

International energy transition: what dynamics of change?

The Mexican model

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au service du développement durable

Introduction

Ases-Ecological & Sustainable services purpose :

- Conservation of the biodiversity

Domains of actions :

- Climate change
- Energy transition
- Environmental impact assessment

Participation :

- Respect of the legal framework
- Effective biodiversity protection (rescue of flora and fauna)

We are a key actor in the energy market development

>> without environmental compliance and authorisation, a firm cannot build its projects on the Mexican ground.



Introduction



Energy transition implies to modify the way we use the ground. For example, in Mexico, where we use to have desert, we may change the use of the desert to build sun power plant or wind farms.



Because of these necessities to change the use of the ground, biodiversity may be impacted. And we know that protecting biodiversity is also a component of the climate change program.



Introduction



Introduction

- During the 10 past years, we mostly work on different kinds of projects impacting the nature (road, urbanization...).
 - Since 2016, the demand for implementing renewable energies in Mexico has been huge.
 - The country is doing its energy transition, and the structure and the design of the country is changing quickly and in an important way.
 - The need for roads, the needs for distribution of energies, the need for pipeline... everything is to build in Mexico, and very big projects are already emerging.
 - Because we have been awarded of this transition, we decided to focus our work on renewable energy projects.
 - Quickly, we have been in charge of managing the biodiversity impacts of the most important project of sun power plant of the American's continent.
- >> So the knowledge and the understanding of the energy transition of our country is now an important key information for us to follow on our dynamics.



Summary

Part I : General energy context of Mexico

Part II : Energy transition of Mexico

Part III : Opportunities and conclusion



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Summary

Part I : General energy context of Mexico

Part II : Energy transition of Mexico

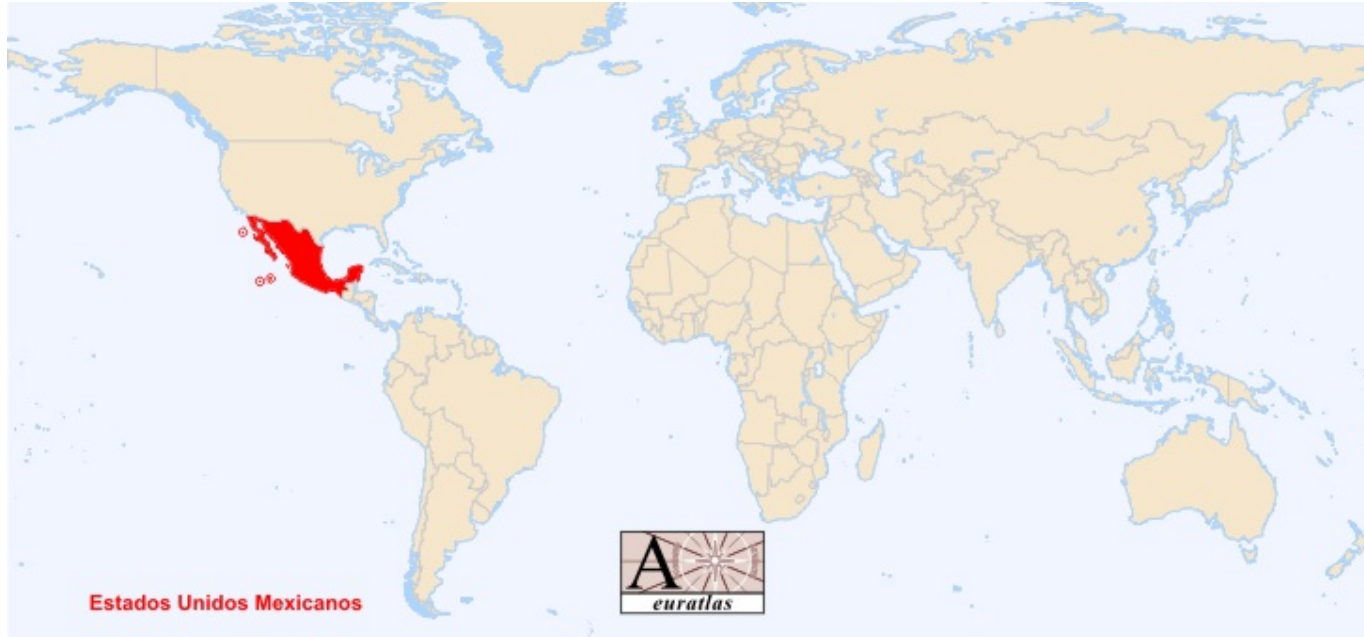
Part III : Opportunities and conclusion



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Part I

General energy context of Mexico



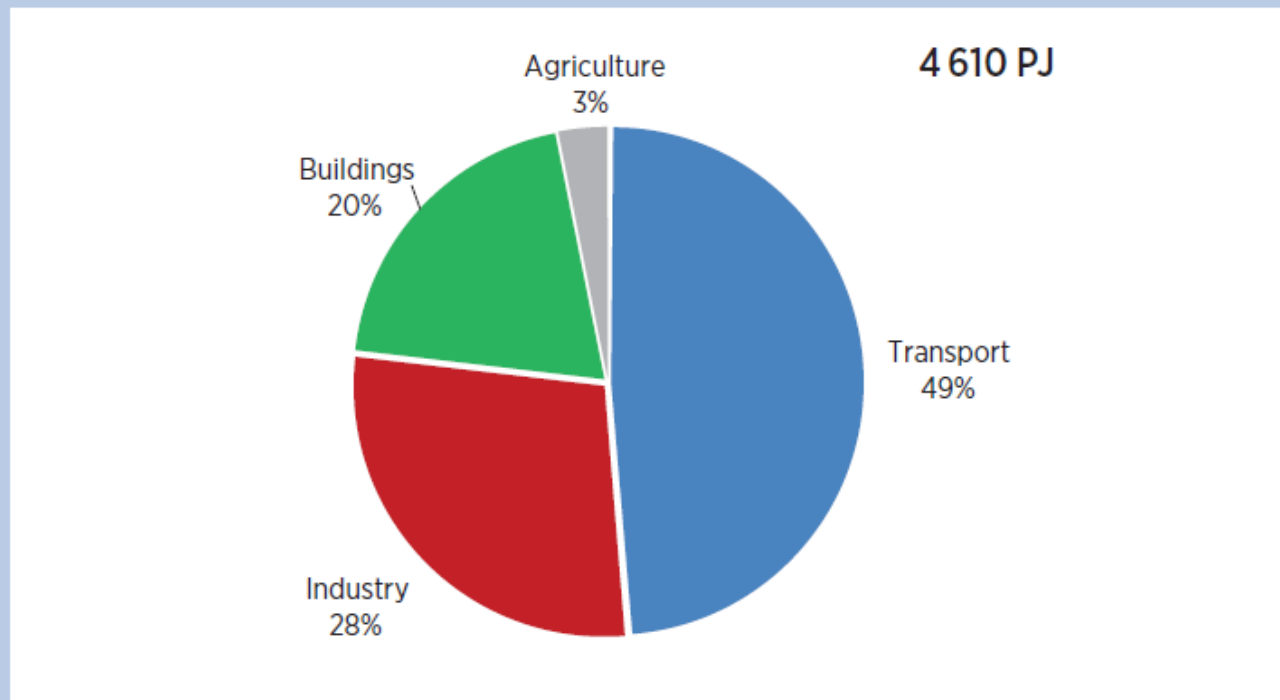
- Mexico is the second largest economy in Latin America, with a GDP of EUR 1,141 billion (2.5% growth in 2015), for a population of 122 million.
- The country also has the advantage of being connected to 46 countries through 12 free trade agreements, including NAFTA (North American Free Trade Agreement).

Part I

General energy context of Mexico

In terms of energy consumption (2010):

Figure 5: Total final energy consumption by sector, 2010



Source: Energy Information System, SENER

The transport sector is the largest energy end-user in Mexico, accounting for half of Mexico's TFEC in 2010.

Part I

General energy context of Mexico

In terms of energy consumption (2010):

In 2010, Mexico's Total Final Energy Consumption (TFEC) was 4.5 EJ, equivalent to 1.4% of global TFEC (SENER, 2012a) (IEA, 2013)

>> TFEC in Mexico is projected to increase significantly, growing from 4.5 EJ in 2010 to 7.4 EJ in 2030, an increase of nearly 70%.



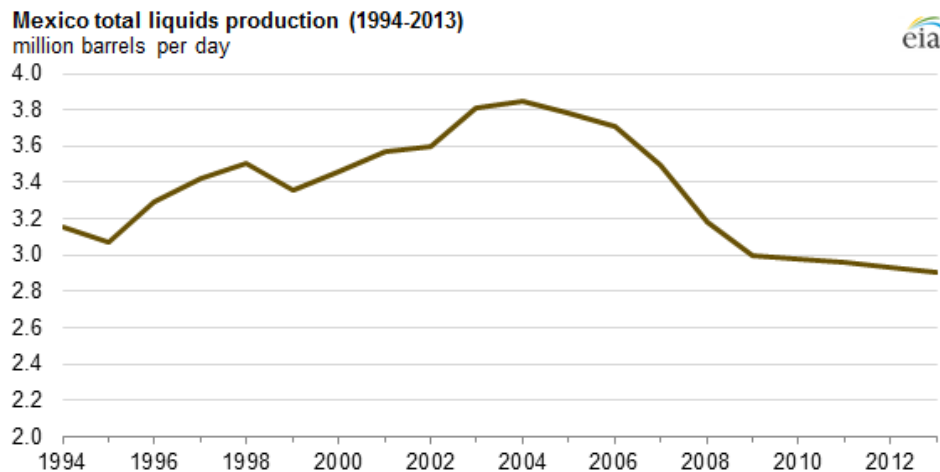
Part I

General energy context of Mexico

In terms of energy production (source IEA):

- Mexico is a major producer of petroleum and other liquids
- It is among the largest sources of U.S. oil imports
 - In 2015, Mexico accounted for 688,000 barrels per day (b/d), or 9%, of U.S. crude oil imports.
- Mexico's oil production has steadily decreased since 2005

Mexico's energy reform seeks to reverse decline in oil production



Source: U.S. Energy Information Administration

Part I

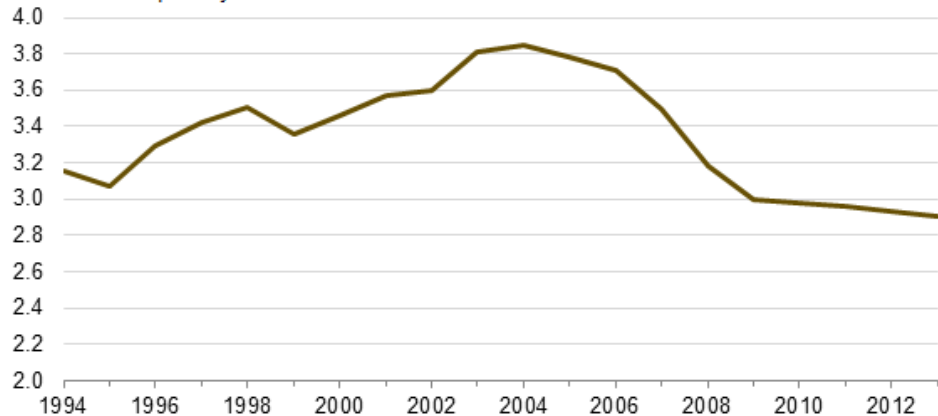
General energy context of Mexico

In terms of energy production (source IEA):

- Mexico's oil production has steadily decreased since 2005

Mexico's energy reform seeks to reverse decline in oil production

Mexico total liquids production (1994-2013)
million barrels per day



Source: U.S. Energy Information Administration

- Result of natural production declines from Cantarell and other large offshore fields.

Consequently :

- August 2014 : constitutional reforms that ended the 75-year monopoly of Petroleos Mexicanos (PEMEX), the state-owned oil company.
- The role of the petroleum sector as a component of Mexico's economy has decreased significantly in recent years as a result of:
 - Tax reform
 - The drop in oil prices
 - The diversification of the Mexican economy

Part I

General energy context of Mexico

How was Mexico's energy profil in 2013?



Part I

General energy context of Mexico

Assessment in 2013 (F.Vanholsbeeck, 2013):

- Decrease in oil and gas production
- Increase in energy demand
- Risk of importing primary energy
- Need for modernization
- Insecurity in the North of the country
- Slow administration
- Insufficient transmission



Part I

General energy context of Mexico

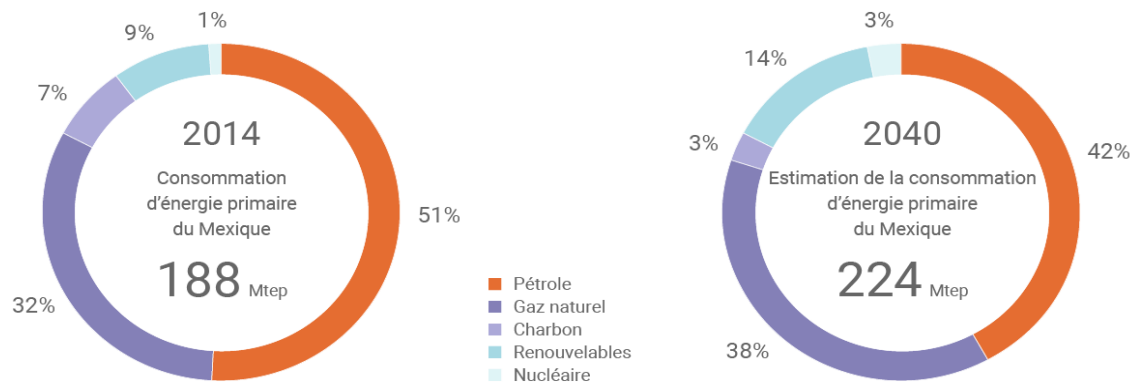
What is the plan for the futur of Mexico's energy ?



Part I

General energy context of Mexico

Projections of primary energy consumption for 2040 (source IEA):



In 2014:

- Oil accounted for more than half of Mexico's primary energy consumption, according to the latest data from the International Energy Agency (IEA).
- Renewable energies and nuclear energy (2 reactors in the country) only accounted for about 10% of Mexican energy consumption.

In its projections for 2040 (IEA):

- The increase in final energy consumption will be half satisfied by an increase in electricity production.
- Natural gas is expected to remain the country's main source of electricity generation by 2040,
- Renewable energy production, led by wind and solar PV, is expected to triple in the next 25 years, thanks in particular to calls for more energy offers supporting the development of these sectors.



Part I

General energy context of Mexico

Why shall we comply these objectives?



Part I

General energy context of Mexico

Mexico's International commitments and climate change :

- Mexico's contribution to COP21 indicated that :
 - It accounted for 1.4% of global greenhouse gas emissions
 - Its 127 million people make up 1.7% of world population
 - The country has undertaken to reduce by 22% the emissions on its territory by 2030 compared to the "Business as usual" projections.
- At the annual "three amigos" summit at the end of June 2016 :
 - Mexico also joined the US-Canada commitment to reduce methane emissions by 40% to 45% by 2025 compared to 2012.
 - The United States , Canada and Mexico announced their joint commitment to produce half of their electricity from low-carbon sources by 2025.



Part I

General energy context of Mexico

Mexico's legal framework of energy transition and climate change (Vietor, 2017)

As a country rich with sunlight, wind, geothermal and water resources, Mexico had significant potential for the development of renewable energy.

While traditionally dependent on hydrocarbons for both energy and government funds, Mexico had already begun bringing renewable energy sources into the mix to meet energy demand and to decrease environmental impact :

- **2008** : Mexico passed a law establishing clean energy generation targets of 35% by 2024 and 50% by 2050
 - Law for the Sustainable Use of Energy (Ley para el Aprovechamiento Sustentable de la Energía–LASE)
- **2012** : Mexico became the second country to enact a legal framework regarding climate control when it passed the General Climate Change Law in 2012.
 - Law for the Development of Renewable Energy and Energy Transition Financing (LAFATERTE)
- **2014** : Publishment of the Programa Nacional para el Aprovechamiento Sustentable de la Energía 2014-2018 (PRONASE) - a roadmap describing best practices, policy guidelines and indicators to evaluate progress in the use of renewable energy.
- **2014** : Carbon tax on the emissions of fossil fuels, excluding natural gas.
 - The tax generated \$540 million USD in revenue in its first year.
- **2015** : Energy Transition Law which reiterated the goal of 35% of clean energy generation by 2024 but also set forth shorter-term goals.
 - The Law affirmed the CEC mechanism, which had converted the country's overall clean energy goals into binding requirements on specific market participants.



Part I

General energy context of Mexico

2 points to remember :

- The climate change and environmental commitments of Mexico
- The important energy transition reforms with the end of the PEMEX and CFE monopolies :
 - The energy of Mexico is now opened to private and foreign investments



Summary

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Part II

The energy transition of Mexico

THE TRADITIONAL ENERGY MODEL OF MEXICO (KPMG study)

- Before the Energy Reform :
 - Traditional industry model :
 - Vertically integrated state government agency (the Federal Electricity Commission (CFE)) responsible for the development of all activities of the industrial energy chain, from generation to its delivery to the end users.
 - This model allowed, as an exception, the participation of private generators in activities that the law did not consider as "public service".

THE NEW ENERGY MODEL OF MEXICO

- New industrial organization
 - Allows the productive sector to acquire electricity at competitive prices in a Wholesale Electricity Market (MEM),
 - Have a legal framework that enables regulators to develop this market efficiently and competitive.
 - Gives strength and drive to an energy sector that faces great challenges, by attracting private resources for its development.



Part II

The energy transition of Mexico

How this transition has been done?

How does the CFE monopoly be unbundled?



Part II

The energy transition of Mexico

On January 2016 (KPMG study):

- SENER published on the Official Gazette the terms under which CFE must be unbundling
- The terms include the separation of CFE into companies with activities that shall be strictly carried out, independently from each other, and categorized as follows:
 - Generation
 - Transmission
 - Distribution
 - Basic supply
 - Commercialization other than basic supply
 - Procurement of primary input
- SENER established that under the generation activity, CFE must constitute at least 6 different companies that operate its electric utilities
- The June 28th 2016, CFE must be fully unbundled and operating independently of each of its divided companies

>> This unbundling seeks to minimize CFE's inherited market power and create a competitive environment that allows new entrants to participate under fair conditions



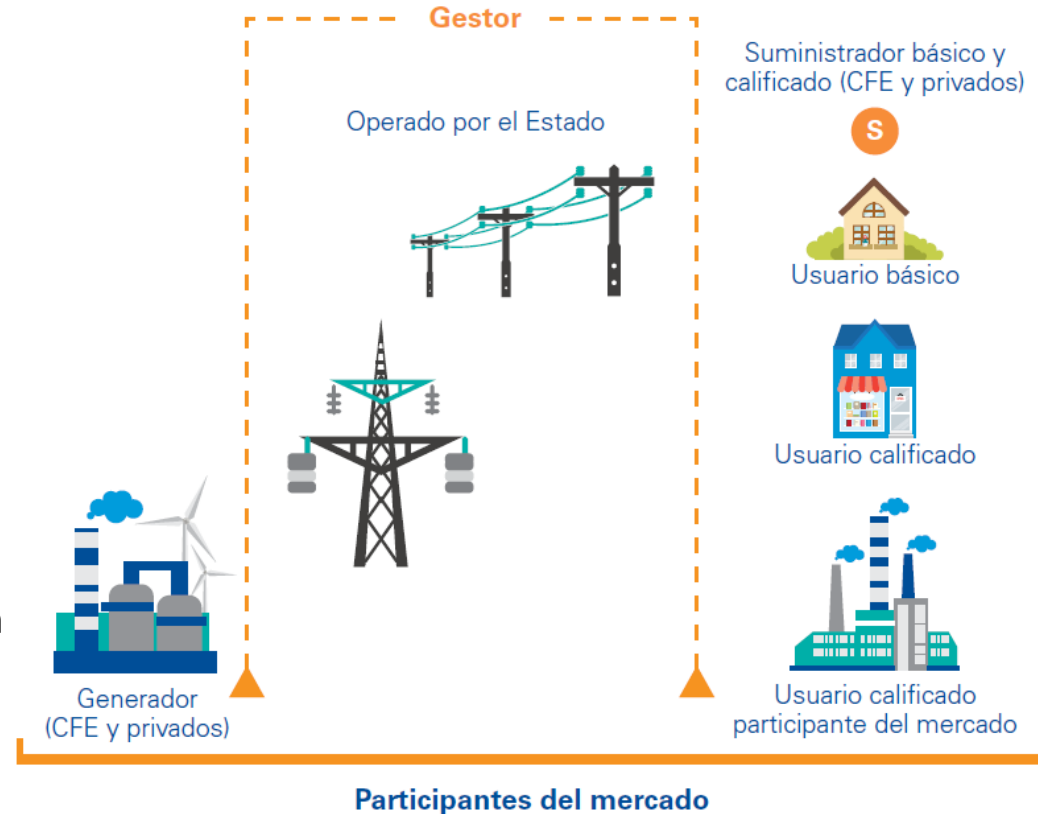
Part II

The energy transition of Mexico

The market is particularly open to private sector for generation and commercialization activities

The electricity transmission and distribution public service remains reserved to the Mexican State

The State may enter into contract or partnership with the private sector for the operation of the transmission and distribution grids



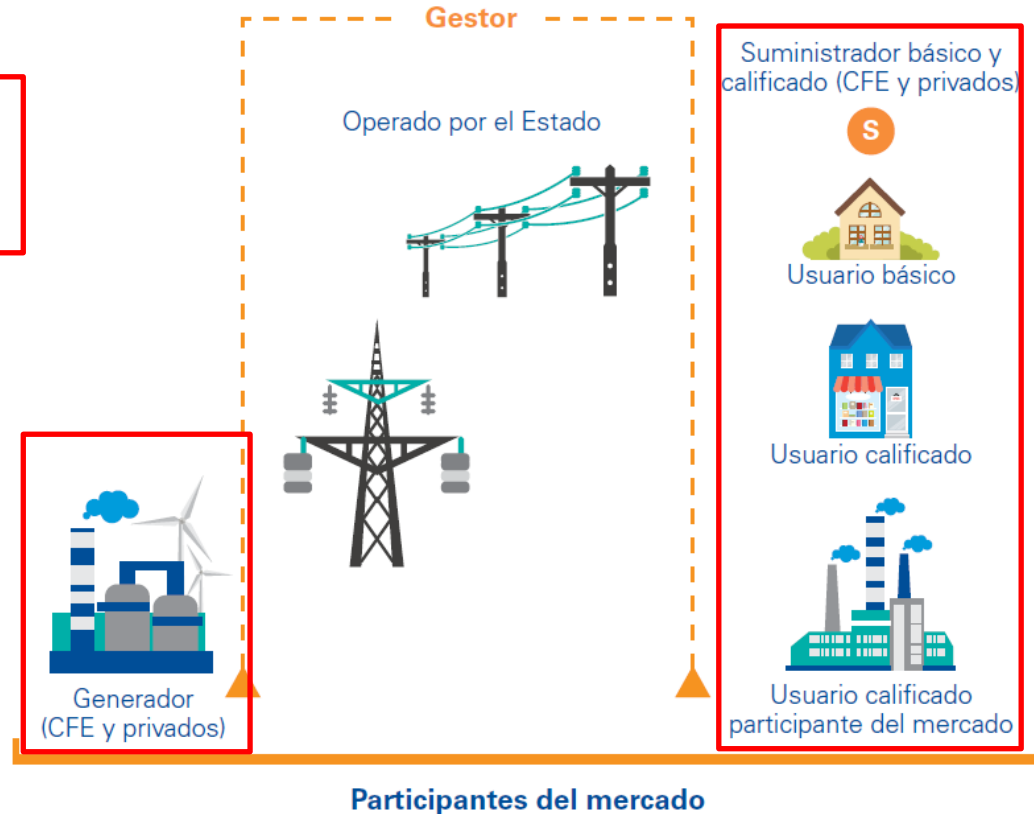
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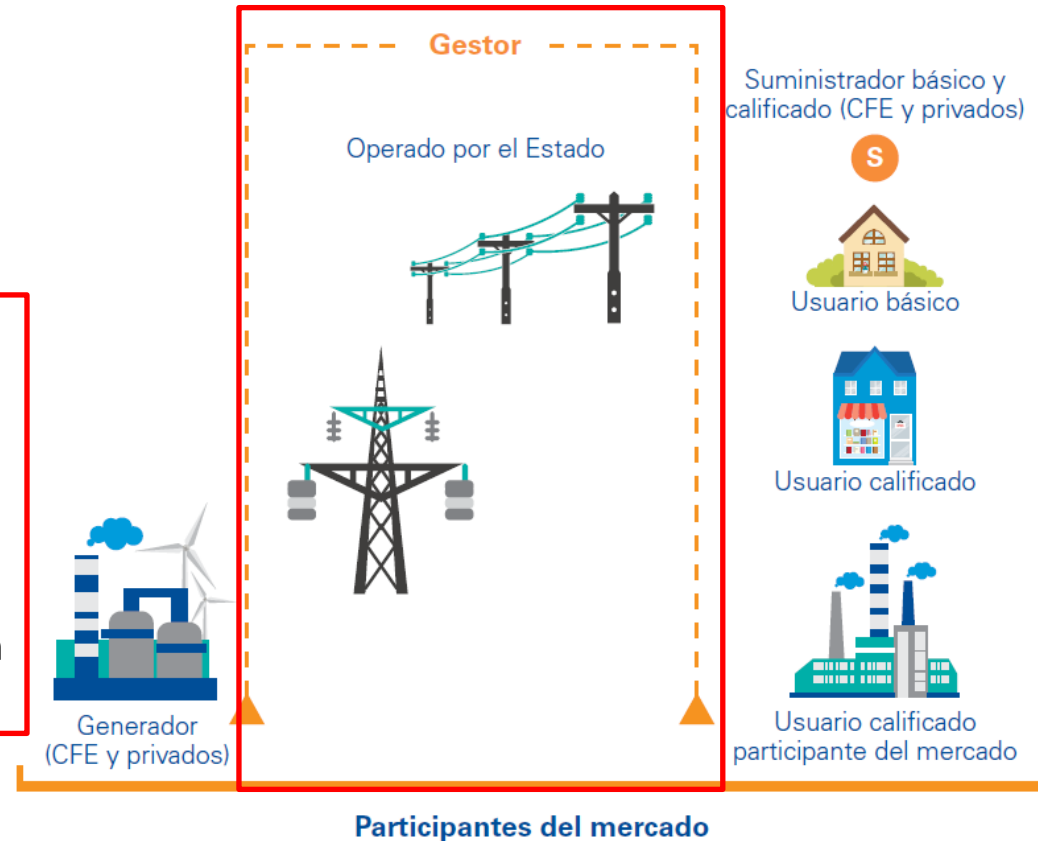
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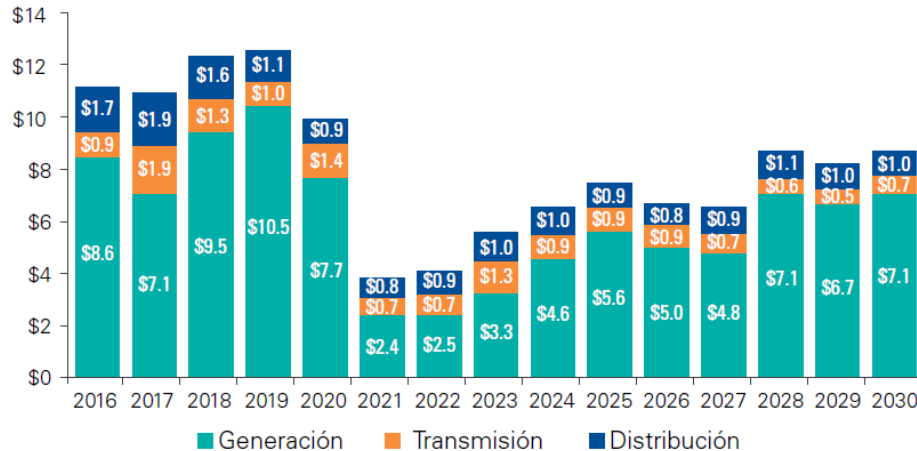
The State may enter into contract or partnership with the private sector for the operation of the transmission and distribution grids



Part II

The energy transition of Mexico

Inversión estimada 2016-2030
(miles de millones de dólares)



During the next 15 years (KPMG study):

- It is estimated that Mexico will require a total investment of USD 123,4 billion in electricity infrastructure
- 75% will correspond to investment in generation infrastructures

Considerando un tipo de cambio de 18.2 MXN/USD.

Fuente: Prodesen 2016.



Part II

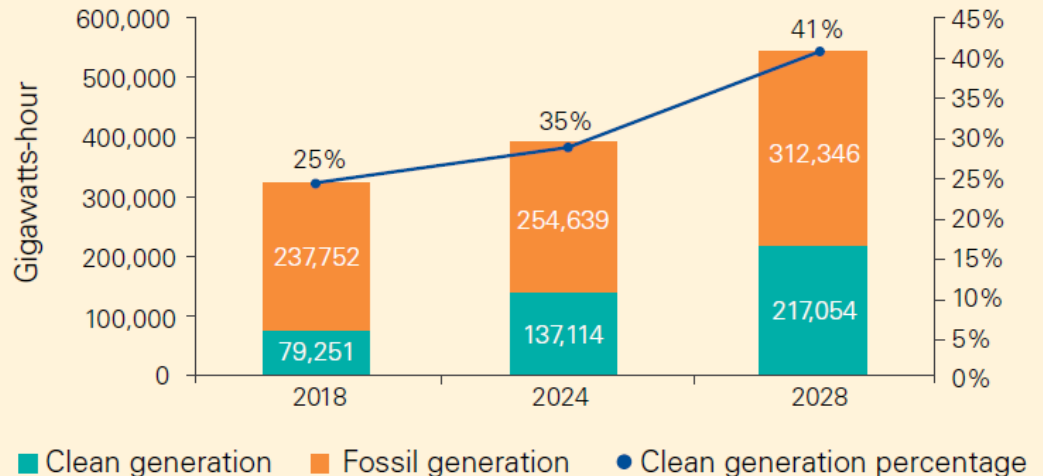
The energy transition of Mexico

Clean Energy Generation

In recent years, international governmental and non-governmental bodies have strived to introduce policy programs that set out a framework for action to reduce greenhouse gas emissions. The COP21 talks in Paris are a strong example of worldwide efforts being made to take action on climate change.

In parallel to the efforts made around the world to secure a cleaner environment, the Energy Reform in Mexico, along with its secondary laws, seeks to reach goals on the matter by setting a minimum percentage of electricity generation from clean sources.

Clean Energy Generation Goals in Mexico



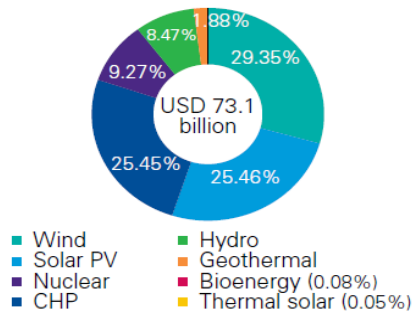
Note: Based on electricity generation estimates.
Source: Energy Transition Law and Renewable Energy Prospective 2014.



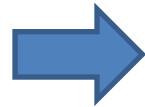
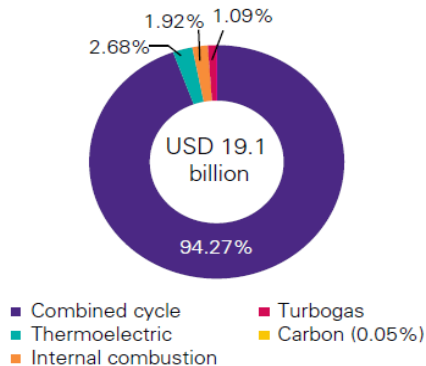
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The energy transition of Mexico

Clean Energy Investment 2016-2030



Conventional Energy Investment 2016-2030



Announced CFE investments

Project	Value
11 natural gas pipelines	USD5.2 billion
7 thermoelectric plant conversions	USD200 million
7 combined cycle power plants	USD6 billion
15 renewable generation projects	USD4.8 billion
A combination of 7 transmission lines and 9 distribution projects	USD1 billion

Source: CFE website.



Part II

The energy transition of Mexico

How to motivate the investments on clean energies?



Part II

The energy transition of Mexico

Incentives to generate clean energy

- The new law aims to accelerate the development of clean energies.
 - According to data from the National Electrical System Development Program (PRODESEN), they must be invested by EUR 58 billion by 2029, wind, cogeneration, solar and geothermal energy leading the way.
- The promotion of clean energy also involves the obligation for large consumers or distributors of electricity **to purchase the equivalent of a minimum percentage of clean energy each year.**
 - These companies must buy on the wholesale market, and from the clean energy producers who emit them, Clean Energy Certificates (CEL) to certify their respect of the percentage floor: 1 CEL equivalent to 1 MWh own



Part II

The energy transition of Mexico

**What is the Clean Energy Certificate mechanism?
(CEL for Certificado de Energia Limpia)**



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Part II

The energy transition of Mexico

The Electricity Industry Law (LIE) defines (Article 3, fraction VIII) :

A Clean Energy Certificates (CEL) is :

- a title issued by the Energy Regulatory Commission (the Commission)
- that accredits the production of a determined amount of energy Electricity from Clean Energies
- and that serves to meet the requirements associated with the consumption of Load Centers



Part II

The energy transition of Mexico

Those technologies that are considered clean as defined in article 3, section XXII of the LIE, namely:

- Wind;
- Solar radiation, in all its forms;
- The oceanic energy in its different forms, tidal, maremothermic, waves, marine currents and salt concentration gradient;
- The heat of the geothermal deposits;
- The bioenergetics determined by the Law of Promotion and Development of Bioenergetics;
- The energy generated by the use of the calorific value of methane and other associated gases in waste disposal sites, livestock farms and in wastewater treatment plants, among others;
- The energy generated by the use of hydrogen through its combustion or its use in fuel cells, provided that the minimum efficiency established by the CRE and the emission criteria established by the Ministry of Environment and Natural Resources in its cycle are complied with. of life;
- The energy coming from hydroelectric power plants;
- Nuclear power
- [...]

>>> So those energy sources are expected to be developed onto the mexican territory



Part II

The energy transition of Mexico

What are the main consequences of the reform ?



Part II

The energy transition of Mexico

The main consequences of the reform :

- A 1st auction allowing the attribution of projects of electric generation was organized and saw its results announced in March 2016.
 - The big consumers, in front of which the CFE (holding the monopoly on the distribution side) acquired LECs and electrical energy, partly from wind and solar sources, from 11 Mexican and international companies.
 - A 2nd auction, focused on solar, wind and geothermal, was held at the end of September 2016.
- >> The Market seems very competitive and promising.



Part II

The energy transition of Mexico

What are the estimated results of the reform?



Part II

The energy transition of Mexico

Based on IRENA study (REmap 2030):

- More than half of Mexico's total renewable energy use would be in **the electricity sector**
- Mexico has the potential to generate 280 TWh of renewable power by 2030, representing a sixfold increase over today's level of 48 TWh.
- Achieving this would require a diversified mix of
 - wind,
 - solar,
 - hydro,
 - geothermal
 - biomass power technologies
- Wind and solar PV combined would account for nearly 60% of Mexico's renewable power generation, and 26% of total generation in 2030.
 - Reaching this level of deployment requires policies that take into account Mexico's major land area, in which demand and supply are often far apart.
- The country has the potential for significant power generation from biomass and geothermal sources, which are also some of the least expensive power supply options.



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Part III

Opportunities and conclusion

JULY 5, 2016

Mexico electricity market reforms attempt to reduce costs and develop new capacity

Average wholesale electricity prices for Mexico load zones, January - June 2016



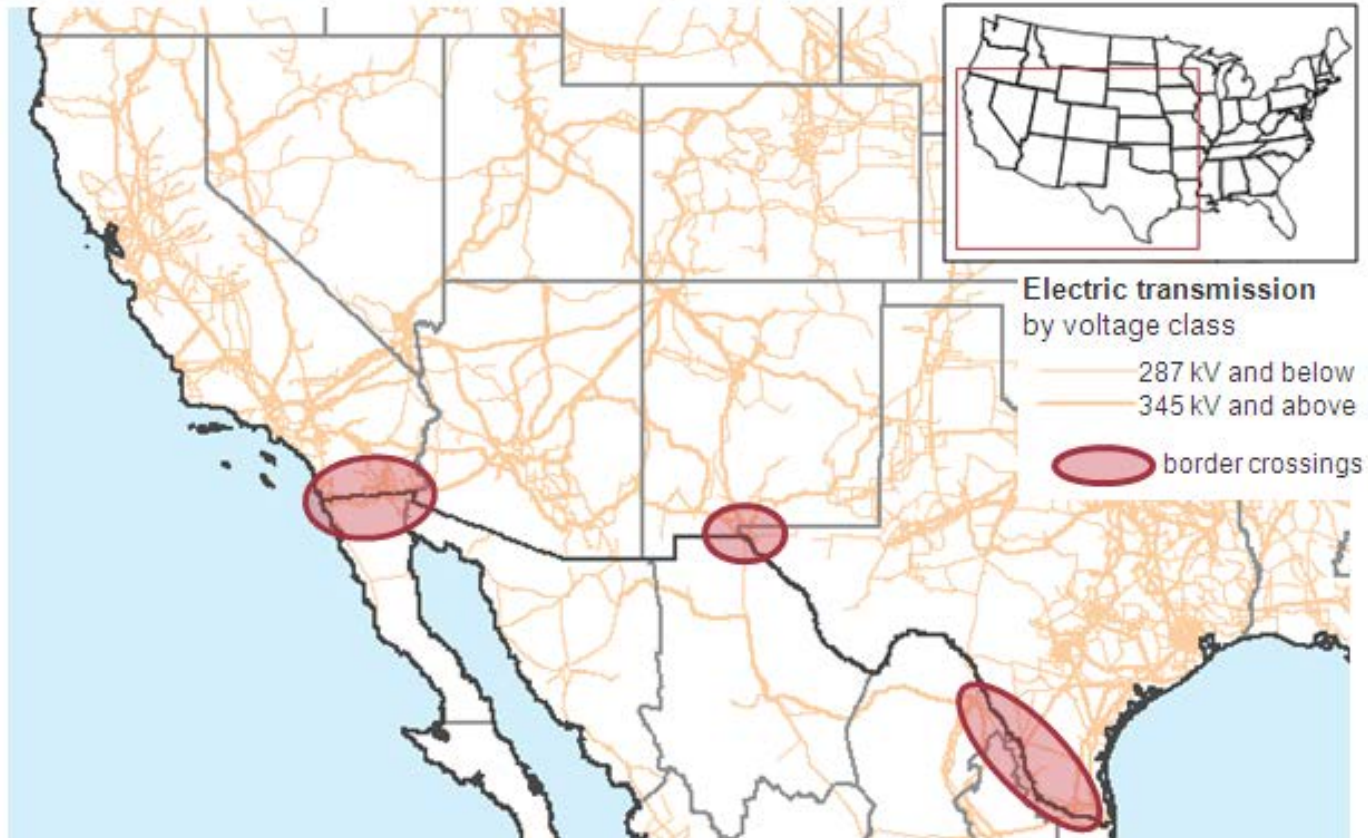
Source: EIA calculations based on locational marginal price data from Mexico CENACE using an exchange rate of 0.054 U.S. dollars per Mexican peso

Note: Locations of load zones on map are approximate.

Part III

Opportunities and conclusion

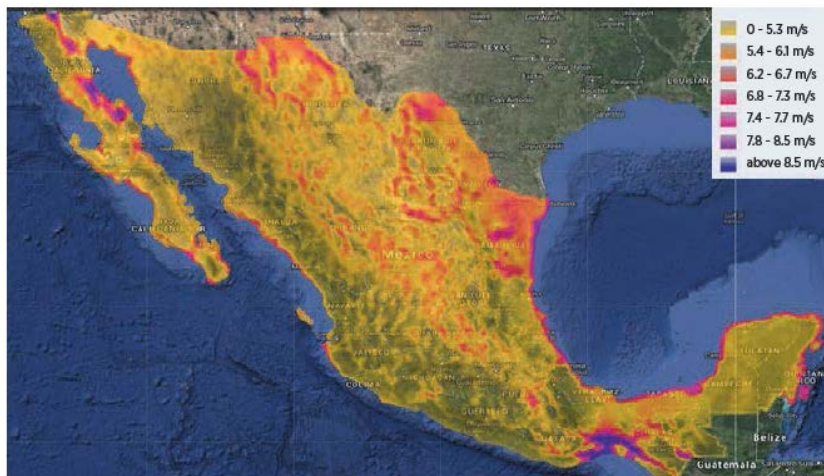
Electric transmission crosses U.S.-Mexico border in only a few places



Part III

Opportunities and conclusion

Figure 18: Annual mean wind speed at 50 metre height



Source: Global Atlas (IRENA, 2015b)

Note: In legend "m/s" is the annual mean wind speed in meters per second

There is a high quality wind resource potential for up to 30 GW of onshore wind in 2030 with an average capacity factor of 35%.

Wind power represents a major opportunity across both the north and the south of Mexico:

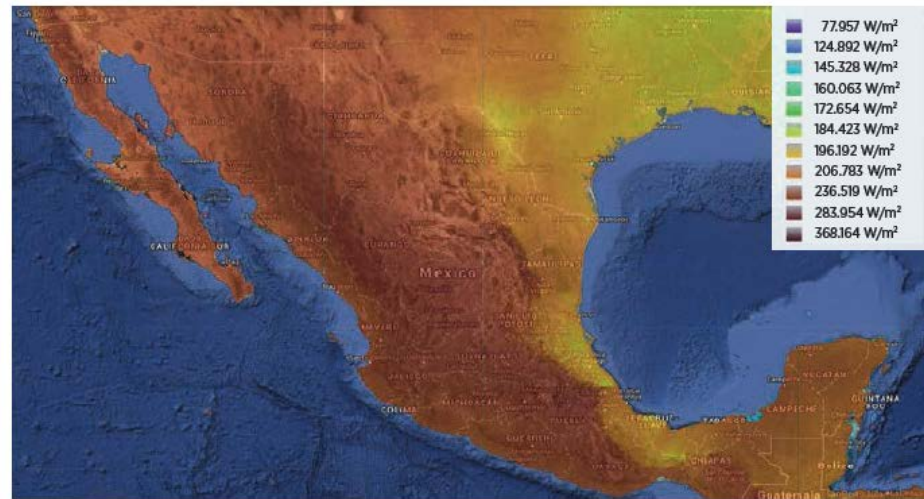
- Potential to produce 92 TWh (terawatt) of electricity per year by 2030.
- Nearly all of this would be derived from onshore wind.
- In the context of the country's total installed wind power capacity of 1.7 GW in 2013, a total of 30 GW in 2030 would require an average annual installation rate of 1.7 GW.



Part III

Opportunities and conclusion

Figure 19: Solar resource



Source: Global Atlas (IRENA, 2015b)

Solar PV could contribute 30 GW of power capacity, generating 66 TWh of electricity per year in 2030.

- This would require an average annual installation rate of 1.5 GW.
- A quarter of the total installed capacity in 2030 would be in the form of distributed PV and mini-grid applications for street lighting, agricultural water pumping and mobile phone towers (7 GW).
- An additional 1.5 GW would come from concentrated solar power (CSP).

Part III

Opportunities and conclusion

First long term auction

The first long term auction in the new Wholesale Electric Market received significant interest from private generators, where more than 460 technical offers were submitted by 103 bidders, out of which 18 offers were selected correspondent to 11 bidders.

Average prices assigned

Out of the 5,402 GWh of electricity and 5.38 million CELs assigned, an average price of USD45.48 per package (MWh + CEL) was obtained in the first long term auction, where 74% of the energy corresponded to Solar PV projects and the remaining 26% to Wind projects:



Wind: USD55.39/MWh+CEL



Solar: USD45.15/MWh+CEL

No capacity was assigned in the first 2015 Long-Term Auction, as no bidders presented an offer for CFE's MXN10,000 max purchase price offer, which seemed too low for most participants.

The assigned projects will supply 15 years of electricity and 20 years of clean energy certificates to CFE's Basic Service Supply subsidiary.

SunPower Systems México S. de R.L. de C.V.
Guanajuato
Cap. MW: 100

Enel Green Power México S. de R.L. de C.V.
Coahuila
Cap. MW: 330

Enel Green Power México S. de R.L. de C.V.
Coahuila
Cap. MW: 250

Enel Green Power México S. de R.L. de C.V.
Guanajuato
Cap. MW: 207

Energía Renovable de la Península S.A.PI de C.V.
Yucatán
Cap. MW: 90

Recurent Energy Mexico Development S. de R.L. de C.V.
Aguascalientes
Cap. MW: 63

Aldesa Energías Renovables S.L.U.
Yucatán
Cap. MW: 30

Aldesa Energías Renovables S.L.U.
Yucatán
Cap. MW: 30



Consorcio Energía Limpia 2010
Yucatán
Cap. MW: 76

Energía Renovable del Istmo II
Tamaulipas
Cap. MW: 168

Photoemer Is Sustentable S.A. de C.V.
Yucatán
Cap. MW: 30

Sol de Insurgentes S. de R.L. de C.V.
Baja California Sur
Cap. MW: 23

Jinkosolar Investment Pte. Ltd.
Yucatán
Cap. MW: 18

Jinkosolar Investment Pte. Ltd.
Yucatán
Cap. MW: 70

Jinkosolar Investment Pte. Ltd.
Jalisco
Cap. MW: 100

Vega Solar 1 S.A.PI de C.V.
Yucatán
Cap. MW: 500

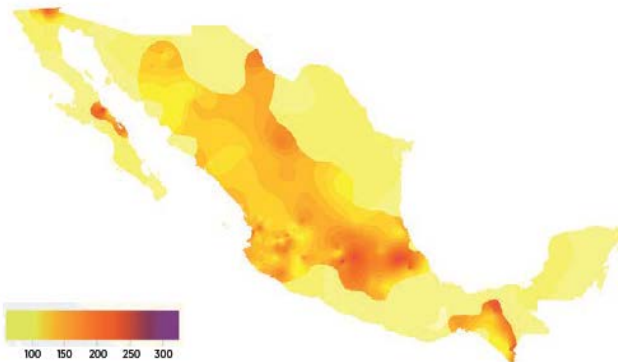
Mexico's first long term auction has shown a clear sign of tangible efforts towards more competitive prices in the market, even when compared to other countries around the world (see the map below), and a shift towards a cleaner technology mix by designing auctions where the most efficient plants (and thus cheaper) are assigned.

Part III

Opportunities and conclusion

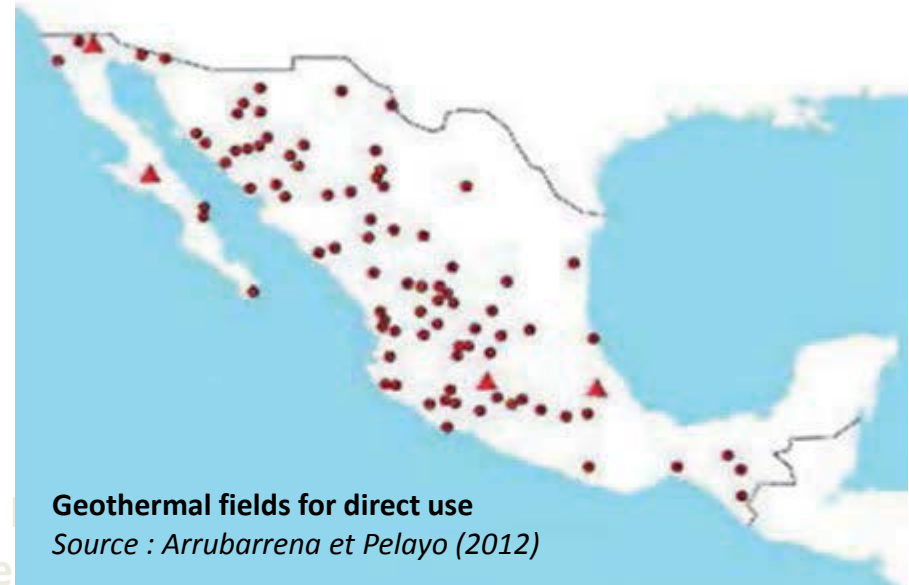
- Mexico already has the world's fifth largest **geothermal power** installed capacity after the US, the Philippines, Indonesia and New Zealand, and could utilise its high-temperature reservoir potential to reach 4.5 GW in 2030.
 - Direct use of geothermal for heating has been largely overlooked in the buildings and industry sectors, as opposed to its use for power generation.
 - Direct geothermal uses in Mexico have a total installed capacity of 550 PJ (or 156 MW) scattered across 19 states in about 165 sites.
 - These sites produced some 2.6 PJ of heat in 2010 mainly for recreational purposes such as baths or spas (IRENA Figure 4) (IEA-GIA, 2013) (GEA, 2013).
 - However, many locations in Mexico have maior potential for use bevond the current focus

Figure 20: Geothermal resource potential



Source: National Renewable Energy Inventory (SENER, 2014a)

Note: Scale corresponds to subsoil temperature in °C.



Part III

Opportunities and conclusion

Hydropower capacity

- Mexico would reach 17 GW of **large hydropower** capacity by 2030. According to REmap, a further 6.5 GW could be installed.
- **Small hydropower** capacity is already forecast to reach 1.8 GW, equivalent to an annual addition of 90 megawatts (MW) in 2015- 30, or about ten small hydropower plants per year.
- Total installed hydropower capacity would reach 26 GW under REmap 2030.

Bioenergy

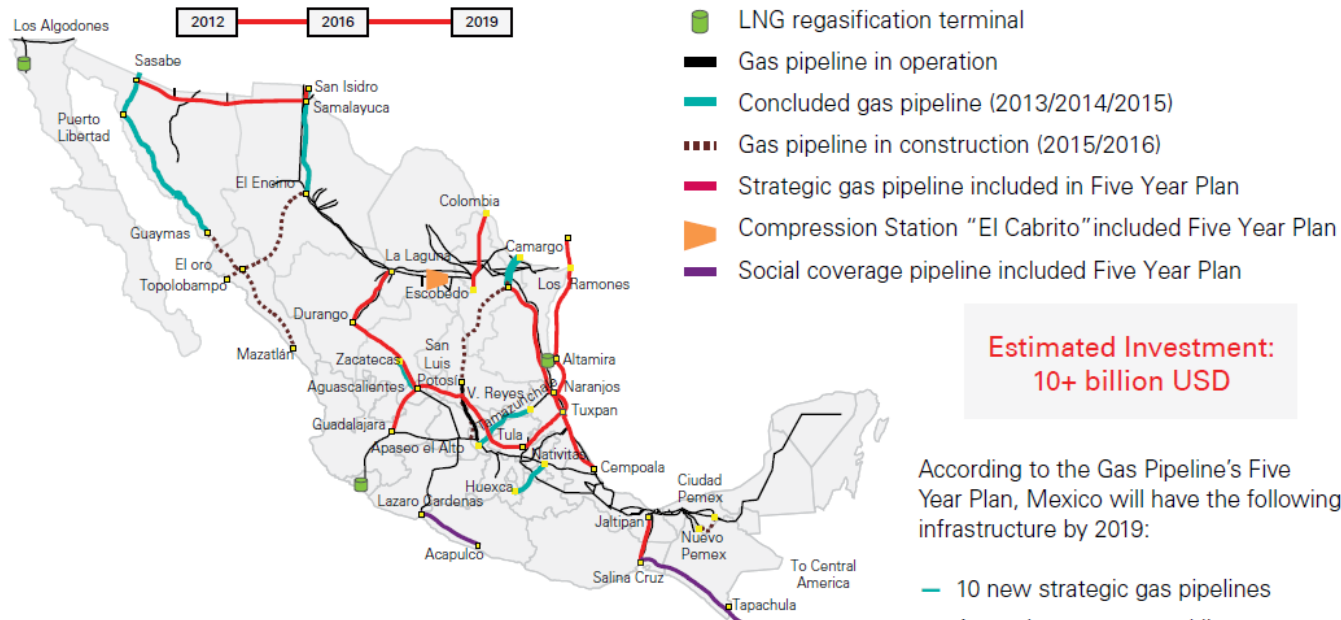
- **Bioenergy** for power generation would amount to around 4 GW of capacity. Approximately 1 GW of this would come from biomass co-firing in coal plants and 1.8 GW from combined heat and power (CHP) in the manufacturing industry.



Part III

Opportunities and conclusion

Five-Year Plan CENAGAS Tenders



According to the Gas Pipeline's Five Year Plan, Mexico will have the following infrastructure by 2019:

- 10 new strategic gas pipelines
- Around 5,000 – 6,000 kilometers of pipelines
- 7 interconnections with the USA
- Connect the Eastern and Western Mexico
- Bring gas to new locations

Source: KPMG analysis with information from Mexico's Ministry of Energy (SENER). Available in Spanish at: <http://www.gob.mx/sener/acciones-y-programas/plan-quinquenal-de-gas-natural-2015-2019>

⁴ IBID.



Part III

Opportunities and conclusion

About transmission capacity : >> **importance of connecting the country !**

- The lack of transmission capacity in areas with high renewable energy resource potential has acted as one of the major obstacles to large-scale renewables deployment. The open season has started to alleviate this problem, and it is expected that investments in transmission will follow more easily now that energy reforms have been made.
- System integration and expansion of transmission capacity will be essential to ensure the smooth integration of renewables.
- This is particularly true given the 26% share of variable renewable energy estimated in the accelerated case in REmap 2030.
- Additional transmission capacity must be planned to exploit wind and solar PV capacity in the northern and western parts of Mexico, which are distant from population centers and industrial activity.
 - The first step will be to fulfil plans to connect Baja California and Baja California Sur to the main grid, both of which have significant resources of solar and wind.
- Mexico covers a large area and has many scattered communities.
- This means mini-grid and rural electrification will play a crucial role, particularly in helping diminish the challenge of grid integration and transmission capacity expansion



Part III

Opportunities and conclusion

To conclude...



Part III

Opportunities and conclusion

The Ases-Sc point of view at the operational level

- The particularity of Mexico is its climate.
- Of course deserts means plenty of sun and wind,
- but it also means to work in hard physical conditions, and sometimes risky conditions when approaching some areas with cartels o migrants o whatever dangerous people leaving there.



Part III

Opportunities and conclusion

Projects crossing the country :



- *“PEMEX (Petroleum Mexico) operates an extensive petroleum pipeline network in Mexico that connects major production centers with domestic refineries and export terminals”.*
- *“According to PEMEX, this network consists of pipelines spanning more than 3,000 miles, with the largest concentration occurring in southern Mexico”.*



Part III

Opportunities and conclusion

For example, the theft of petroleum is a well-known problematic there.

- *“Theft of oil from Mexican pipelines often results in environmental damage or occasional explosions. According to PEMEX, there were 4,125 illegal fuel taps in 2014, an increase of 44% from the previous year.²⁵ Sinaloa and Veracruz have been cited as the states most affected by theft in recent years.²⁶*



Opportunities and conclusion

>> The success of the energy transition may also depends on the control and the security in the country



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- EIA website : <https://www.eia.gov/>
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