology was developed to calculate tolling fees, which are published and change only with inflation. The new fees are transparent, and lower.

- Mexico's **least cost purchase requirement** is being addressed by using a broader definition of cost to include the real cost savings (e.g., fewer energy cost spikes) related to having a more diverse electricity portfolio, and avoiding the harmful effects of alternative energy sources. The economics test was also aided by **government incentives** in the form of accelerated depreciation. This was Mexico's in-kind contribution that helped the country to receive a significant GEF grant that supported feed-in tariffs.

- Mexico overcame the problem of **insufficient transmission** to support significant private sector growth in wind energy by creating a new bidding mechanism for the private sector to cover the costs of new CFE transmission capacity.

- Some progress was made in establishing required process steps to support fair **negotiations with landowners** to compensate the loss of values associated with traditional land uses and benefit the affected communities. However, the guidance did not include suggestions for determining fair amounts of compensation. Landowner negotiations continue to be a time-consuming part of efforts to expand renewable energy capacity and remain a barrier to timely construction and operation.

The Mexico case study also shows how outside financial support can serve as a catalyst to spur renewable energy development, demonstrate the underlying economics and overcome financial barriers. In Mexico's case, this external financial support came in the form of a World Bank loan for the capacity and transmission costs of a large-scale renewable energy project, a promise from the Spanish Carbon Fund and the Bio-Carbon Fund to purchase verified emissions reductions, a GEF grant to support a feed-in tariff program for a large-scale renewable energy project that sought to facilitate IPP involvement, and the broader CDM marketplace. Fast Start Finance offered for Nationally Appropriate Mitigation Actions (NAMAs) presents a new opportunity to promote wind and other renewable energy resources on a more comprehensive basis and with lower transaction costs. NAMA support would be expected to supplant the CDM market as the leading form of international finance.

References

Aldrich, E. L. 2009, "Barriers to Clean Development Mechanism Renewable Energy Projects in Mexico" *Renewable Energy* 34 (3), p. 504-508, http://works.bepress.com/elizabeth_aldrich/13.

Barnés de Castro, F. 2011, private communication, CRE, February 11 and June 28.

Bonetto, C., & Storry, M. 2010, "Power in Mexico: Renewables Remain More Desired than Real," Global Business Reports, POWER Business and Technology for the Global Generation Industry, May 1, http://www.powermag.com/business/Power-in-Mexico-Renewables-Remain-More-Desired-than-Real_2657_p2.html.

Carreón-Rodriguez, V. G., Jiménez San Vicente, A., & Rosellón, J. 2003, The Mexican Electricity Sector: Economic, Legal and Political Issues, Program on Energy and Sustainable Development, Stanford Univ., Working Paper #5, November, http://iis-db.stanford.edu/pubs/20311/WP5%2C_10_May_2004.pdf.

Center for Energy Economics (University of Texas at Austin), & Instituto Tecnológico y de Estudios Superiores de Monterrey. 2006, "Guide to Electric Power in Mexico: First Edition," September, http://www.beg.utexas.edu/energyecon/documents/Guide_To_Electric_Power_in_Mexico.pdf.

Comisión Reguladora de Energía (CRE). 2011, Convocatoria para la Celebracion de Temporadas Abiertas de Reserva de Capacidad de Transmision y Transformacion de Energia Electrica Desarrollarse en los Estados de Oaxaca, Puebla, Tamaulipas y Baja California (Call for an Open Season to be Held for Reserve Capacity and Transformation of Electrical Energy Developed in the States of Oaxaca, Puebla, Tamaulipas and Baja California, www.cre.gob.mx/documento/publicaciones/ConvocatoriaTA.pdf.

CRE. 2011, Tabla de permisos de Generación e Importación de Energía Electrica Administrados al 31 de Agosto de 2011(Versión Excel), available at http://www.cre.gob.mx/articulo.aspx?id=171.

Elizalde Baltierra, A. E., Sasse, D., Zeferino Abundis, Y., Quiroz Juárez, C., López Satow, E., Beltrán Mora, H. & Crisóstomo Ramírez, D. 2011, Use of Renewable Energy in the Electric Power Generation Sector in Mexico: Political, Regulatory, Economic and Technical Issues from 1965 to 2018, World Energy Conference, Montreal, downloaded April 2011, http://www.worldenergy.org/documents/congresspapers/375.pdf.

Farchy, D. 2007, Hedging Mexico's Electricity Bets: The Case for Renewable Energy, ESMAP Knowledge Exchange Series, No. 9, June, http://www.esmap.org/esmap/node/429.

Girolami, J. A. 2009, Going Verde - Renewable Energy in Mexico, *The California International Law Journal,* Vol. 17, No. 2, http://girolami-law.com/GIRO_WhitePapers/Mexico-Goes-Verde.pdf.

Landa, J. A. 2011, private communication, Mexican Wind Energy Association (AMDEE), June 3.

Laguna Estopier, A., & Vásquez Cadena, L. F. 2001, private communication, Acciona Energía, July 26.

Ley del Servicio Público de Energía Eléctrica (LSPEE). 2011, Law for the Public Service of Electricity, June 1, 2011 version, http://www.diputados.gob.mx/LeyesBiblio/pdf/99.pdf.

Ley para el Aprovechamiento de Energías Renovables y el Financiamiento de la Transición Energética (LAERFTE). 2011, Law for the Development of Renewable Energy and Financing of the Energy Transition, June 1, 2011 version, http://www.diputados.gob.mx/LeyesBiblio/pdf/LAERFTE.pdf.

National Institute of Ecology (INE). 2007, Mexico's Third National Communication to the UN Framework Convention on Climate Change, Ministry of Environment and Natural Resources (SEMARNAT), October, http://unfccc.int/resource/docs/natc/mexnc3e.pdf.

Oceransky, S. 2008, Wind Conflicts in the Isthmus of Tehuantepec: The Role of Ownership and Decision-Making Models in Indigenous Resistance to Wind Projects in Southern Mexico, 7th World Wind Energy Conference, Kingston, Ontario, June 23-26, http://www.ontario-sea.org/Storage/26/1834_Wind_Conflicts_in_the_Isthmus_of_Tehuantepec.pdf.

Secretaría de Energía (SENER). 2010, Prospectiva del Sector Eléctrico 2010-2025, Mexico Ministry of Energy, http://www.sener.gob.mx/res/1825/SECTOR_ELECTRICO.pdf.

SENER. 2011, Programa Especial para el Aprovechamiento de Energías Renovables (Special Program for the Development of Renewable Energy), Mexico Ministry of Energy, downloaded April 2011, http://www.sener.gob.mx/res/0/Programa%20Energias%20Renovables.pdf.

Townshend, T., Fankhauser, S., Matthews, A., Feger, C., Liu, J., & Narciso, T. 2011, GLOBE Climate Legislation Study, Global Legislators Organization (GLOBE) International and Grantham Research Institute on Climate Change and the Environment, April, http://www.globeinternational.info/wp-content/uploads/2011/03/GLOBE-CLIMATE-LEGISLATION-STUDY.pdf.

UNFCCC. 2011, CDM Project Design Documents for Mexico wind projects, search parameters: "Sectoral Scopes: Energy Industries (renewable - / non-renewable sources) (1)" and "Host Country: Mexico", http://cdm.unfccc.int/Projects/Validation/index.html.

USAID. 2009, Mexico wind farm case study, September, http://www.energytoolbox.org/gcre/wind_case_study.pdf.

Valle Pereña, J. 2011, private communication, SENER, July 27 and August 31.

World Bank. 2003-2011, Mexico – Wind Umbrella (La Venta II) Carbon Finance Project, La Venta II project home page with link to all project documents, http://web.worldbank.org/external/projects/main?pagePK=64283627&piPK=73230&theSitePK=40941&menuPK=228424&Projectid=P080104 .

World Bank. 2006-2011, Large-scale Renewable Energy Development Project (Phase 1 = $25M; Phase 2 = $45M), La Venta III project home page with link to all project documents, http://web.worldbank.org/external/projects/main?pagePK=64283627&piPK=73230&theSitePK=40941&menuPK=228424&Projectid=P077717.

Xavier Salazar Diez de Sollano, F. 2011, Towards a low carbon emissions energy sector: Mexico's regulatory efforts, CEER-Ariae 2011 Encounter, Comisión Nacional de Energía, Madrid, March 23, http://www.ariae.org/download/reuniones/III_Encuentro_ARIAE-CEER_2011/PDF%203_20110323%20CRE.pdf.

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Annex A. Approved Wind Projects in Mexico as of June 30, 2011

Table A1. Wind Projects in Operation

Project	Site	Project Type	Capacity (MW)	Authorized Capacity (MW)	Authorized Energy (GWh/yr)	Start Date	CDM Project Name
La Venta	Oaxaca	PS	1.35	n/a	n/a	Nov 1994	None
Guerrero Negro	BC	PS	0.6	n/a	n/a	Mar 1999	None
La Venta II	Oaxaca	PS	83.3	n/a	n/a	Jan 2007	La Venta II
Parques Ecológicos de México	Oaxaca	SS	79.9	79.9	280.00	Jan 2009	La Ventosa Wind Energy Project
Eurus	Oaxaca	SS	250.5	300.0	876.00	Jun 2009	Eurus Wind Farm
Municipio de Mexicali	BC	SS	10.0	10.0	27.00	Oct 2009	La Rumorosa I Wind Farm
Eléctrica del Valle de México	Oaxaca	SS	67.5	67.5	365.16	Apr 2010	Eléctrica del Valle de México Wind Farm
Bii Nee Stipa	Oaxaca	SS	26.35	26.35	100.13	Apr 2010	Bii Nee Stipa
Centro Regional de Tecnología Eólica	Oaxaca	SP	5.0	5.0	21.90	Jul 2010	None

Codes – *Site:* BC = Baja California; *Project Type:* PS = Public Service, SS = Self Supply, SP = Small Producer

Table A2. Wind Projects Under Construction (per CRE Permits)

Project	Site	Project Type	Capacity (MW)	Authorized Capacity (MW)	Authorized Energy (GWh/yr)	Projected Start Date	CDM Project Name
La Venta III	Oaxaca	IPP	101.4	102.85	288.00	Jun 2011	None
Demex (2 Phases)	Oaxaca	SS	227.5	227.5	933.30	Oct 2011	Piedra Larga Wind Farm, Piedra Larga Fase II Wind Farm
Oaxaca I	Oaxaca	IPP	102.0	102.0	410.00	Nov 2011	Oaxaca I Wind Farm
Oaxaca II	Oaxaca	IPP	102.0	102.0	326.40	Dec 2011	Oaxaca II Wind Energy Project
Oaxaca III	Oaxaca	IPP	102.0	102.0	326.40	Dec 2011	Oaxaca III Wind Energy Project
Oaxaca IV	Oaxaca	IPP	102.0	102.0	326.40	Dec 2011	Oaxaca IV Wind Energy Project
Fuerza Eólica del Istmo (2 Phases)	Oaxaca	SS	80.0	80.0	350.00	Dec 2011	Fuerza Eólica del Istmo Wind Farm, Fuerza Eólica del Istmo – Phase II Wind Farm
San Matias	BC	SP	20.0	20.0	70.00	Dec 2011	None
Rumocannon Primera Fase	BC	SS	72.0	72.0	220.75	Dec 2011	None
Bii Stinu (2 Phases)	Oaxaca	SS	164.2	164.0	642.00	Mar 2012	Bii Stinu Wind Energy Project
Santa Catarina	NL	SS	20.0	17.5	37.30	2012	Santa Catarina Wind Farm Project
Istmeño	Oaxaca	SS	215.65	215.65	943.60	Apr 2013	Istmeño Wind Farm
Santo Domingo	Oaxaca	SS	160.0	160.0	600.00	Nov 2013	Santo Domingo Wind Energy Project

Codes – *Site:* BC = Baja California, NL = Nuevo Leon; *Project Type:* IPP = Independent Power Producer, SS = Self Supply, SP = Small Producer

Table B3. Other Planned Wind Projects (per CRE Permits)

Project	Site	Project Type	Capacity (MW)	Authorized Capacity (MW)	Authorized Energy (GWh/yr)	Projected Construction Start Date	CDM Project Name
El Porvenir I	Tam	SS	54.0	54.0	170.30	Mar 2012	EL PORVENIR I Wind Farm
Bií Hioxo	Oaxaca	SS	227.5	226.8	645.62	Dec 2012	None
Energía Eólica Mareña	Oaxaca	SS	180.0	180.0	776.00	Dec 2013	None

Codes – *Site:* Tam = Tamaulipas; *Project Type:* SS = Self Supply

Table B4. Other Planned Wind Projects (Capacity Additions per CFE; no CRE Permits yet)

Project	Site	Project Type	Capacity (MW)	Authorized Capacity (MW)	Authorized Energy (GWh/yr)	Projected Start Date	CDM Project Name
Sureste I-II	Oaxaca	IPP	608.0	n/a	n/a	2013	None
Rumorosa I-II	BC	IPP	200.0	n/a	n/a	2014	None
Sureste III	Oaxaca	IPP	304.0	n/a	n/a	2015	None
Rumorosa III	BC	IPP	100.0	n/a	n/a	2015	None
Sureste IV	Oaxaca	IPP	304.0	n/a	n/a	2016	None

Codes – *Site:* BC = Baja California; *Project Type:* IPP = Independent Power Producer

Note: A number of other planned wind projects for self-supply or export have been reported by various sources, but these projects have not yet obtained permits from CRE for the operation of a wind farm and are therefore not listed in the above table.