

# Renewable Energy

## in Mexico's Northern Border Region



Jonathan Pinzon  
Lilia de Diego  
Rafael Carmona  
Luis Aguirre-Torres

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Mexico Institute  
Woodrow Wilson International Center for Scholars  
One Woodrow Wilson Plaza  
1300 Pennsylvania Avenue NW  
Washington, DC 20004-3027

[www.wilsoncenter.org/mexico](http://www.wilsoncenter.org/mexico)





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# 1. Introduction – Renewable Energy in Mexico

On September 23, 2003, the Nuevo Leon state government inaugurated the first landfill biogas project in Latin America with an initial installed capacity of 7.4 megawatts (MW),<sup>1</sup> which has since grown to 16.96 MW. This date is significant, as it was the first major self-supply renewable energy project in Mexico, and also the first where a local government was involved. Over ten years later, in Nuevo Leon there are four major renewable energy generation projects, including a 22 MW wind farm. Nonetheless, Nuevo Leon currently generates only about half of its electricity requirements, and over 99% of electricity generated in the state relies on fossil fuels.

Heavy reliance on fossil fuels is a common theme across the Mexican Northern Border States with the notable exception of Baja California (which gets over 30% of its public service electricity<sup>2</sup> from the Cerro Prieto geothermal plant). Despite abundant wind, solar and bioenergy resources, Northern Mexico has yet to fully embrace the energy transition, but this could rapidly change in the next few years.

Mexico's recent Energy Reform, which included modifications to the Constitution in December 2013 and a comprehensive package of implementing legislation on August of 2014, represents a fundamental transformation of the sector.<sup>3</sup> For renewable energy, the major opportunities are

related to the creation of a new electricity market and the introduction of Clean Energy Certificates. In the new market, the National Center for Electricity Control and Dispatch (CENACE) will be fully independent of Mexico's Federal Electricity Commission (CFE), thus allowing for a more transparent wholesale electricity market in which users above a set consumption threshold will be allowed to freely switch between generators. Mexico has already committed to produce 35% of its electricity from clean sources by 2024.<sup>4</sup> The new proposed legislation states that set targets will be made obligatory to all generators in the electricity market. To this end it proposes the introduction of Clean Energy Certificates, details of which will be defined by the Secretariat of Energy and administered by the Energy Regulatory Commission but will most likely emulate Renewable Energy Certificates in electricity markets in the United Kingdom and the United States.<sup>5</sup>

As of August 2014, Mexico has reached 25% of installed capacity from renewable energy, although close to 20% is from large-scale hydroelectric plants, which have their own set of social and environmental problems. Nonetheless, the most notable growth in recent years has come from wind farms, most of which are in Oaxaca. In its most recent planning documents CFE<sup>6</sup> and Mexico's Ministry of Energy's (SENER)<sup>7</sup> baseline scenario projects that by 2027

Table 1. Mexico's Evolving Energy Matrix

	2010*	2014**	2027p	2027a
Total Installed capacity	60,072 MW	62,233 MW	98,652 MW	114,874 MW
Hydroelectric	19.3%	20%	16.9%	14.5%
Wind energy	0.7%	3.1%	10.5%	25.6%
Geothermal	1.6%	1.3%	1.1%	0.9%
Solar	0%	0.1%	0.4%	0.4%
Biomass and biogas	0.1%	0.3%	0.3%	0.2%

\* Source: CFE

\*\* Source: SENER, CRE, Asociación Mexicana de Energía Eólica, Asociación Mexicana de Geotermia  
 2027p is the "planning scenario" and includes nuclear, clean coal and other to be identified clean energy sources.  
 2027a is the "alternate scenario" which would be mainly driven by wind energy, reaching almost 30 GW by 2027



Table 2. Total Authorized Generation Capacity from Renewable Sources

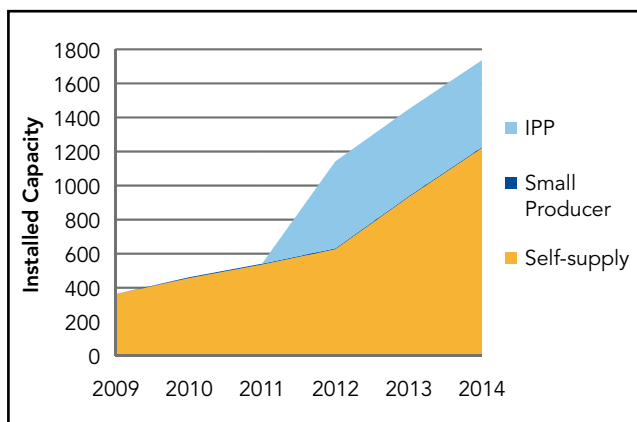
Energy source	Number of projects	Authorized capacity (MW)	Average project size (MW)
Wind	55	5,198.36	94.5
Solar	105	3,010.54	28.6
Hydro	63	1,138.35	18
Sugarcane Bagasse*	15	318.17	21.2
Biogas	22	112.75	4.75
Geothermal	2	65	32.5

installed capacity from renewables will reach 29.2%, but in order to reach the goal of 35% generation from non-fossil fuel sources, installed capacity would have to reach 41.6%.

Clean electricity generation in Mexico is off to a good start, and its growth has been through a combination of incentives, regulation, competitive generation costs (particularly for wind energy) and demand by large consumers. In recent years, CFE has reached close to 700 MW of wind energy, mostly through Independent Power Producers, and a 5 MW solar pilot plant. But the real growth of renewables in Mexico has been mostly fueled by the private sector. There are currently over 400 private generation projects (self-supply, cogeneration and small producer) with an authorized capacity of close to 8,000 MW, out of which about 20% is from renewable sources. Over the last 6 years, private generators have added close to 1.8 GW of wind energy to the electric system.<sup>8</sup>

By the end of 2014, private generators had gained regulatory approval from the Mexican Energy Regulatory Commission (CRE) for an additional 9.8 GW for projects that have been planned before the end of 2018, which include over 5 GW of wind, 3 GW of solar, 420 MW from biofuels and 65 MW from geothermal.<sup>9</sup> All of these permits fall under legacy rules and will be able to decide if they participate in the new electricity market from the 2013-2014 Energy Reform. Although the majority of these projects will never see the light of day (particularly for solar, as most of the approved permits are for the small producer modality that has a higher level of risk involved) the private sector has indicated a major interest that will be crucial in order to achieve the 35% 2024 goal.

Graph 1. Cumulative Wind Energy Installed Capacity from Private Generators by Modality



One final recent development worth mentioning is the sudden increase in small and medium distributed generation projects. By law, only projects larger than 500 kW require regulatory approval through permits with CRE. Projects smaller than that only require an interconnection contract with electricity supplier (which is currently limited to CFE), which allows users to discount energy generated on-site in a billing period. At the end of 2013, CRE reported a total of 29 MW in over 4,600 small and medium interconnection contracts, mostly in small-scale solar (19.7 MW), medium-scale solar (6.9 MW) and biogas (2.4 MW). The majority of contracts (12.9 MW) are under 10 kW. CRE estimates that by 2020 there could be close to 205 MW from such projects,<sup>10</sup> although this is undoubtedly a conservative estimate as rooftop solar is competitive in the residential (DAC tariff) and commercial (Tariff 2) sectors.



## 2. Mexico's Northern Border States Renewable Energy Potential

Mexico is endowed with a large amount of resources that could be used for electricity generation from renewable sources. According to the first phase results of the National Renewable Energy Inventory, Mexico's strengths lie in wind, solar and geothermal energy.

### Geothermal

CFE has identified seven exploitable geothermal reservoirs in the State of Baja California, including Cerro Prieto. The largest, Laguna Salada, could have an installed capacity of over 2 GW. In Sonora, only one reservoir with a potential installed capacity of over 5 MW has been identified. Chihuahua has over 20 potential locations, though each one could have an average of only 5 MW. Overall, Mexico's geothermal potential is confined to Baja California and the Central volcanic region.

### Solar

Mexico has the largest solar energy potential in Latin America with an annual average irradiation of 6 kWh/m<sup>2</sup>. Baja California, Sonora and Chihuahua are among the states with the best available resource. To date there are almost 50 MW of utility scale installed capacity, which includes the largest photovoltaic project in Latin America, built in 2013 in the state of Baja California Sur with a capacity of 30 MW.<sup>11</sup> The project was developed under the small producer scheme, which allows private developers to arrange power purchase agreements with CFE. Across the country, there are currently 66 projects planned with an authorized capacity of 1,625 MW.

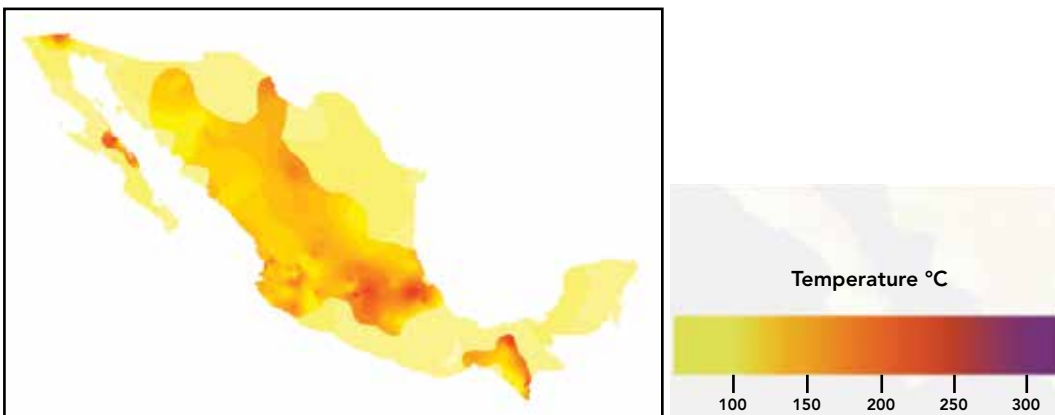
Table 3. Mexico's Possible Renewal Resource\*

Resource	Geothermal	Hydro	Mini-hydro	Wind	Solar	Bioenergy
Possible resources	7,422 MW	9,243 MW	670 MW	50,000 MW	5,000,000 MW	3,642 MW

Source: Inventario Nacional de Energías Renovables, <http://iner.energia.gob.mx/>

\*These figures do not take into account technical or economical viability and are only meant to reflect the country's rich resource potential.

Map 1. Mexico Geothermal Potential



Source: Inventario Nacional de Energías Renovables <http://inere.energia.gob.mx>



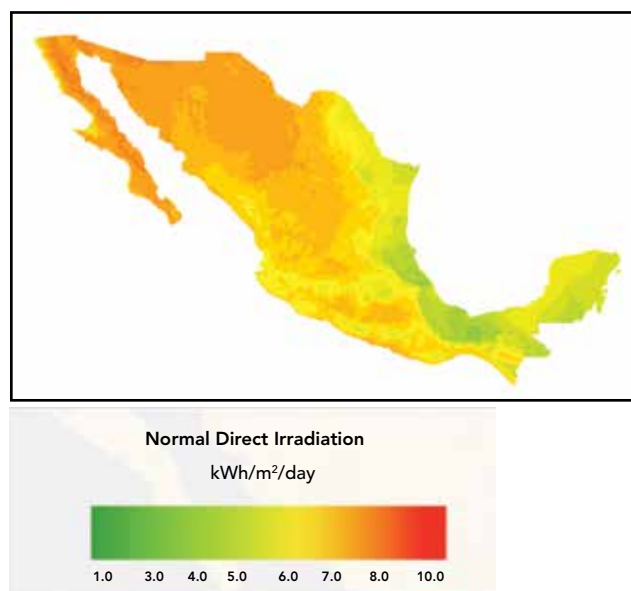
Table 4. Installed Capacity from Utility Scale Solar Projects

Modality	Authorized capacity (MW)	Technology	State	Year of operation
Self-supply	0.787	Photovoltaic	Aguascalientes	2011
CFE Public Service	5	Photovoltaic, Thin Film, Concentrated PV	Baja California	2012
Self-supply	1.04	Photovoltaic	Baja California	2014
CFE Public Service	1	Photovoltaic	Baja California Sur	2012
Small Producer	30	Photovoltaic	Baja California Sur	2013
Small Producer*	15.62	Photovoltaic	Durango	2014
Self-supply	0.97	Photovoltaic	Guanajuato	2013
Self-supply	0.51	Photovoltaic	Guanajuato	2013
Self-supply	0.98	Photovoltaic	Sinaloa	2014

\* In January, 2015 this project received a permit for the self-supply modality, overriding the previous permit.

It is estimated that there are about 20 MW of solar panel installations for rural and off-grid electrification.<sup>12</sup> Rooftop solar is experiencing significant growth. As of December 2013, there are about 26.5 MW coming from small and medium scale solar installations with net-metering contracts with CFE. The three states with the highest number of interconnection contracts are Jalisco, Guanajuato and Baja California (this last one with about 4 MW installed up to last year).<sup>13</sup> These, and other small-scale renewables, could reach close to 200 MW by 2020.<sup>14</sup> Some noteworthy projects have been installed in the border states, including a 150 kW in a hospital in Tijuana, Baja California;<sup>15</sup> a 30 kW public lighting project in Mexicali, Baja California;<sup>16</sup> a 16 kW at the offices of the Border Environmental Cooperation Commission in Ciudad Juarez, Chihuahua;<sup>17</sup> and a 1 kW at the Valle de las Misiones housing project in Mexicali, Baja California.<sup>18</sup>

Map 2. Mexico Solar Potential



Source: Inventario Nacional de Energías Renovables, <http://inere.energia.gob.mx/>

### Wind

Since 2009, wind energy installations in the country have grown at an impressive rate and are currently just shy of 2 GW. Additionally, CRE has approved a total of 33 projects across the country with an authorized capacity of 3,339 MW. Almost all of the projects are located in the state of Oaxaca (small

Table 5. Self-supply and Independent Power Producer Wind Projects in Operation

State	Number of Projects	Average Authorized Capacity (MW)	Total Authorized Capacity (MW)
Baja California	1	10	10
Chiapas	1	28.80	28.80
Jalisco	1	50.40	50.4
Nuevo León	1	22	22
Oaxaca	22	98.47	1,674
Tamaulipas	1	54	54

and medium sized projects have been also installed in Baja California, Nuevo Leon, Chiapas and Jalisco) but this is quickly reaching its limit, which will likely peak somewhere between 3,000-4,000 MW.

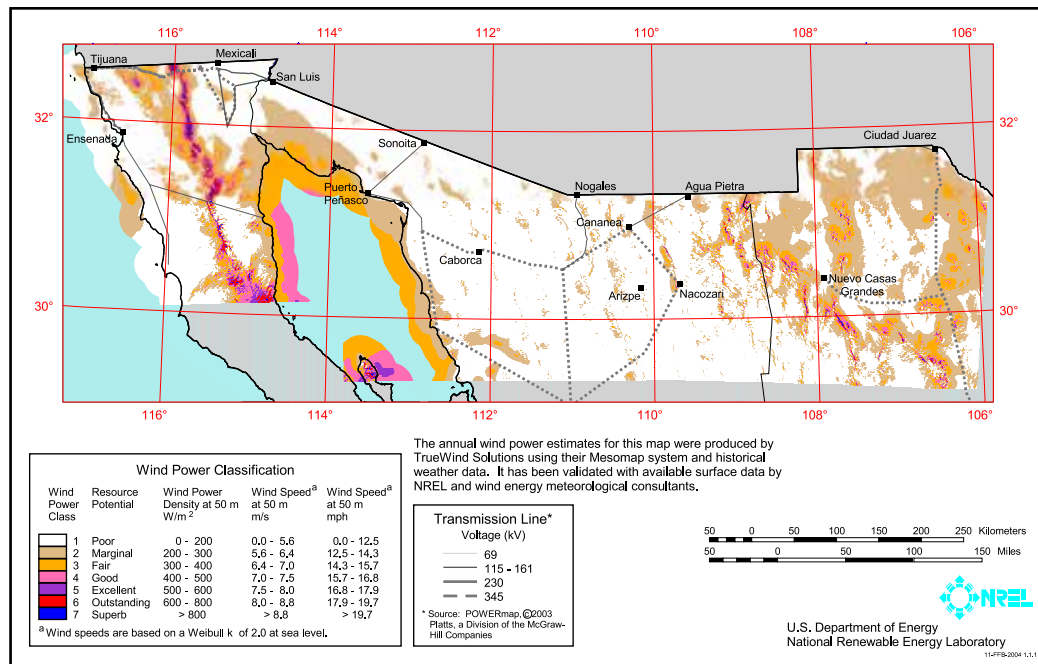
The other two regions with good wind resource are Baja California and the area between Coahuila and Tamaulipas. Indeed, these two regions will have a significant growth in the next 6 years, which could add about 3,000 MW of wind energy installed capacity to the country.

## Bioenergy

Although this paper focuses on electricity generation, there is interesting potential for non-electric applications from renewable energy in Mexico's Northern Border. In particular, it is worth mentioning the interest in energy crops for biofuels from the 2008 *Ley de Promocion y Desarrollo de los Bioenergeticos*. There are several programs in place that seek to encourage the beginning of the bioenergy industry in Mexico. The government's

goal was to achieve 6% bioethanol mix in gasolines by 2012 in the three biggest metropolitan areas (Mexico City, Guadalajara and Monterrey) and 1% biodiesel mix in low sulfur diesel.<sup>19</sup> Tamaulipas is the number one producer of sorghum and, according to the State government, it has the potential to produce 200 million liters of bioethanol.<sup>20</sup>

Map 3. Northwestern Mexico Border Areas - 50 m Wind Power







### 3. Renewable Energy in Mexico's Northern Border

Mexico's national electric system has been divided into nine regions, with eight regional system dispatch and control centers that depend on CENACE. The Northern Border States fall into four: Baja California, Northwest, North and Northeast. All, except for Baja California, are part of the National Interconnected System. There have been plans for many years to connect the Baja California system through a 300 MW line and the latest planning document from SENER aims to have it installed by the end of 2016.

*Map 4. National Electric System Regions*



Source: Prospectiva del Sector Eléctrico 2013-2027

These regions have been the backbone of the public service electricity market, which has until now been a vertically integrated monopoly. The 1992 electricity reform gave way to two other distinct electricity markets: self-supply

and imports/exports. A big part of the self-supply market has been interconnected to CFE's transmission and distribution network, but has operated as a separate market where project developers and users arranged to work around the prohibition on electricity commercialization. The third market is the private export/import market. In this section, we shall integrate information related to all three electricity markets in order to provide a wider picture related to the state of power generation along the border.

The Border States have a very high reliance on fossil fuels for electricity generation despite having extraordinary geothermal, wind and solar resources. All of the states have set up, at one point or another, an energy agency, commission or office. Municipalities of Nuevo León were the first to embrace renewable energy for public lighting through an alliance with a public-private entity, and the Baja California Government is a rare example of a subnational government that owns and operates a major electricity generation project.

It is undeniable that CFE has played an important role in geothermal, and recently solar, generation in this region. In Cerro Prieto, located to the south of Mexicali, it has operated one of the world's largest geothermal facilities since the 1970s and recently set up a solar pilot project to test four different technologies. But recent and expected growth in renewable generation will flow from the private sector, with some local governments also participating (mainly as off-takers).

Table 6. Major Renewable Energy Projects in the Border

State	Municipality	Resource	Installed Capacity	Start of operations	Type of Consumer
Baja California	Mexicali	Geothermal	570 MW	1973	Public Service
Baja California	Tecate	Wind	10 MW	2009	Municipal Government
Baja California	Mexicali	Solar	5 MW	2013	Public Service
Baja California	Tijuana	Solar	1.04 MW	2014	Manufacturing
Chihuahua	San Francisco de Conchos	Hydroelectric	3 MW	1928	Public Service
Chihuahua	Delicias	Biogas	0.80 MW	2009	Livestock
Chihuahua	Juárez	Biogas	6.40 MW	2011	Municipal Government
Nuevo León	Monterrey	Biogas	9.20 MW	1997	Municipal Government
Nuevo León	Monterrey	Biogas	1.60 MW	1997	Municipal Government
Nuevo León	Santa Catarina	Biogas	16.96 MW	2003	Municipal Government
Nuevo León	Santa Catarina	Wind	22 MW	2013	Municipal Government
Sonora	Cajeme	Hydroelectric	19.20 MW	1957	Public Service
Sonora	Navojoa	Hydroelectric	9.60 MW	1959	Public Service
Tamaulipas	Xicontenatl	Sugarcane bagasse	45.50 MW	2010	Sugar refinery
Tamaulipas	Reynosa	Wind	54 MW	2014	Convenience stores

\* Only hydroelectric plants of less than 30 MW are listed above. Most of the projects listed above are greater than 0.5 MW for which CRE has regulatory oversight. A high number of small projects, particularly solar, are known to be installed, particularly in Baja California and Chihuahua but we have omitted them for this list to avoid information bias. ANES, the Mexican Solar Energy Association, is currently working on developing a census of projects across the country.

## Baja California

Baja California is the state with the most active electricity market in the whole country. Isolated from the rest of the interconnected system, CFE actively trades energy with the United States through two permanent connections to substations in Otay Mesa and Imperial Valley and has even signed a power purchase agreement with the City of Los Angeles to supply it with geothermal energy. Of the 34 electricity import permits nation-wide, 27 are for companies operating in the state (the remaining import permits are for 4 companies in Sonora, 1 company and 2 municipalities in Coahuila). It also has 3 of the 4 export permits for over 1.2 GW, which is performed through dedicated export lines to the California market. Adding all three markets, the total installed capacity in the state in 2014 is over 4,000 MW. This is most evident in comparing public service generation in

geothermal, which accounted for 33.2% in 2012,<sup>21</sup> whilst this technology only accounts for 14.11% of the installed capacity in the state in 2014.

Table 7. Baja California Installed Capacity (2014)

	Installed capacity (MW)	Percentage
Fossil fuels (CFE)	2019.22	46.55%
Fossil fuels (self-supply)	200.95	4.98%
Fossil fuels (export)	1235.37	30.59%
Geothermal	570	14.11%
Solar	6.04	0.15%
Wind	10.6	0.26%



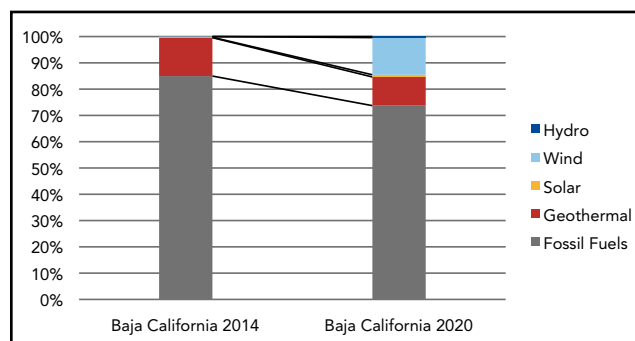
Cerro Prieto, Mexico's largest geothermal project, started operations in the 1970s with major expansions through the 1980s and most recently at the turn of the century. Due to its massive operating capacity of 570 MW, over one third of electricity generated for public service in the State comes from renewable sources. CFE also has a 5 MW solar pilot project within Cerro Prieto that has been used to test four different solar energy technologies (thin film, one axis polycrystalline, two axis polycrystalline and two axis concentrated photovoltaic).

There has been long-standing interest in the export potential to the California market and one project, Energía Sierra Juarez (being built by IEnova, a Mexican subsidiary of Sempra Energy), is under construction for the first phase of 155 MW and is expected to begin operations in the first semester of 2015 and could eventually reach 1,200 MW.

In Baja California, the latest information available related to the open season for transmission capacity indicates a reserved capacity of 740.50 MW for 7 wind energy projects, although only 568.8 MW have been authorized by CRE. Additionally, CFE has planned three projects (Rumorosa I, II and III) for a total of 300 MW.

For 2020, Baja California could achieve an installed capacity of 6,280 MW, 72% of which is from fossil fuels. Wind energy could climb from the current 10 MW to a number of projects with a potential installed capacity of 968.8 MW, representing 13.85%, part of which is to be destined to the cross-border California market. Geothermal energy could go down to 10.67% of the total installed capacity while solar and hydroelectric power would continue to represent minor quantities: only 1.2% between both of them.

Graph 2. Baja California's Installed Capacity in 2014 and 2020



### Chihuahua

Chihuahua is the largest state in Mexico and a big consumer of electricity. In 2012, it generated 13,400 GWh for public service, representing 5.1% of CFE electricity generation in Mexico, and consumed 10,744 GWh, or 5.2% of the country's total consumption. Given the manufacturing activities that characterize this state, the major energy consumer is the industrial sector, which captured 52.4% of the generated electricity, followed by the commerce and services sector with 30.6%, while residential use represented only 17.1%.<sup>22</sup>

In 2014, the total installed capacity was 2,788 MW and it is largely dominated by fossil fuels representing 98.6%, including CFE and self-supply, while the remaining 1.4% is comprised by hydroelectric power and biogas. The self-supply market has been so far served by fossil fuels and adds up to almost 8% of the installed capacity in the state.

Chihuahua's installed capacity could reach 4,762 MW in 2020. Although fossil fuels will still dominate (89.6%), private solar energy projects could achieve 271.72 MW of installed capacity (5.75%). Additionally, two more projects have been announced: Aleph Solar Fields with an initial

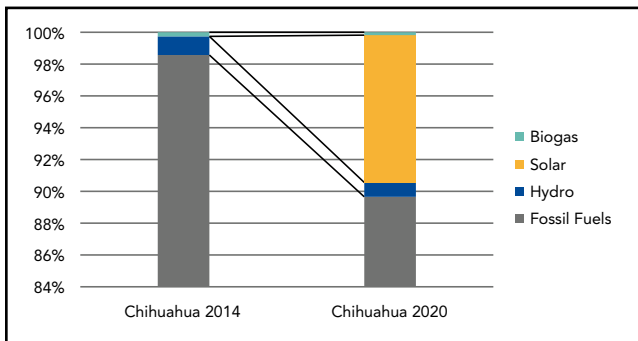
Table 8. Chihuahua Installed Capacity (2014)

	Installed capacity (MW)	Percentage
Fossil fuels (CFE)	2524.5032	90.52%
Fossil fuels (self-supply)	224.36	8.05%
Hydroelectric	29.6968	1.06%
Biogas	7.2	0.26%



investment of 500 million pesos (38 million dollars) and an installed capacity of 180 MW; and Los Santos Solar I and II with an installed capacity of 305 MW.<sup>23</sup> Together, these projects have the potential to set a precedent for renewable energy in this Northern state.

Graph 3. Chihuahua's Installed Capacity 2014 v. 2020



### Coahuila

Coahuila is the state that currently relies the most on coal electric power plants for electricity generation (90.1%). In 2012, Coahuila generated 19,669 GWh, which constituted 7.6% of the power produced in Mexico.

Being a predominantly manufacturing economy, it is not surprising that Coahuila's main energy consumer in 2012 was the industrial sector representing 71.6%, distantly followed by the residential sector (16.8%) and commerce and services sector (11.6%). By the end of 2014, Coahuila had an installed capacity of 3,292.2 MW and relies on fossil fuels (98%) both from CFE and self-supply, while hydroelectric power reaches 2%.<sup>24</sup>

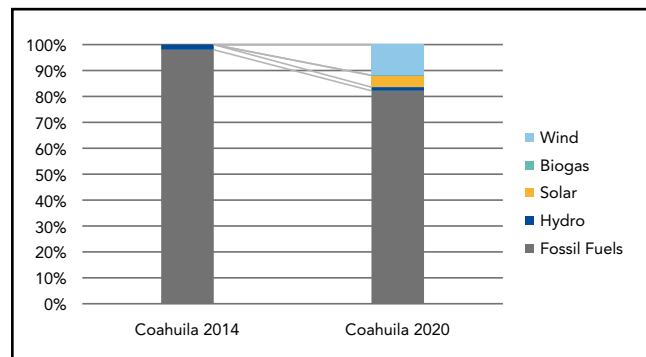
Table 9. Coahuila Installed Capacity (2014)

	Installed capacity (MW)	Percentage
Fossil fuels (CFE)	2923.731	88.81%
Fossil fuels (self-supply and cogeneration)	273.692	9.19%
Hydroelectric	65.769	2.0%

Still, by 2020, projections indicate that installed capacity from fossil fuels could go down to 82.2%, through the addition of solar, wind and biogas. This potential change could make Coahuila one of the most interesting cases in the region, as currently power generation relies mainly on coal power plants. Wind energy generation stands out with a projected installed capacity of 550.6 MW (11.83%) followed by solar with 210 MW (4.52%) and biogas with less than 1%.

Wind power generation is to be achieved mainly through two private projects: Eolica de Coahuila, with an installed capacity of 200.6 MW for self-supply; and Operadora Eolica Mexicana which will also power the local mining industry with an installed capacity of 300 MW. Additionally, with an initial investment of 600 million pesos, the state government and the municipalities of Torreon and Matamoros municipalities are expected to be supplied with electricity generated by Parque Solar Coahuila, a self-supply photovoltaic project.<sup>25</sup>

Graph 4. Coahuila's Installed Capacity 2014 v. 2020



### Nuevo Leon

Nuevo Leon is the second largest consumer of electricity in the country. In 2012, it accounted for 8.7% of CFE's nation-wide electricity sales but only 4% of public service generation. It is the only state in the Northern border that depends entirely on fossil fuels for public service generation, with over 90% generation from combined cycle plants.<sup>26</sup> Installed capacity from self-supply projects adds up an additional 1,175 MW, out of which only 60.56 MW come from renewable energy sources and provided electricity for state and municipal governments. The self-supply market is actually



larger, with large corporations involved in energy generation projects elsewhere (mainly in the state of Oaxaca). Of the total installed capacity in the state, over 98% is from fossil fuels.

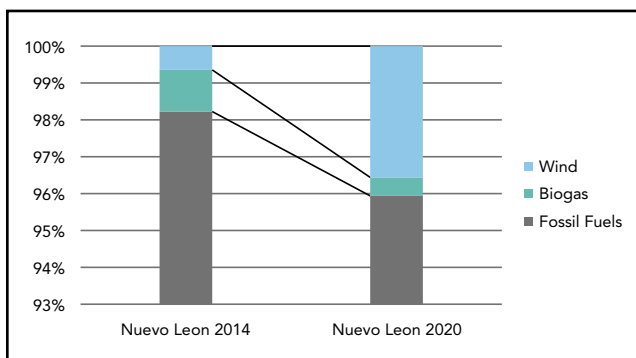
Table 10. Nuevo Leon Installed Capacity (2014)

	Installed capacity (MW)	Percentage
Fossil fuels (CFE)	1512.9	44.34%
Fossil fuels (self-supply)	1114.636	32.67%
Biogas	27.76	0.81%
Wind	22	0.64%

In spite of having interesting wind generation potential and demonstrated interest in renewable from two of Mexico's largest corporations, CEMEX and FEMSA,<sup>27</sup> in 2014 the state's wind power has an installed capacity of 22 MW, representing less than 1% of the overall 2,568.4 MW.

By 2020, Nuevo Leon is expected to still largely depend on electricity from fossil fuels (95.94%), with the rest mainly from wind power and biogas. Three self-supply wind power plants are to provide electricity to CEMEX and the mining industry, particularly Compañía Minera Autlan.

Graph 5. Nuevo Leon's Installed Capacity 2014 v. 2020



### Sonora

The industrial sector in the state has the smallest comparative demand across the Border States, with only 51.8% of electricity demand in 2012.

Close to 50% of the generation is from combined cycle plants. Sonora is the state with the highest participation of hydroelectric generation, accounting for 4.3% of electricity generated in 2012 for public service.<sup>28</sup>

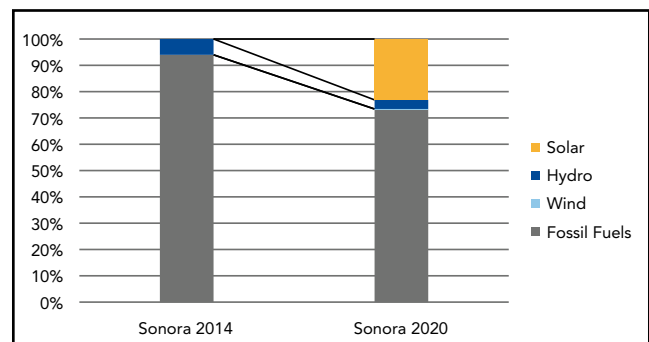
Table 11. Sonora Installed Capacity (2014)

	Installed capacity (MW)	Percentage
Fossil fuels (CFE)	1908.8646	70.06%
Fossil fuels (self-supply)	652.08	23.93%
Hydroelectric	163.7354	6.01%

Although Sonora is the territory with the highest solar insolation in Mexico, with an average of 8 KWh/m<sup>2</sup> a day, currently 94% of its installed capacity relies on fossil fuels with the rest (6%) from hydroelectric power plants. In 2020, the scenario might be rather different as fossil fuels are expected to go down to 73.4% and hydroelectric to 3.45%, while solar energy could represent 20.46% with an installed capacity of 1190 MW.

Renewable energy project off-takers, particularly for solar, will be municipalities and the Ford Motor Company plant in Hermosillo, while the mining industry (Industrial Minera Mexico) is posed to become a consumer of hydroelectric power, through the 30 MW Generadora de Energia La Angostura project. In addition, the vast majority of the solar projects are under the small power producer modality.

Graph 6. Sonora's Installed Capacity 2014 v. 2020





### Tamaulipas

Tamaulipas is the top electric power generator state in Mexico. In 2012, it produced 32,958.5 GWh, or 12.7% of the national public service generation. In the same year, only 8,907 GWh were consumed within the same state. The public service installed capacity is 5,484.6 MW, 79.4% of which corresponds to combined cycle plants.

The main electricity consumer is the industrial sector with the 60.9%, followed by the residential sector with 31.5% and only 7.6% for commerce and services, with all of them representing only 3.3% of CFE consumers.<sup>29</sup> In 2014, the total installed capacity was 5.6 GW and it is dominated by fossil fuels (CFE and self-supply) with 97.6%, with some hydroelectric power and a recently inaugurated private wind farm.

Table 12. Tamaulipas Installed Capacity (2014)

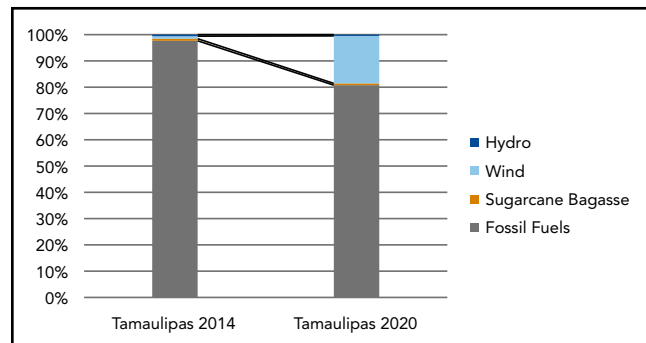
	Installed capacity (MW)	Percentage
Fossil fuels (CFE)	5517.2914	97.66%
Fossil fuels (self-supply)	324.624	5.75%
Hydroelectric	32.9076	0.58%
Wind	54	0.96%

In Tamaulipas, the latest information available related to the “Open Season” for transmission capacity, indicates a reserved capacity of 1,526.25

MW for 16 wind energy projects.<sup>30</sup> But only 635 MW have received CRE approval. CFE has planned three projects in the state (Tamaulipas I, II, and III) for a total of 600 MW.

Tamaulipas’ energy matrix by 2020 could be transformed, with fossil fuels reducing their contribution to 81.26% (down from 98.24%). The growth in renewable sources will result mainly from a big push by CFE and private generators, which could easily exceed the projected 18% of wind installed capacity (as we only consider projects with CRE approval), while biomass and hydroelectric together would cover only 1.1%. Wind energy private self-supply projects are expected to supply municipalities and a wide variety of industries, particularly the convenience and retail sector, Soriana and Nueva Wal-Mart de Mexico being the main off-takers.

Graph 7. Tamaulipas’ Installed Capacity 2014 v. 2020



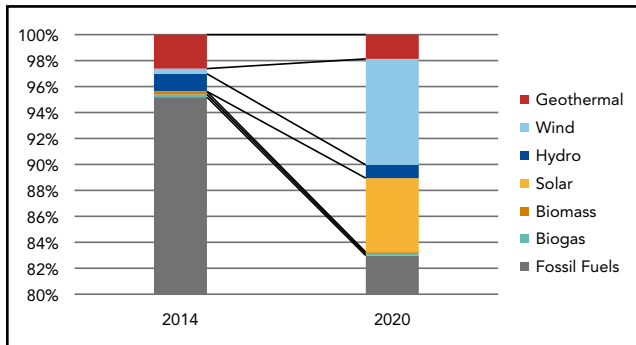


## 4. Major New Trends

### The Border's Renewable Energy Transformation

In the next six years, the region as a whole is poised to increase its installed capacity of renewable sources from 4.82% to 17.03%. The growth in renewable energy installed capacity will potentially be mostly driven by wind and solar installations with both CFE and private generators playing an important role.

Graph 8. The Border's Energy Transition



In total, for the period 2014-2020, CFE has estimated that it requires an additional 17,092 MW of installed capacity throughout the country for public service,<sup>31</sup> of which 7,424 MW (43.4%) are planned in 5 of the 6 border states, as summarized below. Of these, only 1,000 MW are planned from renewable energy.

Table 13. Public Service Additional Capacity (2014-2020)

	Combined Cycle	Turbogas	Wind	Geothermal	Solar
Baja California	830 MW	56 MW	300 MW	100 MW	
Chihuahua	1,922 MW				
Coahuila					
Nuevo León	2,122 MW				
Sonora	1,494 MW				14 MW*
Tamaulipas			600 MW		

\*This thermosolar project is under construction in conjunction with the Agua Prieta II Combined Cycle plant, but is included in this list to reflect the areas where CFE is considering adding renewable energy  
Source: Prospectiva del Sector Electrico 2013-2027

For the period 2021-2027, CFE estimates a total nation-wide additional installed capacity need of 24,665 MW. Of this, 8,408 MW (34%) are to be installed in the border states, with clean energy accounting for 2,052 MW (24.4%) of which 300 MW would be wind, 352 MW large hydro and 1,400 MW of “clean coal.” For planning, SENER and CFE often times refer to new clean energy projects, which can include Carbon Capture and Storage (CCS), wind, solar, nuclear or imports.

In contrast, of the projects that have received regulatory approval by CRE for the period 2014-2020, adding up to 7.2 GW of capacity, only 51% are from fossil fuels, 28% from wind and 20% from solar. The numbers below could be considerably higher, as not all interested parties of the open seasons in Baja California and Tamaulipas have requested/received regulatory approval. As mentioned above, interested parties in those states have reserved a transmission capacity of 740.50 and 1,526.25 MW, respectively.

Table 14. Public Service Additional Capacity (2021-2027)

	Combined Cycle	Clean Coal	Large Hydro	Wind
Baja California	1,156 MW			
Chihuahua	1,968 MW		352 MW	
Coahuila		1,400 MW		300 MW
Nuevo León	1,466 MW			
Sonora	700 MW			
Tamaulipas	1,066 MW			

Source: Prospectiva del Sector Eléctrico 2013-2027

Table 15. CRE Approved Projects (2014-2018)

	Fossil fuels	Wind	Solar	Hydro	Biogas
Baja California	382.6 MW	568.8 MW*	45.4 MW	24 MW	
Chihuahua			437.7 MW	9.98 MW	1.35 MW
Coahuila	598.1 MW	550.6 MW	210.1 MW		3 MW
Nuevo León	1,907MW	302 MW			
Sonora	159.7 MW	2 MW	724.5 MW	37 MW	
Tamaulipas	635 MW	581 MW			45.5 MW

\*Includes projects for exports

Source: CRE projects with permits up to December, 2014.

### State and Municipal Projects

Over the last few years, there has been a major drive to incorporate state and municipal governments as off-takers of renewable energy projects. To date, over 300 MW of projects with state and municipal off-takers are in operation or development, mainly with wind and biogas, but increasingly with solar and even geothermal.<sup>32</sup>

Nuevo Leon was the first state to adopt, in 2003, a renewable energy generation project, a public-private alliance that to this date is operated by Bioenergía de Nuevo León S.A. (Benlesa). The energy generated is used by municipal governments for public lighting and by state government entities.<sup>33</sup> In 2009, Baja California built the first

renewable energy facility owned and operated by a state government, La Rumorosa I, a 10 MW project that generates electricity for the public lighting of Mexicali.<sup>34</sup>

More recently, state and municipal governments across the country have turned their attention to public-private partnerships (PPP) as a means to obtain savings in their electricity bill.<sup>35</sup> PPPs enable long term contracting of services, and local legislation has steadily evolved since 2005, even before there was a federal law. PPPs for renewable energy generation have been used mostly to supply with wind power to municipalities from Chiapas<sup>36</sup> to Coahuila.<sup>37</sup>





## 5. Obstacles and Challenges

### Regulatory

Perhaps the most important and difficult challenge remaining is the government's ability to implement and streamline permitting and interconnection agreements. This will be within the purview of the new regulatory agencies – including the National Safety and Environmental Protection Agency, the National Hydrocarbons Commission and the Energy Regulatory Commission – expected to be fully functional by mid-2015. These agencies, however, face other pressing challenges following the publication of the secondary energy laws in August 2014, namely human resources needed to enact the current and proposed regulation.

### Land use

Due to the complex structure of land ownership in Mexico, land use has been a painful process for both local and foreign project developers. There are two basic schemes of land ownership in Mexico, private ownership and social ownership. There is a significant amount of land under the social property model, roughly 50% of the national territory is registered under an ejido or community model of land tenure that combines communal ownership with individual use. In Oaxaca, where most of the wind projects have been developed so far, more than 75% of the territory ownership is under the social property model. This means that in order to build a wind project, developers need to convince hundreds of persons, hiring local experts to develop and match the social and commercial component of the projects.<sup>38</sup>

### Financial

As a way of incentivizing growth, Mexico's government has offered a number of incentives to renewable energy producers, including accelerated depreciation of specific assets during the first fiscal year. There is no indication of whether this incentive will continue once the energy reform is implemented. This could mean that Mexican producers would require other and more robust incentives such as those offered in the US in the form of tax credits.

### Security

Organized crime and drug trafficking-related violence generate high rates of murder and extortion. As of August 2014, this region registers 5,329 assassinations in the year, Chihuahua and Tamaulipas being the most violent with 1,108 and 1,257 homicides respectively.<sup>39</sup> Additionally, organized crime has been increasingly involved in illegal pipeline tapping around the country. In 2010, there were 691 cases and in 2013 they climbed up to 2,340, 824 of which took place in these six states, and over half of them occurred only in Tamaulipas.<sup>40</sup> An example of how insecurity may affect the development of renewable energy projects is, precisely, Tamaulipas. It has one of the highest potentials of wind energy in Mexico after Oaxaca reaching 20 GW. However, due to the high rate of violence in the state, there is only one wind project in operation, El Porvenir with 54 MW, but the rest of the proposed wind projects are facing a slower than usual development process.

### Transmission capacity

As with renewable energy projects around the world, the question of transmission is crucial in Mexico. Getting power to market from often-distant locations that are not currently connected to the grid, or that lack adequate transmission capacity due to use by existing generation facilities, is a challenge that continues to stymie projects. In the case of Baja California, the absence of cross-border transmission has oft been cited as a limiting factor for the development of major wind energy projects in the La Rumorosa region. However, the traditional reliance on CFE for transmission capacity has been eased somewhat by the spin-off of the CENACE since the 2013 energy reform, which should provide a more agile mechanism for securing access to the grid. Nonetheless, permitting and securing finance for new transmission lines should be expected to negatively impact the development of wind, solar and geothermal for the foreseeable future.



## 6. The Impact of the Energy Reform

On August 11, 2014, President Enrique Peña Nieto signed the comprehensive Energy Reform package that includes the completely new Electric Industry Law and the Geothermal Energy Law. The Electric Industry Law, while not addressing renewable energy directly, completely redefined the electricity sector in Mexico, eliminating the vertically integrated government-owned monopoly, and creating a competitive market where private players will be able to participate in electricity generation and commercialization.

The new Electric Industry Law opens a wholesale market where “qualified” users (big consumers) will be able to procure power directly from different generators, in a more streamlined process that will be governed by power purchase agreements instead of the obfuscated self-supply modality. Mexico has already committed to attain 35% of its electricity from clean sources by 2024, a target included in the Climate Change General Law signed in 2012 by President Felipe Calderón. The new electric

industry legislation states that set targets will be made obligatory to both generators and qualified consumers in the electricity market. To this end, it proposes the introduction of Clean Energy Certificates, details of which are being defined by the Secretariat of Energy and will be administered by the Energy Regulatory Commission, but will most likely emulate Renewable Energy Certificates, used in electricity markets and similar to those in certain markets of the United States.<sup>41</sup> The Clean Energy Certificates is the most important tool that the new legislation creates to promote further deployment of renewable energy.

During the next few months, it is expected that President Enrique Peña Nieto will propose to Congress a “Green Package” that includes additional laws, which would address renewable energy directly. According to the President of the Energy Commission in the Senate, David Penchyna, this package may include focalized subsidies evaluated through specific mechanisms such as the measurement of carbon dioxide emissions.<sup>42</sup>



## 7. Policy Recommendations

Local governments should be encouraged to take an increasingly active role in the energy sector. Further liberalization of the sector would benefit from having strong local institutions. In the recent past, there have been several different attempts to introduce energy into the local government agenda. Indeed, all of the Border States have at one time or another set a specific energy agency or commission with varying degrees of results. But most states in the region have only focused on energy generation as another economic activity in their portfolio of promotion activities, whilst neglecting the wider implications of energy for development.

Most recently, Coahuila and Nuevo Leon announced the creation of an Undersecretariat of Energy, both in their respective Secretariats of Economic Development. On September 10, 2014, State Governor Egidio Torre Cantu announced the creation of a State Energy Agency under the “Tamaulipas Energy Agenda,”<sup>43</sup> a government initiative that seeks to capitalize on the recently promulgated Federal Energy Reform.<sup>44</sup> But, in reality, energy policy still remains a very centralized issue with few spaces for policy intervention at the local level.

If Mexico is to achieve its long-term energy sustainability goals it will require more than new market rules. More aggressive targets for renewable energy deployment will need to be set and local-level governments should have an increasingly important role in energy stewardship. Doing so could also entail a significant economic opportunity, as clearly defined targets have contributed to the growth of the industry,<sup>45</sup> and have encouraged the development and commercialization of technological innovation elsewhere.<sup>46</sup>

In order to further encourage renewable energy across the border, we recommend the following policy actions:

- SENER and CRE should differentiate large-scale from small-scale clean energy certificates to encourage clean technology adoption by a wider group of users (which could include rooftop solar, solar water heaters and geothermal heat pumps, to name a few).
  - The Federal Government should strengthen state government energy agencies and encourage the participation of state-level institutions from government, academia and the private sector in the energy planning process. In the past, the Energy Savings Commission (CONUEE) encouraged the creation of local government agencies, and in 2008 a network of state governments (the *Red Nacional de Comisiones de Energía*) was born but has been mostly dormant.
  - State governments and legislatures should streamline the process for municipalities to procure renewable energy, as energy public-private partnerships have already demonstrated their potential across the country.
- SENER should set aggressive, yet feasible, renewable energy generation goals at the regional level (for each of the nine electricity regions) through complimentary Renewable Portfolio Standards.

## Endnotes

- 1 We will refer to energy projects based on the nominal installed capacity in watts as opposed to actual generation (watts/hour) due to the nature of the data currently available and to give readers a comparable sense of magnitude between technologies and across states.
- 2 Prior to the recently enacted Energy Reform, Mexico's electricity sector was mostly a vertical integrated monopoly which provided the "public service" with exceptions that were incorporated in 1992 that allowed for a secondary private sector electricity market through self-supply and cogeneration (for large scale users), small-production and independent power producers (whose generation was exclusively for CFE), imports and exports.
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- 5 Jonathan Pinzon, "Renewable Energy in a Reformed Electricity Market: Where to?" *GreenMomentum Blog*, May 16, 2014, <http://blog.greenmomentum.com/wp/?p=1304> and for an overview of the implication of Clean Energy Certificates in the UK see Jesús Alarcón, "¿Para qué sirven los Certificados de Energía Limpia que propone la reforma energética?," *Animal Politico*, May 21, 2014, <http://www.animalpolitico.com/blogueros-neoliberal-nel-liberal/2014/05/21/para-que-sirven-los-certificados-de-energia-limpia-que-propone-la-reforma-energetica/>
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