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Mexico: Redrawing the global energy map through its energy reform

New challenges and opportunities

Pablo D. Necoechea Porras

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Foreword

By Dr Gerhard Wahlers, Deputy Secretary General, Konrad-Adenauer-Stiftung (KAS) and Professor Dr Friedbert Pflüger, Director, EUCERS, King's College London.

In 2016/17, for the fifth time in a row, the Konrad-Adenauer-Stiftung (KAS) supported the Fellowship in Energy Security at EUCERS. This year we welcomed two fellows at the European Centre for Energy and Resource Security, Department of War Studies, King's College London. This year's fellowship topic was "The Impact of the Paris Agreement on the Energy Sector".

Beyond the research study, the fellows also assisted in a workshop series jointly organised by EUCERS and KAS on four different topics related to the impact of the Paris agreement on the energy sector. These topics focused on energy and climate policy between the Trump presidency and Paris Agreement, the role of natural gas in the EU energy mix in the context of Paris, a discussion on industrial carbon performance and the security and financial dimension of climate change. We welcomed a variety of speakers from the energy industry, academia and policy-makers. Amongst others, Claire Perry MP, Minister of State at the Department for Business, Energy and Industrial Strategy. The energy talks series offered fellows the opportunity to present their findings at the workshops that related to their subject and incorporate feedback and results from the energy talks into their research.

The following research study is the product of Pablo Necoechea's fellowship year. His research focused on the undergoing energy reform in Mexico. While in the past the energy sector has been a driver in the country's economic development, Mexico's energy industry has been undergoing dramatic changes and decline in production levels. The Mexican government has introduced a reform to open oil and gas exploration and production to foreign investments and modernised the energy sector. Pablo Necochea's study provides an overview of these changes and promotes an understanding of how historic these regulatory changes to the oil sector in Mexico are. But, while it is undeniable that the reform is a significant step, there are also important issues that need to be addressed such as seeking new energy sources that along with the Energy Reform can drive Mexico forward in the 21st century.

EUCERS is delighted to host this exceptional Fellowship jointly and funded by KAS. We would like to take the opportunity to thank Hans-Hartwig Blomeier, Director of the KAS London office and the EUCERS team for their unwavering support of our joint projects and we are looking forward to our continued cooperation.

We hope you will enjoy the following study.

Abstract

In the past, the energy sector has been the driving force behind Mexico's economic development. However, Mexican oil production has declined over recent decades due to lack of dynamism, capacity, and investments. Dramatic changes have taken place in Mexico's energy sector over its history. On December 2013, Mexico's Congress approved a series of constitutional amendments that ended the 75-year state oil monopoly of the State Petroleum Corporation (Petroleos Mexicanos, Pemex).

The Reform opened oil and gas exploration and production to foreign investment. It has the explicit aim of attracting investment and modernizing the energy sector through a dynamic energy model, founded on the pillars of competitiveness, openness, sustainability, and transparency. The Reform brings significant implications for energy consumption, trade, production and regulatory policies in Mexico.

This research aims to provide a thorough understanding of the historic regulatory changes of the oil sector in Mexico, and its implications, by providing a comprehensive image of past events in the sector and the influence of the Energy Reform. This study analyzes the Mexican energy sector regarding its system, economy, and global market. Finally, it explores challenges and opportunities for the energy industry to redraw the global energy map.

The findings of this study determined that the energy sector has been unproductively managed for a long time, lacking technological and technical expertise, as well as financial resources. If the Reform is implemented well, it could boost energy production and increase economic growth in Mexico quickly.

These findings aim to be useful for policy-makers, sectoral agents, and academics as a contribution to the research on the energy sector's development through a deregulation process in Mexico. Moreover, it contributes to the global debate of energy sources.

Keywords: Mexico energy reform, hydrocarbons, energy security, economic growth.

Introduction

During the 20th century, foreign investors had a significant role in helping Mexico become a leading player in global energy. The constitution of 1917 announced that the Mexican subsoil and its contents belonged to the state. The first land oil exploration and oil production were done by Royal Dutch Shell, Jersey Standard and Standard Oil of California, resulting in Mexico becoming the world's largest oil producer during the 1920s. However, the foreign ownership resulted in discontent among the Mexican people.[1] In 1938, Mexico carried out oil expropriation. This situation caused energy nationalization and the creation of Petroleos Mexicanos.[2],[3] The government now held a monopoly over the industry, which barred all foreign companies from operating in Mexico. Historically, Pemex became a symbol of national pride with oil strongly tied to Mexican nationalism.

Pemex remained a monopoly of the Mexican oil sector, with the government maintaining tight control over the finances and the management. On 1938, Mexico had a nationalized energy sector with domestic production entirely under the auspices of national oil company Pemex. The country's development strategy at the time was based on the protection of the internal market, through tariff and non-tariff barriers that kept the productive apparatus virtually isolated from international competition.

Experts had long urged the Mexican government to reduce the massive fiscal burden on Pemex and amend the constitution to enable Pemex to partner with international corporations with the experience and resources required for exploring Mexico's deep water and shale resources. Numerous stakeholders in Mexico remained concerned, however, that increasing private involvement in Pemex could threaten Mexico's traditional control over its natural resources.[4]

In the early 2000s, approximately 40 percent of government revenues had come from Pemex, highlighting the state company's importance for the country. However, in the following years profits declined due to the technical and economic inability to exploit Mexican waters for oil or gas. Mexican oil production declined due to lack of dynamism, capacity, and investments.

President Enrique Peña Nieto became the Mexican president on December 1, 2012. Then, in 2013, in a bid to attract foreign capital and technology to revitalize the domestic energy industry, he proposed the Energy Reform that would allow foreign companies to invest in Mexico under a profit and risk sharing model with Pemex.[5] It was encouraged by the recognition that crucial energy indicators were moving in the wrong direction, with the consequent risk of a widening gap between the performance of the oil and gas industry and the needs and aspirations of an innovative nation.

The Reform reorganized the structures that had governed the energy sector for more than 80 years. Moreover, it pursued investment and technology across the hydrocarbons value chain by ending the monopoly of Pemex as well as by attracting new players into the sector. The changes reflected the modernizing Mexican economy vision. With the Reform, Mexico reaffirmed its intention to lead environmental issues, the same path that Mexico chose with the Paris Agreement summit to embed its clean energy target in domestic legislation.

The Mexican Congress approved a series of constitutional amendments that ended the 75-year state oil monopoly by Pemex. The Reform opens oil and gas exploration and production to foreign investment and aims to attract investment and modernize the energy sector through a dynamic energy model, founded on the pillars of competitiveness, openness, sustainability, and transparency.

With the Reform, Pemex remains the property of the state; however, it is given more autonomy in the budget and administrative share, and in turn, becomes a competitor for the new projects. The Reform is one of the most significant pieces of legislation since the signing of NAFTA[6] in 1994.

With the Reform, Mexico's oil resources[7] are open to international companies for investment but no Mexican assets are privatized. Pemex is losing its monopoly status. However, it will remain the dominant player in the oil sector in some areas as well as benefit from the reform with the technological expertise and technological spillovers of the international oil companies.

In August 2014, Mexico approved the Secondary Laws granting the entire approbation to the Energy Reform.[8] This Reform presents a new panorama for the generation, distribution, and commercialization of energy in the country. Although it constitutes a significant opportunity for the development of this sector in Mexico, this does not take into account the gaps and negative externalities that it entails, and that could result in its failure. It is essential

1 Brookings (2013)

2 Pemex www.pemex.com

3 A state-owned firm

4 US Department of State (2014)

5 Peña Nieto (2013)

6 North America Free Trade Agreement (1994)

7 Including offshore and unconventional fields

8 Approbation under significant opposition

to present different perspectives on this subject, informed and technical.[9]

Mexico has thrown an ambitious energy sector transformation process through constitutional amendments, which allows it to bring to an end a longstanding and entrenched state monopoly. Mexican oil production has declined over recent decades due to lack of dynamism, capacity, and investments. The reform aims to establish new industry structures in oil, natural gas, and electricity, as well as foster competitiveness and openness in the sector. The Reform has the encouragement to establish an entirely new oil regime, with its rules, institutions, agents, and policies, and will require a consensus, and a smart implementation strategy.

The future of Mexican oil and natural gas production is a critical point in the country's economic growth agenda, and the nation's energy security. Mexico has been a top crude oil exporter; mainly a critical supplier to the US. However, the production has declined dramatically in recent years.[10] The Reform opens Mexico's oil and natural gas sector to international companies that could potentially help to foster the hydrocarbon production.

The reform provides a historic opportunity to revitalize Mexico's fragile energy sector and strengthen its global competitiveness. There are still unresolved issues which require specific solutions and imply social and political costs. The government must now transmit consensus as well as articulate rigorous milestones and control of its reform agenda and preserve the flexibility to regulate possible unintentional concerns.

The lack of information about energy reform creates a critical sectoral condition, which impedes knowledge flows among the agents involved and discourages private participation. This strategy paper aims to serve as an academic tool to analyze energy sector deregulation. This study tries to fill the gap between the Reform and its implications in the Mexican energy sector, and how they play out in the global context. The findings are useful for policy-makers, sectoral agents, and academics and contribute to adding new and specific knowledge about Mexico's energy situation, and its new challenges and opportunities to redraw the global energy map.

This strategy paper contains five chapters, each corresponding to a different subject from those that make up the analysis considered most relevant. The first chapter is the Introduction and describes the problem discussion, purpose, and research questions. The second chapter provides an overview of historical regulatory changes, regarding the following stages: pre-expropriation, expropriation, post-expropriation, the 1992 Deregulation Project, and the 2013 Energy Reform. It also describes why energy reform was needed and talks about the evolution of energy needs.

The third chapter analyses the Mexican economy, the energy system concerning the following points: energy security, sustainability from a Paris Agreement approach, and competitiveness and affordability. The fourth chapter explores challenges and opportunities of the Mexican energy sector from the following perspectives: environmental, political, social, economic, and global, as well as pointing out strengths and weaknesses of the industry. The fifth chapter provides policy recommendations and describes concluding remarks.

1.1. Discussion of the problem

The energy sector has represented a vast source of revenues for the Mexican economy for the past 100 years. However, in recent years there has been declining production and low revenues. Mexico, through an Energy Reform, is dealing with the shift from a monopoly to an open market with the expectation of economic growth. The government is implementing new rules to regulate and strengthen the energy sector to redraw the global energy map.

Mexico is a country with enormous potential for growth and is expected to be a significant world energy sector player. The energy sector is identified as having high potential for the future. This research aims to contribute to the research on the energy industry's development in Mexico, and also to the worldwide energy demand and energy sources debates.

1.2. Purpose

The goal of this research is to provide a thorough understanding of the historic regulatory changes of the oil sector in Mexico, and its implications, by providing a comprehensive account of the past events in the industry and the influence of the Energy Reform. This study also analyzes the challenges and opportunities of the Mexican energy sector regarding its system, economy, and global market, as well as describing issues and possibilities to enhance the energy industry.

These findings aim to be useful for policy-makers, sectoral agents, and academics as a contribution to the research on the energy sector's development through a deregulation process in Mexico. They also aim to contribute to the global debate on energy sources.

9 Rather than pure ideological discussions

10 IEA (2015)

1.3. Research questions

This strategy paper aims to provide answers to three research questions, which will help analyze the Mexican energy sector:

- What are the historic regulatory changes of the Mexican energy industry, and their implications?
- What is the potential of the Mexican energy sector development regarding its system, economy, and global market?
- What are the issues and opportunities of the Mexican energy sector?

These research questions were chosen to bring a clear understanding of the historical energy sector changes, the actual situation, and its potential future. By answering the research questions comprehensively, the study will be able to fulfill the purpose of understanding the development of the energy sector in Mexico.

2. Historic Regulatory Changes

2.1. Pre-expropriation

The use of fossil fuels goes back many centuries in Mexico, even before its birth as a nation. Due to its abundance of fossil deposits, the natural appearance of oil on the ground in Mexico was used by the ancient Mesoamerican civilizations for crafting clay figures and by the Spanish colonizers for medicinal purposes as well as in the maintenance of ships.[11]

The proper birth of the oil industry in Mexico can be traced back to 1863, when a priest named Manuel Gil y Saenz discovered a surface deposit of oil in the State of Tabasco, in the so-called San Fernando Oil Mine.[12] He traded this oil back to the US, where the industry was booming, but he was unable to compete due to the advance of technologies in the US.[13] The oil reached its destination, and the Americans discovered the proper quality of the Mexican oil, which turned the attention of American entrepreneurs to its southern neighbour. The Mexican president at that time, Porfirio Diaz, dictated an accommodating policy for foreign investment in the oil industry to boost the industrialization of the economy of Mexico in the early 1900s. The Eagle[14] dominated the market in the first quarter of the XX century.

Commercial oil production started in Mexico around 1901, though the amounts produced were too insignificant for companies to export. On 1910, the prospect of producing oil drew entrepreneurs and oil workers from the US and Britain to the region.[15] During the Mexican Revolution,[16] new political leaders emerged in the country which ended a revolt caused by the miserable living conditions of Mexico´s poorest inhabitants. After a period of benefits for the corporations, the new policy in Mexico was to adopt a project for the nation that set as a priority the well-being of the Mexican rural population.

Article 27 of the Constitution promulgated in 1917 established the Nation's dominion over all minerals, as well as petroleum and solid, liquid or gaseous hydrogen carbides. It allows to the Federal Executive to grant oil extraction and other hydrocarbons to other agents.

US investment grew from 38.5 percent of total investment in 1910 to 61 percent by 1921, as the reserves proved bountiful.[17] Mexico was the world's second largest oil producer by the early 1920s.[18],[19] The energy market in Mexico was divided into oil and fossil fuel production for domestic consumption and export, and imports of energetics such as gasoline and diesel. Exploration, exploitation, and transport are components of the Mexican energy market, as well as import operations.

Former president Lazaro Cárdenas[20] promoted particular expropriating policies that served the goal to protect the well-being of the Mexican population. Besides the Petroleum Expropriation in 1938, he also promoted the Agrarian Reform, in which the federal government yielded land for the poor to tend and harvest on it.[21]

2.1.1. Causes that led to the petroleum expropriation

The Political Constitution of Mexico, in 1917, established that both the maritime and terrestrial resources of the territory were the patrimony of the nation, in addition to the labour rights of Mexican workers, among other necessary laws. However, the Mexican government had conceded to foreign companies the exploitation of many of the country's natural resources[22] for a long time.

Foreign companies had an increasing contempt for Mexican law. Due to this, conflicts between the Mexican government and foreign companies intensified gradually. The foreign companies did not want to pay any taxes for the concession of the exploitation of natural resources. Also, the foreign corporations did not respect Mexican worker's labour rights.

During President Lázaro Cárdenas' term, Mexican workers began a strike to demand better wages and working conditions from foreign companies. The Mexican Supreme Court of Justice of the Nation ordered that salary increases had to be granted to workers, but foreign companies refused to do so.[23] So, Lázaro Cárdenas took the most important measure of his presidential term. This was the Expropriation Reform.[24]

2.2. Expropriation Reform

On 18th March, 1938, the Expropriation Reform took over administration of the national oil resources. It occurred after a series of labour conflicts between Mexican oil workers

11 Salgado (1998)

12 Mina de Petroleo de San Fernando

13 Alvarez de la Borda (2006)

14 Mexican Oil Company

15 Vietor, (2017)

16 From 1910 to 1920

17 Linda (1984)

18 With peak production in 1921

19 Congressional Research Service (2015)

20 From 1934-1940

21 Alvarez de la Borda (2006)

22 Such as oil, silver, copper and various agricultural and fishing products

23 Corona (1975)

24 Expropiación Petrolera

and foreign corporations. The new law for the exploitation of petroleum in Mexico was incorporated into Article 27 of the Mexican Constitution of 1917, which contains policy concerning the use of national natural resources. It indicated the exclusive property of the State over resources in the subsoil.

All plant, equipment, personnel, and operations of the foreign oil companies were expropriated. All the expropriated resources became part of the creation of the national petroleum company, called Petromex at the beginning, which was renamed Pemex, and became the largest company in Latin America.[25]

The Expropriation Reform was the first Energy Reform in Mexican history. It considered it the exclusive right of the State to exploit hydrocarbons. The Articles 26, 27, and 28 of the Constitution were amended to establish particular State functions in strategic areas of oil and other hydrocarbons, as well as basic petrochemicals. The initiative's Secondary's Laws were approved and published in the Official Journal of the Federation in November 1940.[26]

Also, the statutory law of Article 27 of the Constitution was published in 1940. This law created instruments to conclude contracts with individuals so those individuals could carry out the exploration and exploitation of hydrocarbons.[27] It also established the regime of concessions for the construction of refineries and pipelines and the distribution of gas.

2.3. Post-expropriation

Article 27 of the Constitution had a new Regulatory Law in 1958. It was about the elimination of the possibility of entering into a contract with individuals on the holding, as well as reserved all the activities of the petroleum industry to Pemex. Two years later, in January 1960, a constitutional Reform incorporated this prohibition of contracts.

After the expropriation, international problems occurred. The United Kingdom broke diplomatic relations with Mexico, the Netherlands and the US decreed a commercial embargo and retired all its technical personnel. Moreover, the US Treasury stopped buying Mexican oil and silver and gave all its preference to Venezuela's oil.

For many, expropriation meant a final shaking of imperialism that had so long bled Mexico, preventing it from relying on its strength and capacity. However, these were difficult times for the country because the gasoline reserves were depleted and the knowledge and the expertise to synthesize the tetraethyl had gone out the country. So, Pemex needed to seek out the best specialists from all over the country to find process expertise.

2.4. 1992 Deregulation project

The Deregulation Project of the Mexican Energy Sector was launched by former President Carlos Salinas de Gortari in 1992. The Deregulation Project started by justifying the insufficiency of State resources to invest what is necessary to guarantee the service of electric power with timeliness and quality. The Deregulation Project began dealing with the reform of the electric energy law to link the generation of electricity to private companies for public service, and with the creation of the Energy Regulatory Commission.[28] The Deregulation Project allowed for the oil industry to open up private investment activities of transport, storage, and distribution of natural gas, and later the petrochemical industry.[29]

The aim of the Deregulation Project focused on the full opening of the electricity market. Moreover, in general terms, since 1992, the State has maintained a policy of stimulating investment beyond the requirements of demand.

Deregulation implied opening a real generator market. The Deregulation Project was not enough to attract more investment. The only results were a group of companies that were dependent on fixed-income contracts[30] where they did not contribute to lower rates, but, on the contrary, became a pressure group to increase them.

Regarding natural gas, in 1995, Article 4 of the Oil Law was amended to facilitate the formation of a natural gas market. From that year on, private individuals could own the pipelines and facilities that they require for the development of the commercialization of this energy, from import, transport, storage, and distribution. Pemex's national gas pipeline system was opened for private use. However, the national pipeline system (Sistema Nacional de Gasoductos, SNG) didn't grow. Moreover, there are no plans to build, private natural gas storage infrastructure. This activity has reduced its dynamism in recent years and is very far from covering the demand of the vast conurbations of the country.

The deregulation of the energy sector has had some positive and negative effects. It is necessary to completely rethink energy policy to avoid the continual advancement along a path that presents severe difficulties. Also, a more productive coexistence is necessary between public and private, collaborating to offer real benefits for consumers and the country's energy security. It has been 25 years since the Deregulation Project began, which is a sufficient period

25 Labastida (1990)

26 Huesca (1988)

27 On behalf of the government, and without putting at risk the State rights

28 Comisión Reguladora Energética, CRE www.gob.mx/cre

29 GLI (2017)

30 Some contracts have entered their final phase

to interpret the results of a policy model focused on open market activities operated by the State. In the case of the electricity sector, the productive capacity generation linked to public services has grown considerably: from 27 thousand megawatts (MW) in 1992 to 52 thousand MW in 2010, which implies an infrastructure increase of 92 percent.[31]

In December 1992, Article 3 of the Public Electric Power Service Act was reformed to incorporate the figure of independent electricity producers, whose purpose has been to sell its generation to the Federal Electric Commission (Comisión Federal de Electricidad, CFE[32]). The private companies that participate as independent producers have built a generating capacity of 12,600 MW, plus another 3,400 MW with self-supply and export permits.[33] So, the private sector has contributed approximately 50 percent of the country's electricity generation infrastructure expansion. It is an impressive percentage from a sector which is essential to the economic and social life of the country.

2.4.1. Concerns about production declines, stagnation, and underperformance

Most of the Mexican deposits[34] are situated in the southern offshore part of the country, mainly at Campeche Basin, at the Gulf of Mexico separated into two fields; Ku-Maloob-Zaap (KMZ) and Cantarell.

There are also onshore basins in the northern parts. Figure 1 shows the Mexican oil and gas fields.

Crude oil production has steadily declined since 2004, down by nearly 1 million barrels per day (BPD) over the past ten years.[35] From 2004 to 2009, Mexico suffered rapid loss rates in the supergiant Cantarell field[36].

Recent decreases have been more gradual, but the downward trajectory will not be reversed merely given the maturity of Pemex legacy oil and gas fields and the vast concentration of production in a number of minor fields.

The stability of the KMZ super-giant field, which has plateaued at 850,00 BPD[37], will be critical if Mexico is to retain output levels over this period, yet substantial risks exist relative to its pattern and rate of decline.

In the past, Pemex was not free to reinvest its profits in technology, infrastructure, and training of human resources, which has limited its development as a modern company. It was prevented from assimilating modern deep-water exploration technologies and making costly investments in exploration and extraction of fossil hydrocarbons or venturing into the development of renewable energies. In contrast, given the multiple national financial crises,

31 Colmenares (2008)

32 Comisión Federal de Electricidad, CFE www.cfe.gob.mx

33 Birol (2010)

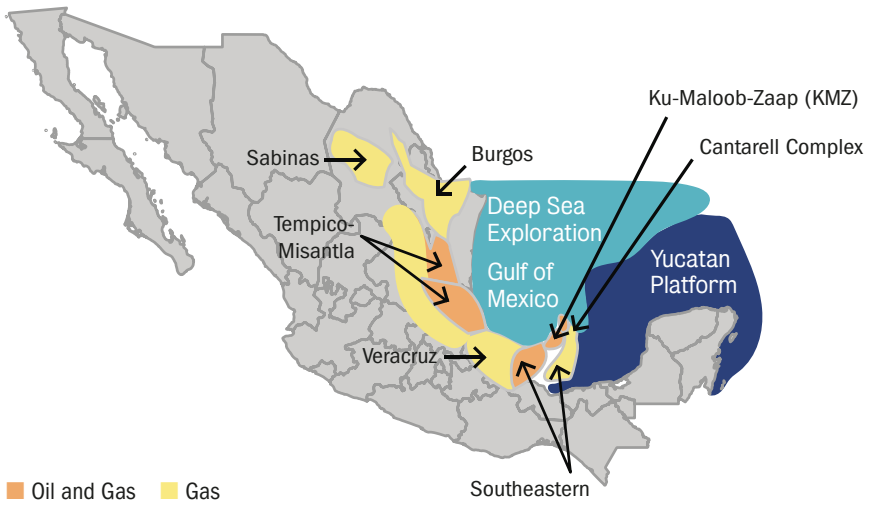
34 Proved reserves corresponds to the definition established by the Securities and Exchange Commission (SEC), a US body that regulates America's securities and financial markets, while the definitions established by the Society of Petroleum Engineers (SPE), the American Association of Petroleum Geologists (AAPG), and the World Petroleum Council (WPC), technical organizations in which Mexico participates, are used for the probable and possible reserves

35 Lajous (2014)

36 Birol (2010)

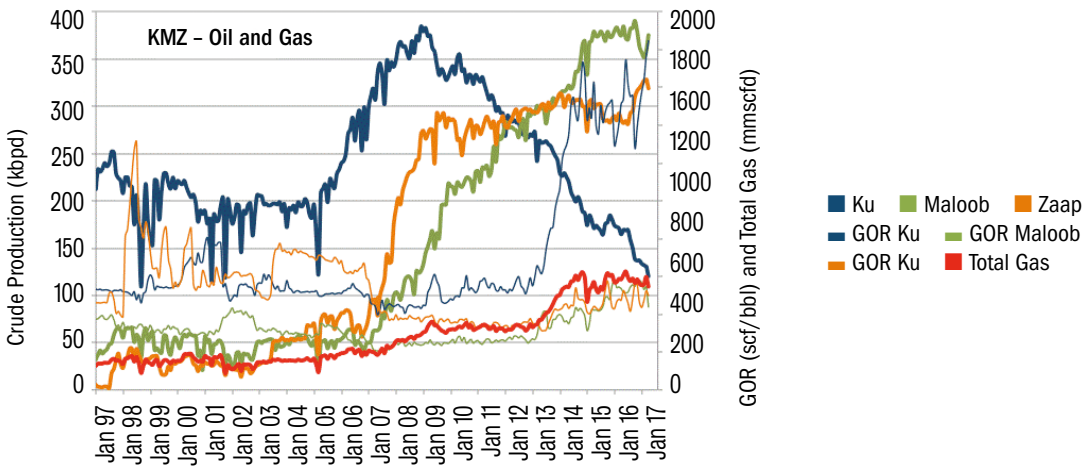
37 Sener (2016)

Figure 1. Mexican oil and gas fields



Source: Sener

Figure 2. Mexican oil and gas fields' production



Source: Seeking Alpha 2017

Pemex has been the short-term fiscal provider for the Mexican government, contributing between 31 and 38 percent of tax revenue between 2007 and 2013 or 7.4 to 8.7 percent of GDP, during the same period.[38]

2.5. 2013 Energy Reform

The energy sector develops a strategic economic role in Mexico because of its significant historical contribution as the main sources of foreign exchange as well as fiscal revenues. Mexico needed to make strong, strategic policies, especially in the energy sector, due to the country's largest sources of emissions, and with particular alignment between the regulatory frameworks of the country's energy sector as well international commitments.

On December 20, 2013, a Decree was published in the Official Journal of the Federation, which amended and added various provisions of the Constitution. This set of changes is known as Energy Reform. Articles 25, 27, and 28 on energy were again amended. The Energy Reform was proposed and approved in 2013.[39]

The Ministry of Energy, also known as Sener[40], is the governmental institution in charge of the energy sector. The Sener has recognized the importance of energy security as the midpoint of sustainable energy policies[41]. Sener collaborates with other government bodies, such as CFE, Pemex, and Legislative Commissions to promote and develop the energy sector from an equality perspective with an energy security focus. Energy security has risen up the political agenda over the last decade in Mexico due to several problems, some of them expressed in the followings paragraphs:

- First, Mexico suffered after years of under-investment by state-owned companies, but non-privatized assets. Transportation restrictions due to pipeline bottlenecks have caused a crisis in natural gas supply, and inadequate transportation and storage capacities have increased the risk of a supply disruption of petroleum products.

- Second, there have been significant oil production declines over the last ten years in the country.

- Third, in recent years, there has been a weak growth in GDP which is driving the need to open up the energy sector. The GDP decreased from 6.4 percent in the period 1950 to 1980 to 2.4 percent between 1980 and 2010.[42] Mexican oil production fell to just over 1 million barrels per day since 2004 in the giant Cantarell complex. [43]

- Finally, Mexico's manufacturing sector is vital for the economic system. However, the country electricity prices are higher than in other nations.[44] Reducing these costs is essential to improve competitiveness. Otherwise, Mexico would face increased competition from US and Canadian heavy oil on the Gulf Coast of the US, which could sell in Asia at reduced prices.[45]

The Energy Reform means a change of such magnitude that it requires a new institutional arrangement that allows the

38 SHCP (2013)

39 Reyes-Heroles G.G., (2015)

40 Secretaría de Energía

41 Sener (2014)

42 SHCP (2013)

43 Sener, (2016)

44 Sener (2014)

45 Kilian (2016)

authorities to achieve the objectives that gave rise to the reform. Among the other leading changes, with the reform, the country will be able to carry out the exploration and extraction of hydrocarbons through assignments to productive state firms or contracts. It also provides that the processing and refining of oil, natural gas processing, transportation, as well as storage and distribution of hydrocarbons and their derivatives may be carried out by natural or legal persons using permits.

2.5.1. Breaking a monopoly

Mexico has taken a profound change of direction regarding structural policies since the mid-1980s. A set of policies aimed mainly looking to increase efficiency, facilitate the operation of markets and also reducing the distorting effects of government intervention in economic activities replaced the development model based on protecting national markets and government intervention.[46]

In Mexico, among the many reforms that President Enrique Peña Nieto has put on the country's agenda, energy reform is perhaps one of the most ambitious, because of the radically transforming energy sector. The Reform ends the state oil monopoly of 75 years and opens exploration and production of oil and gas to foreign investment. For those 75 years, Pemex controlled oil production in the country, contributing one-third of the turnover. Recently, however, investment has been needed. Pemex is now open to new alliances and foreign investment. The government pursues private investment to increase oil and gas exploration and production through the Reform. In particular, the government hopes that private investors will contribute to Pemex to exploit future fields, including promising oil and shale gas fields in Mexico and deep-sea oil resources.[47]

2.5.2. New legal framework content

Regarding the Reform, the state will maintain complete ownership and control of subsoil hydrocarbon assets. So, Pemex and CFE will remain dominant industry agents, wholly owned by the state. None of the existing assets will be sold to private parties.

The government expects that the modifications arising from the Energy Reform will allow modernization of the industry, improving competitiveness and fostering social and economic development. It is also expected that the reform will become the basis for increasing oil revenues, resulting in job creation, strengthening state companies, such as Pemex and CFE, and ensuring economic growth and access to competitive lower-cost energies.

Mexico's energy reforms are likely to have a profound impact on long-term oil and gas production in the country as well as providing a historic opportunity to revitalize the sector and redraw the global energy map. Energy reform gives oxygen to the necessary structural changes. The new laws are a clear pathway to set stages for the energy sector development and reformation by the following points[48]:

- Reshaping existing institutions and creation of new ones
- Limiting and replacing direct government intervention with regulation
- Regulator features consolidation and independence
- Creating independent system operators to manage transmission, transportation and distribution networks
- Offering new governance structures and processes for Pemex and CFE.

Regarding oil and other hydrocarbons, the Reform allows individuals to take part in hydrocarbons subsoil extraction. The amendment does not alter the nation's ownership of hydrocarbons and maintains the prohibition of granting concessions giving natural resources rights to individuals. These contracts, determined in their form by the corresponding regulatory law, allow the participation of the social and private sector in the exploration and extraction of hydrocarbons in exchange for payments based on the resources obtained.

Also, there is an exclusion of basic petrochemicals from Article 28 of the Constitution as a strategic area that does not constitute a monopoly. It allows individuals to participate directly in schemes regulated in the value chain after extraction, comprising crude oil, natural gas, and its liquid transportation, as well as petrochemicals and refined products, through permits fixed under the terms established by secondary legislation.

There has been a restructuring of Pemex and its subsidiaries into two divisions: Exploration and Production, and Industrial Transformation. There has also been a change in the conditions of transparency and accountability in Pemex, and the establishment of a national policy to encourage the purchase of domestic suppliers in the hydrocarbons sector.

Regarding electricity, a market for electricity generation opens up without the State losing its leadership in controlling the national electricity system and the exclusivity of transmitting and distributing energy as an essential public service. It is desired that the national electricity system is jointly promoted by CFE and the private sector under the guidance of the State, with the objective of reducing costs and increasing the productivity

46 Lora (2001)

47 Sener (2014)

48 Sener (2016)

and efficiency of the electricity system, thus reducing electricity rates. The ownership of power plants and the transmission and distribution networks of the CFE, which are public, are still in the hands of the Nation. Also, there is the promotion of diversification in energy production with the use of wind, geothermal, hydraulic and mini-hydraulics, biomass and solar energy.

Regarding the National Centres, Article 16 creates a decentralized public body called the National Centre for Control of Natural Gas, in charge of the operation of the national system of transport and storage pipelines. This National Centre acquires and manages the infrastructure for the carriage by pipelines and natural gas storage, which they own, to provide services to the corresponding users.

The Reform creates another decentralized public body called the National Centre for Energy Control, in authority for the operational control of the national electricity system, to operate the wholesale electric market, for open and not excessively discriminatory access to the national transmission network and general distribution systems.

The Reform creates the Mexican Petroleum Fund, which is responsible for receiving all income, except for contributions, corresponding to the State derived from the assignments and contracts referred to in the seventh paragraph of Article 27 of the Constitution.

State revenues received as a proportion of the gross value of the extracted hydrocarbons shall be allocated by the Mexican Petroleum Fund to the Funds for the Stabilization of Oil Revenues and the Stabilization of the Income of the Federative Entities. The Fund has a Technical Committee composed of three members representing the State and two independent members. The members representing the State are the holders of the Ministry of Finance and Public Credit, the Energy Secretariat and the Bank of Mexico.

The Reform creates the National Agency for Industrial Safety and Environmental Protection of the Hydrocarbons Sector, as a decentralized federal agency of the Ministry of the Environment and Natural Resources, with professional and management autonomy. The Agency supervises, in matters of operational safety and protection of the environment, facilities, and activities of the hydrocarbons sector.

Regarding the Secondary Laws Approved in August 2014, while the constitutional reforms drew the broad outlines of Mexico's oil and gas reform, much information was left to be defined in Secondary Laws needed to implement the Reform.[49] The main provisions dealing with the hydrocarbons sector not mentioned above include:

- Pemex: is more independent of the state, but must adopt internal reforms; is to pay a tax rate of roughly 65 percent, and is permitted to keep some of its existing fields.
- Pemex's monopoly on retail gasoline and diesel sales finishes.
- Companies will pay royalties and taxes according to oil prices.
- Companies require respecting national content requirements of 25 percent in 2015, rising to 35 percent in 2025.[50]
- Companies may not expropriate land from communities for exploration and development, but instead temporarily occupy land and compensate its owners.
- The National Hydrocarbons Commission (CNH) is reinforced and established as a constitutionally coordinated entity to gather and manage information about the energy sector, issue regulations and monitor compliance, and manage the bidding rounds, award contracts, and supervise those contracts.

The Reform maintains and includes new institutions to deal with Mexico's hydrocarbon industry:

- Ministry of Energy (Sener): This institution develops Mexico's upstream policy; regulates areas to be made available and the schedule for public bidding.
- Ministry of Finance and Public Credit (SHCP): This institution determines the financial terms to apply to each contract and participates in audits.
- National Hydrocarbons Commission (CNH): This institution interfaces with Pemex and private companies, conducts and manages contracts, and oversees the industry.
- Energy Regulatory Commission (CRE): This institution supervises the transportation, storage, distribution, gasification, liquefaction, sales and marketing of natural gas and oil products.
- National Agency for Industrial Safety and Environmental Protection: This institution regulates environmental and safety concerns.

2.6. Why was Energy Reform needed?

There are two main reasons why Energy Reform was needed: supply/demand and evolution of energy needs.

49 David (2014)

50 Excluding deep water activities

2.6.1. Supply and demand

Mexico's consumption of energy is increasing, and its production is decreasing. In Mexico, the market for refined products[51] is estimated to continue to grow through 2027.

However, Mexico's production, (yellow line below), will not be able to catch up with the demand (red line) (Figure 3). Thus, there is a need for external sources to fill the gap between demand and supply.

Moreover, Mexico's opportunities do not stop at refined products but extend to other petroleum products and gas, and. Mexico has 9.8 billion barrels of oil reserves and 17 trillion cubic feet (TCF) of natural gas reserves. Despite the fact that reserves are critical in times of need, excessive reserves can hinder growth. With examples of both demand surpassing supply, as in the case of refined products, and supply surpassing demand, as in the case of the oil and natural gas, Mexico had to look for ways to correct this situation. Two options to relieve these imbalances were identified: decree reforms to let private investment in the sector help to catch up with the demand, or otherwise, to keep importing petroleum products and natural gas despite its vast energy.[52]

2.7. Evolution of energy needs

The global changes in energy make the country even more relegated by competitiveness and economic growth. Without an Energy Reform, the country runs the risk of being left behind; the global energy sector is moving at extraordinary speed with technological developments that are accelerating the global map.

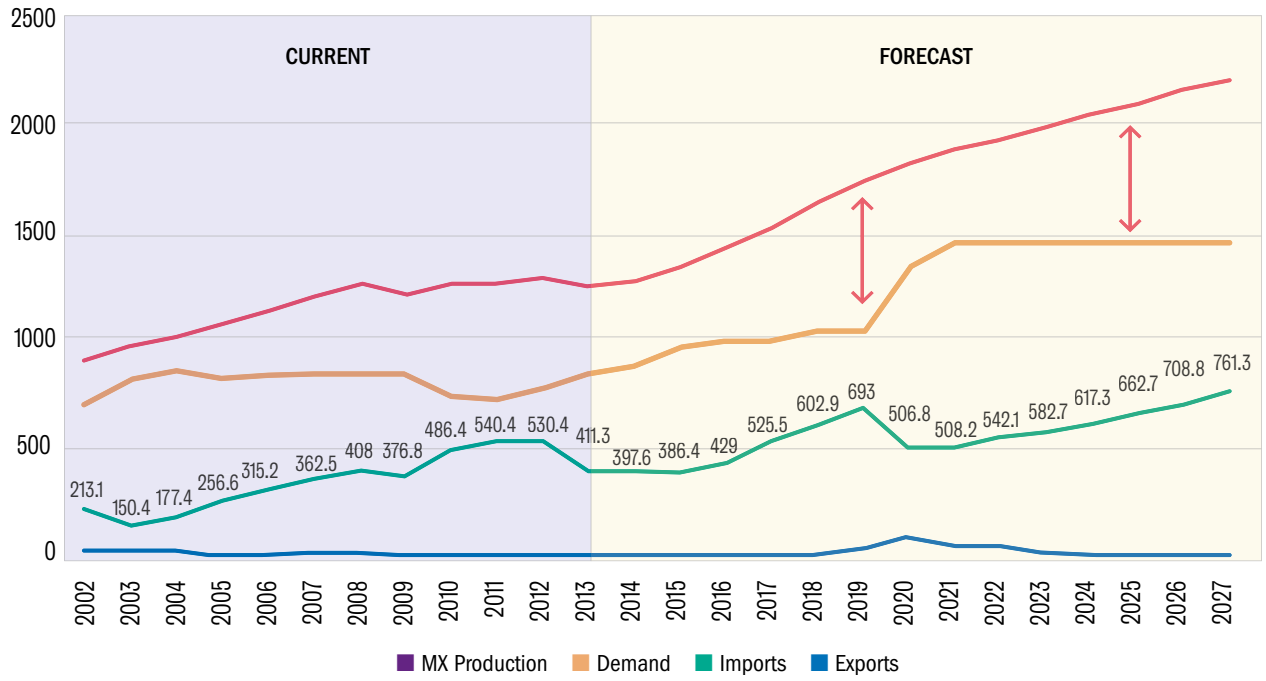
Historically, Mexico has had an ineffectiveness of its refineries, creating high levels of residual fuel oil that is difficult to set on the international market at a reasonable price. However, modern refineries create petroleum from fuel crude. Mexican refineries are not designed to process them.

The Mexican energy sector needs necessary capital investment in order to improve Mexico's refineries to be able to process crude efficiently. The Energy Reform pursues the goal of changing the capability of Mexico's refineries, to provide competitive refinery processes.

51 Such as gasoline, diesel and jet fuel

52 Market Realist (2014)

Figure 3. Mexico gasoline, diesel and jet fuel market



Source: Oro Negro

Note: Thousands of barrels per day

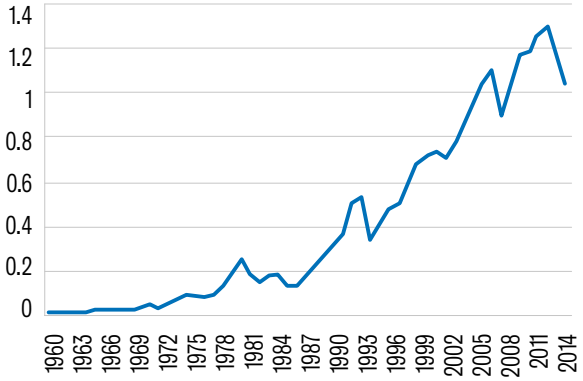
3. The Mexican Economy and the Energy System

3.1. Mexican economy

The growing complexity of the energy sector resulting from the reform required the separation of functions between the administration of the nation's oil resources and the protection of industrial, operational and environmental safety. Energy reform responds to the urgent need to increase the rate of economic growth, improve productivity, economic needs, industry stagnation and global challenges.

Figure 4 shows the Mexican GDP development, in which it is easy to find a growth stage from 1950 to 1980 with an annual average of 6.4 percent, and in the following years with the slow rate of 2.4 percent.

Figure 4. Mexico GDP



Own elaboration. Source: World Bank.

Note: GDP (current US$ Billions)

Mexico has abundant and potentially accessible oil and gas resources and is also known for one of the largest reserves, yet it is currently untapped. Mexican oil and gas reserves are comparable to Saudi Arabia's, and, according to the EIA, Mexico's shale gas and oil reserves are the sixth and eighth largest in the world.[53] With the 2013 Energy Reform, Mexico loosened monopoly laws in both the oil and gas sectors.

3.2. The gas sector

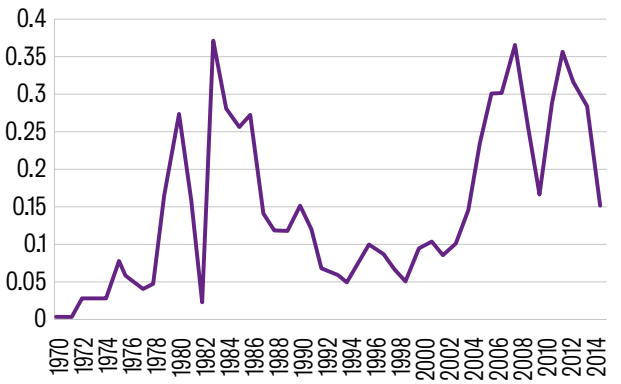
Mexico's energy mix is controlled by oil and gas, with oil accounting for around half of the total. Traditionally oil has played a dominant role as a fuel for power generation. Nowadays, the country is increasing the natural gas production as a consequence of the shale gas boom in the United States. On the other hand, non-fossil fuel generation, and nuclear, currently accounts for one-fifth of the total.

3.2.1. Natural gas

In Mexico, natural gas is one of the leading sources of energy, and is used in various sectors such as electric, industrial and residential because, compared to other fossil fuels such as coal, diesel, and fuel oil, it is an economical fuel and environmentally friendly. The energy transition that is taking place in the country promotes the participation of cleaner fuels for the generation of energy.

Mexico's interest in natural gas for power generation has triggered imports from the United States in recent years. Figure 5 shows Mexican gas revenues as a portion of the GDP.

Figure 5. Mexico gas revenues, % of GDP



Own elaboration. Source: World Bank.

Note: Gas rents (% of GDP)

Mexico acquired about US $3.6 billion of natural gas from US companies in 2016, the most significant amount between the two nations in its history.[54] Pemex makes just over 50% of that import with a daily average of 1,934 million cubic feet; the rest is privately owned. Pemex's imports of natural gas grew 36.6% annually in 2016 over the previous year.

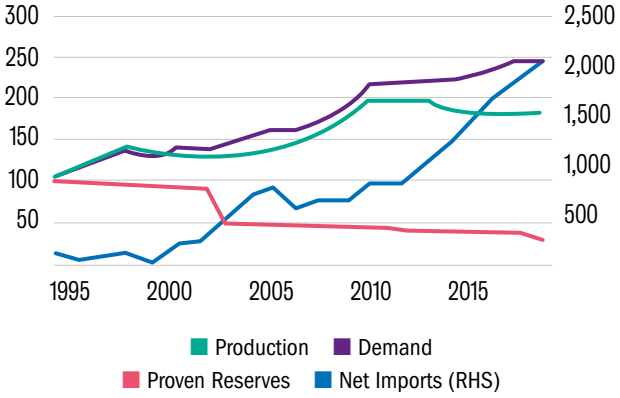
The increase in imports is due to the decline in the production of natural gas by Pemex, which indirectly has hit the country's reserves of this hydrocarbon.

53 Financial Times (2015)

54 Expansión (2017)

The country's proven natural gas reserves fell 17.8% year-on-year from 12,651 million cubic feet in 2015 to 10,402 million in 2016, according to data from the CNH. The fall reaches 37% when comparing the data with the registry of 2013.

Figure 6. Mexico natural gas indicators



Source: EY.

Note: 1995=100

Mexico has been changing from fuel oil- and diesel-fired electricity, so gas now accounts for nearly 60% of the whole energy mix, and it could reach 72–75% by 2022. Mexico's domestic gas production, however, has continued to fall, frequently because it is produced as an associated gas.[55] Mexico's oil production is down 30-35% in the past decade.[56]

3.2.2. Shale Gas

Shale gas is considered as one of the new sources of cheap energy. The shale gas revolution is transforming the US economy, as the gas reserves that the country has are sufficient for the next 100 years if the current consumption rate is maintained. Faced with this phenomenon, the energy reform of Mexico should establish conditions similar to those that exist in the US to partake in this great opportunity. The rising prices of natural gas at a given moment stimulated the necessary investments for the expansion of shale gas in the US. The US shale gas boom was supported by a slowly developed hydrocarbon industry, serving unconventional gas fields.

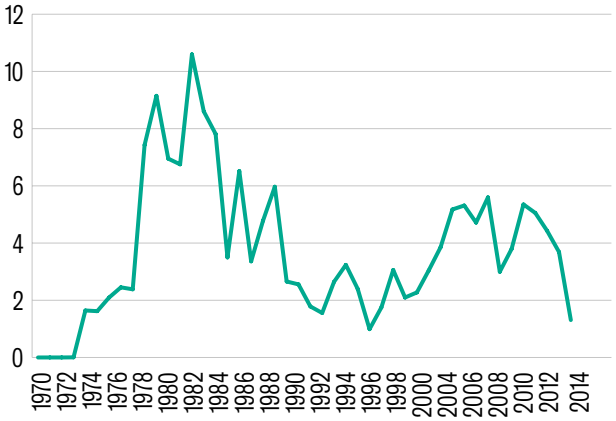
On the other hand, Mexico is the sixth country in the world with more reserves of this gas, although exploration has been scarce and the profitability of the extraction makes the investment less. In Mexico, there has been an apparent interest in developing oil projects given the level of income they represent, to the detriment of conventional and non-conventional natural gas projects. Mexico has been importing gas because of the lack of technology, financial and human resources. However, with the Reform, Mexico starts the exploration and exploitation of shale gas to stop importing gas. The Reform raises competition in the gas value chain.

The Federal Government considers that through the Reform, opening up to private initiative would have the following consequences: 1) Increase the natural gas production of the 5.7 billion cubic feet per day currently generated to 8 billion by 2018 and 10.4 billion in 2025; 2) Lower the price of natural gas thanks to which multiple companies will be able to invest and participate in the exploration and extraction of natural gas. It has been stated that natural gas has been imported at a price of up to $19 when in Mexico it would be produced at only $3.[57]

3.3. The oil sector

Deficient investment in public goods is the source of the lack of an efficient infrastructure and non-oil tax ratios. Direct private investment (gross fixed capital) has remained, above 20 percent as a proportion of GDP. This is due to the state, historically, tending to have weak state-owned capital-intensive energy companies.

Figure 7. Mexico oil revenues, % of GDP



Own elaboration. Source: World Bank.

Note: Oil rents (% of GDP)

The performance of the past 30 years has been disappointing compared to its history. After rising at a yearly average rate of 6.4 percent between 1950 and 1980, GDP increased at a rate of 2.4 percent between 1980 and 2010. Recently the average growth was even slower.[58]

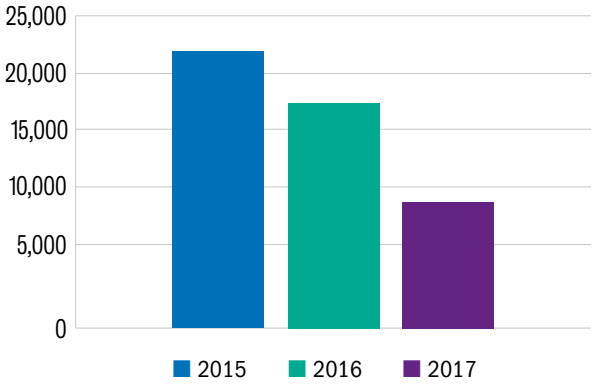
55 Which comes along with oil production

56 Forbes (2017)

57 Presidency of the Republic, December 21, 2013

58 SIE (2016)

Figure 8. Mexico petroleum exports



Own elaboration. Source: INEGI.

Notes: US$ Millions. Includes crude oil, petroleum products, and petrochemicals

Despite the growing flow of foreign direct investment, gross capital formation has stabilized GDP at levels just over 20 percent.

An insufficient complementary investment in public goods is the source of severe bottlenecks in the physical and social infrastructure of the country, and the non-oil tax burden remains at unusually low levels, even in other Latin American countries, of less than 10 percent. Maintaining the macroeconomic balance has resulted in severe capital restrictions in the state energy sector.[59]

In general terms, in recent decades there has existed a sense of crisis in the energy sector. An uncompetitive electricity prices have limited manufacturing growth. The hydrocarbon production and exports are not comparable with the rest of North America.

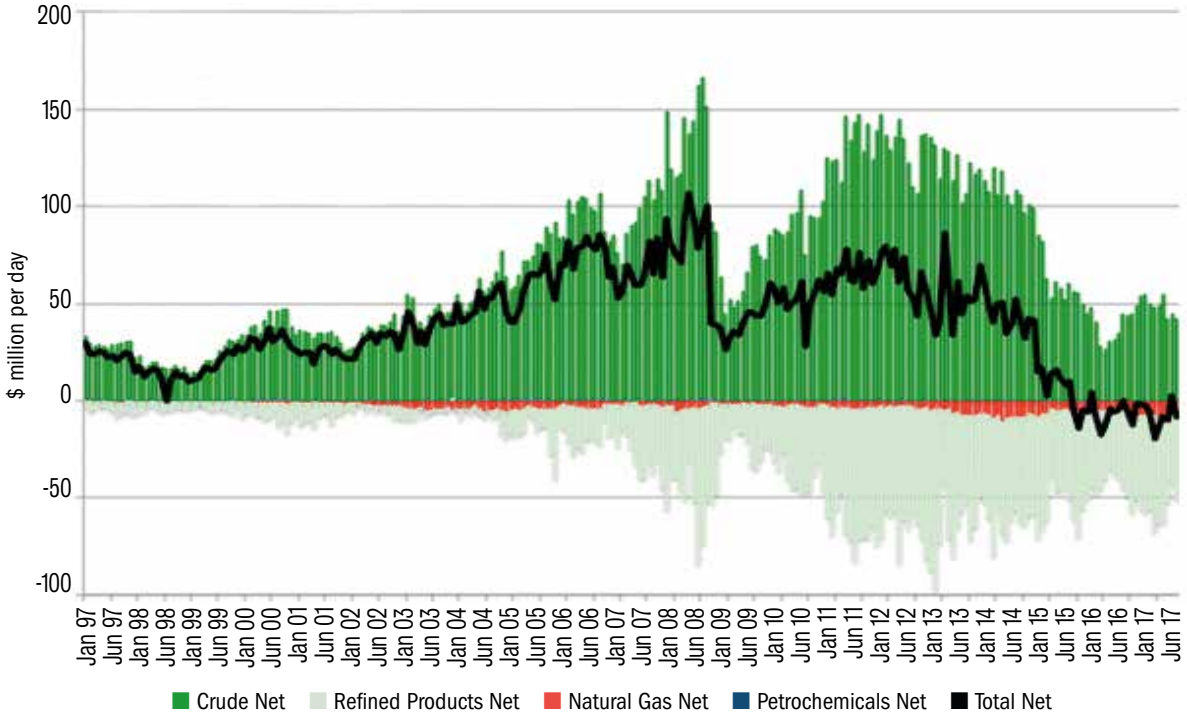
Since mid-2015, Mexico petroleum exports have fallen, and Mexico has been a net importer of hydrocarbons.[60] It has been a relatively small and relatively constant amount, but with their oil production and oil price falls while natural gas prices may be on the rise, the net cost could now start to increase. As Figure 6 shows, overall, all categories of reserves have been falling for some years.

Other determinants of energy reform have been the substantial drop in crude oil production and exports in the context of the recent growth in oil and natural gas production in the rest of North America. In Mexico, net production of natural gas has remained stagnant. The resultant increase in imports has been insufficient to cope with total demand, owing to problems in the logistics

59 Especially in the oil industry, in which state issues are accused of deficit performance

60 Oil, natural gas, petroleum products and petrochemicals combined

Figure 9. Mexico hydrocarbon exports



Source: Seeking Alpha 2017

infrastructure, in particular the restrictions on the transport capacity of the pipeline network. In turn, prices, tariffs and non-competitive electricity costs limit the growth of the manufacturing industry.

3.4. Energy security

Energy security has been a much studied area in recent years. Different aspects have been covered in the literature. Over the world, the term energy security has not been precisely defined, which makes it hard to measure and hard to balance against other policy objectives. There are numerous definitions of energy security, characterized according to the sources of risk, the impacts scope, and the severity filters in the form of the speed, size, spread, singularity and sureness of impacts, as well as continuity of demand for energy supplies.[61]

Energy security allows the rational use of energy while maintaining the levels of competitiveness. A country needs fundamentally to find the best model of how it produces and uses energy to ensure a sustainable future. Due to this, the energy sector has become an essential part of the economic and social development of all countries. Each country needs to focus energy security on climate change because it is a global environmental externality, which if unchecked will increase the likelihood of severe, pervasive and irreversible impacts for people and ecosystems.[62]

The concept of energy security is closely related to geopolitical events and armed conflicts but also to the prices and the permanent supply of hydrocarbons. For this reason, it not only has a military origin but is analyzed within the framework of political, economic, societal and environmental security. Mexico cannot escape the conceptualization of energy security and its discussion at the global level. As an exporter of crude oil and as an importer of reigned gasoline, the country depends on the international prices of hydrocarbons.

The Mexican policy on national security has given priority to sectoral security, both energy, water, and food. However, these safeguards should guarantee to any citizen, permanently, a situation of freedom, peace, development and social justice, which would exceed the limited vision of political-military security.[63]

Mexico belongs to the small group of oil and gas producing countries that, in principle, could supply their domestic energy market and also export hydrocarbons to other nations. Oil has determined the economic and energy life of the country in recent last years. The idea that the oil boom will last for many years is not only wrong, it has also fed the political decisions that have determined its unsustainable exploitation.

According to the International Energy Agency, Mexico had increased its oil consumption by 1.27 million barrels per day (MMBPD) in 1980 to 2.19 MMBPD in 2012. In the same period and according to figures, domestic crude oil production remained in the range of 2.5 to 3.3 MMBPD between 1990 and 2012. Crude oil exports stood between 1.2 and 1.8 Mbps in the same period, with an export peak in 2004 and the subsequent fall to reach a figure similar to that of 1990.[64]

According to the National Hydrocarbons Commission, Cantarell went from contributing 48 percent of total production in 2000 to only 15 percent in 2013.[65] The capacities to ensure energy security in this zone are getting smaller. The remaining options (KMZ) have offset, to a certain extent, the loss of the primary reservoir, but require more investment, generate lower productivity and continue to increase GHG emissions levels in the sector.

The information from the Energy Information System[66] confirms the following trend: in 1997, the investment of US$3.1 billion resulted in a production of 3 MMBPD, while in 2013 an investment almost seven times higher (US$20.5 thousand million) generated only 2.5 MMBPD. With accumulated losses of up to 124 billion pesos in 10 years, Pemex has significantly decreased its yields, which has limited its capacity to supply the current needs of the core petrochemical industry.[67] Also, the current tax regime still accounts for a significant portion of revenues in the sector: on average, between 2 and 3 pesos out of 10 of the Federation's expenditure budget comes from Pemex's oil and gas sales.[68]

3.4.1. Deposits and reserves

Cantarell[69] started to have problems during the 1990s. During that time, efforts were made to reverse the production decline, leading to positive results for a while and the field touched its peak in 2004 at 2.1 MMBPD. Since then, the decay has been considerable with Cantarell producing approximately 400,000 BPD less in 2012.

61 Winzer (2012)

62 IPCC (2014)

63 Sener (2012)

64 EIS (2016)

65 Sener (2016)

66 EIS (2016)

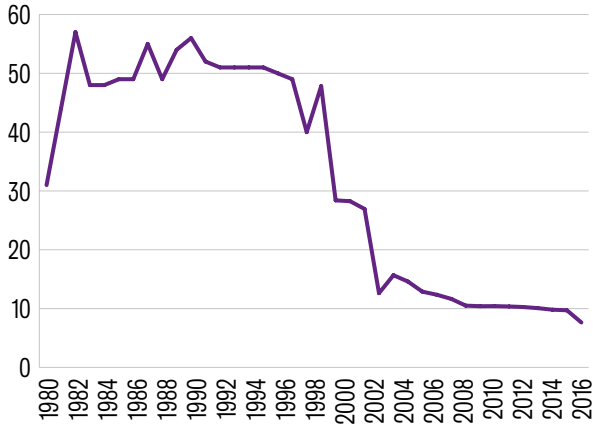
67 SHCP (2013)

68 Sener (2016)

69 Once the largest producing field in the world

The production of KMZ has been increasing since 2006, reaching approximately 867,000 BPD at the end of 2012, substituting parts of Cantarell's decline.[70] Figure 7 shows proved crude oil reserves between 1980 and 2017.

Figure10. Mexico crude oil proved reserves



Own elaboration. Source: World Bank.

Note: Billion Barrels

Continuing with an extractive energy model, unsustainable and environmentally damaging, not only jeopardizes the country's energy or economic security, as the numbers corroborate. Public health and the still fragile efforts on climate change are also at stake. However, Energy Reform should modify this scenario.

3.5. Sustainability: a Paris Agreement approach

Sustainability and climate change considerations are prominent in Mexico's energy policy. Mexico was among the first nations to submit a climate pledge in the run-up to the Paris Agreement (PA) and was among the countries that pushed hardest for a climate change agreement in Paris. It has legislated to adopt a binding climate target: the second country in the world to do so. With institutional changes that help promote clean energy, Mexico is embarked on a course towards a considerably more sustainable and efficient energy system in the future.

With a lack of necessary money for its development and consolidation, the Mexican government was unable to take advantage of the opportunity cost of declining wells, which are now not being exploited, nor to discover new deposits or, even less, to develop renewable energies.[71] Also, a modern energy company requires storage and distribution systems, where pipelines are crucial, but also refining plants and the production of petrochemicals. Today, Pemex is profoundly indebted and under current conditions does not have the financial capacity to meet the challenges of a modern company that guarantees energy security to Mexico.

Also, the sharp fall in international crude oil prices has deprived the national government of the resources needed to modernize Pemex[72] and also cover the investment required to create infrastructure in the country. However, with the INDC (Intended Nationally Determined Contributions), assumed and ratified as PA, Mexico has had the possibility of developing their abundant renewable energies[73] with public, private, national and international investments to consolidate an alternative energy security, based on sustainability and collective well-being.

The Mexico participation in the PA represents their keen interest in being an active participant in the development and implementation of international climate agreements. The PA pursues limiting the mean increase in global temperatures to well below 2 degrees Celsius and to follow efforts to limit global mean temperatures to 1.5 degrees. It is a long-term goal to reduce greenhouse gas emissions aiming to reach neutrality in the second half of the century.[74]

A significant number of countries have agreed upon the PA to limit warming to well below 2 degrees Celsius above pre-industrial temperatures. The PA includes legally binding obligations for all countries to regularly prepare climate plans called Nationally Determined Contributions (NDCs). The NDCs will be reviewed every five years starting in 2018 to assure progress toward achieving the long-term goals. With an update in 2020, each country that signed the PA must prepare, communicate and maintain its contribution to reducing GHG emissions, and these targets must be progressive. On the other hand, Mexico has engaged the following PA commitments:[75]

- Mexico committed to reducing GHG emissions (water vapour, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), chlorofluorocarbons (CFC) and ozone (O3) by 2026 by 20 percent; and to cut carbon emissions by 51 percent by 2026.

- The Mexican government guaranteed that in 2024, 35 percent of the energy generated in the country would be clean, that is, using natural sources.[76] By 2030, the country pledged 43 percent of its energy to be clean. Also, Mexico plans to modernize its power plants by 22.5 percent, reduce technical losses in the electricity

70 EIA (2014)

71 Gutierrez (2016)

72 IEA (2016)

73 Including the wind, solar, geothermal, and biomass energies

74 Rogelj (2016)

75 Chamber of Deputies (2016)

76 Such as wind, hydroelectric, solar and geothermal.

grid by 10.5 percent, and replace heavy fuels with 1 percent natural gas.

Mexican society must understand the urgent need to combat global warming and work in partnership with the three levels of government, NGOs, the private sector and universities to create a system that will reach its potential in climate action. The Mexican private sector should continue its commitment to work with governments to build public-private partnerships. Mexico should increase its leadership in global efforts on climate change to negotiate new regional financial products for clean technologies through innovation.

3.6 Competitiveness and affordability

Mexico is an important country on the global economic map. The country has an area of 1,964,380 km2, and is the third largest country in Latin America, behind Brazil and Argentina. In 2014 its gross domestic product (GDP) reached US$1.283 billion, and its population reached 125.4 million inhabitants.[77] Gross National Income per capita for the same year was US$9,860 (current dollars), 8.8 percent higher than the average for Latin American countries. Regarding the per capita income level, Mexico ranks among the World Bank's middle-income countries.

Regarding the energy sector, the electricity subsector's available figures indicate that in 2013 Mexico had an installed capacity of 53,455 MW and a total generation of 297,097 GW, the second highest in LAC, after Brazil.[78] According to data from the World Bank[79] for the period 2011-15, 99.1 percent of households have access to electricity.

On the other hand, regarding the oil sector, Mexico is the eleventh largest oil producer in the world and one of the primary producers in Latin America and the Caribbean, along with Venezuela. In 2014 it had an average production of 2.78 MMBPD, of which it exported 1.29 MMBPD, which represents about 46 percent of the total. That year, exports to the US reached 65 percent of total production (0.842 MMBPD on average). Despite being a net exporter of crude, Mexico is currently a net importer of petroleum products, with a volume close to 0.641 MMBPD.

The overview of the energy demands and forecast of production for the country is as follows (Reyes-Heroles, 2015):

- Mexico is the 15th economy in the world in terms of GDP.
- An increase is expected in oil production from 2.5 MMBPD in 2016, to 3.0 MMBPD in 2018 and 3.5 MMBPD in 2025.
- There are 27,000 million barrels of crude oil in Deepwater reserves.
- Current demand for refined products is 50 percent larger than national production.
- There has been a 30 percent increase in demand for petroleum products since 2003.
- There has been a 5.6 percent annual increase in natural gas requests since 2000.
- An increase is expected in natural gas production from 5.7 thousand millions of cubic feet (2016) to 8 thousand in 2018 and 10.4 thousand in 2025.
- There is an expected of US$ 7,454 million investment to increase in the length of the national duct system.

Pemex is the largest energy company in Mexico regarding revenues with its production output of 2.55 MMBPD.[80] The focus of the energy market is on the export of crude oil to foreign countries and the import of distilled oil products such as gasoline and diesel mainly from the USA (Cruz Serrano, 2014). Pemex has almost 140,000 workers, and it is subdivided into the following subsidiary firms:

- Pemex Exploration and Production
- Pemex Drilling and Services
- Pemex Logistics
- Pemex Cogeneration and Services
- Pemex Fertilizers
- Pemex Ethylene. For context, Figure 8 shows Pemex ranks in the following global positions:[81]

77 World Bank (2014)

78 Olade (2014)

79 World Bank (2016)

80 Pemex (2016)

81 Pemex (2016)

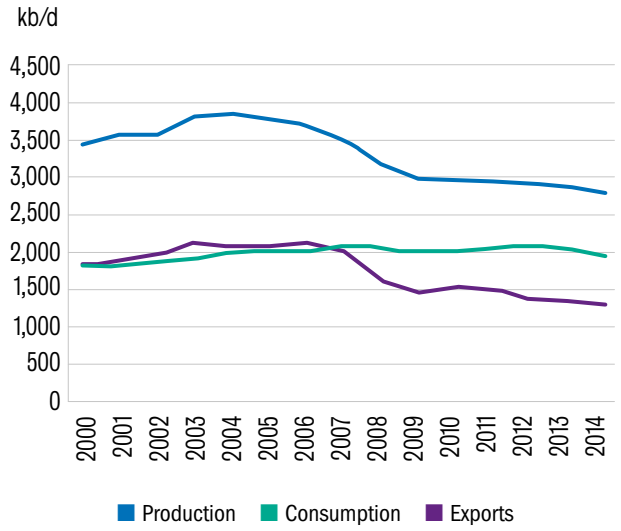
Figure 11. Pemex world context rank

Concept	Rank
Proven oil reserves	17th
Proven Natural Gas reserves	31st
Oil production	10th
Gas production	12th
Primarily Oil distillation capacity	13th

Own elaboration. Source: Pemex

Mexico is the world's 10th leading producer of oil and holds around 11.1 billion barrels of oil reserves – the 18th largest in the world. Mexico also has the 8th most abundant oil resources worldwide, with another 13 billion barrels.[82]

Figure 12. Mexico oil production, consumption, and exports



Source: BP Statistical Review 2001-2015

Note: Thousand barrel per day

Mexico's oil production declined by some 20 percent from 2005 through 2009; production has fallen by roughly 1 percent per year since that time. However, the EIA has estimated that the Energy Reform could lift Mexico's long-term oil production potential to 3.7 Mbps by 2040 from the 2.9 MMBPD produced in 2013. That estimate is 75 percent higher than the EIA's 2013 forecast for Mexico's long-term oil production which was issued before the enactment of the Reform.[83]

82 EIA (2013)

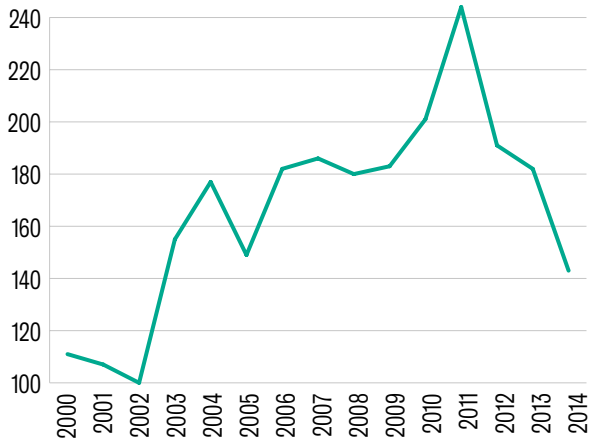
83 EIA (2014)

3.6.1. The oil trade

Oil is a crucial part of the Mexican economy, making 13 percent of the country's export incomes, a proportion that has reduced over the past decade. Moreover, gains from the oil industry, with taxes and direct payments included from Pemex, accounted for around 32 percent of government revenues in 2013. Figure 10 shows refined petroleum product exports between 2000 and 2012. The crude oil accounts for 82 percent of the total hydrocarbon exports, while the lighter crude oil is mostly retained for domestic consumption.

The exports of crude oil will most likely continue to go to the US as the leading destination, due to the US possessing more sophisticated refining techniques necessary to process the heavier crude oil (CRS, 2014). Mexico is a significant but decreasing net crude oil exporter, and a net importer of refined petroleum products. The most extensive trading partner is the United States, which is the target for most of the exported crude oil and also the source of most of the Mexican imported refined products.

Figure 13. Total exports of refined petroleum products

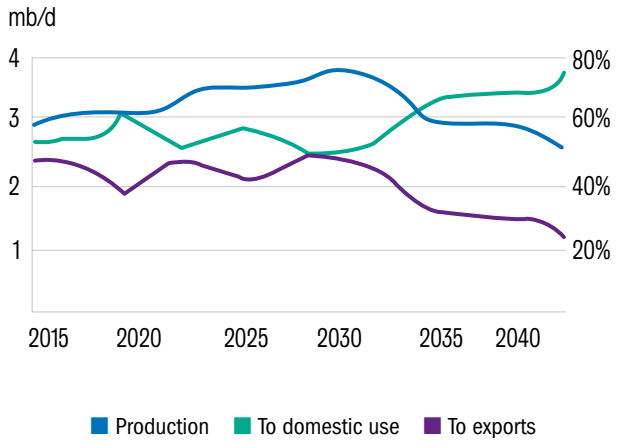


Own elaboration. Source: World Bank.

Note: Thousand Barrels Per Day

Figure 14 shows that since its peak of 3.8 MMBPD in 2004, oil production and exports have been declining at an alarming rate mainly due to the depletion of its main oil-field, Cantarell.[84] Oil exports have fallen from 1.9 MMBPD to 1.2 MMBPD in 10 years.

Figure 14. Mexico oil production and exports



Own elaboration. Source: IEA.

Note: (%) = Share of production

84 IEA (2016)

4. Challenges and Opportunities

Mexico is an industrialized economy, a developing nation regarding population as well as regarding institutions whose primary goal is to contribute to the economic development of the nation and its inhabitants. Mexican territory is well endowed with natural resources including oil and gas, which ruled economic development in the last century and indeed will be substantial for at least the first half of this century. However, more importantly for the future, its location near the tropics and long coasts give Mexico a considerable potential regarding renewable energies. A robust and competitive energy market, and the use of renewables could be the critical factor in the success of any nation to become a developed economy.

In the scenario presented in the coming decades, the world will need more energy, at least 30% more by 2040.[85] With the opening of its energy sector, Mexico faces the challenge of taking advantage of the opportunities presented by this renewed industry. The Energy Reform is transforming the sector and boosting the need to create new businesses and train energy professionals, aligning the country's vision in this matter with trends in the global energy environment.

The Mexican government is aware of the magnitude of the investments that this challenge entails – about 150 billion dollars over the next 15 years. That is why it has sought to make the reform more conducive to private capital and create the conditions necessary to attract investors: a well-designed, stable and predictable regulatory framework based on market principles.

The reform has profoundly changed the structure of the Mexican electricity sector, but it is necessary to consolidate market liberalization, maintain regulatory stability, and invest in medium- and long-term visibility by setting clear energy targets and facilitating procedures to producers and suppliers. Those responsible for implementing the reform must also ensure the quality of service and reduce system losses, taking full advantage of new digital technologies. Finally, they must invest in training, and development of human capital in this new technological era. Mexico faces challenges opportunities, this strategy paper analyses them from environmental, political social and economic perspectives:

There is a challenge with the country human resources: there is a deficit of professionals, technicians, and trained and certified workers. However, there is the opportunity to increase the volume and quality of professionals, technicians, and operators. The country needs to estimate the human capital requirements of the short-, medium- and long-term.

85 IEA (2015)

There is also a challenge with the actual infrastructure situation: the major and rural roads and airports are limited and in a poor condition in most cases. There is an institutional weakness, both at the local and federal level, to cover current the infrastructure demands. However, there is the opportunity to implement an immediate communications infrastructure programme and support the development of the energy industry, as well as financing to strengthen urban services, education, and health infrastructure.

There is a challenge with the supply chain situation: there is no consolidated market of operating companies and suppliers. Most local, medium and small enterprises are not prepared to join the hydrocarbon industry. However, there is the opportunity to disseminate information about business opportunities as providers in the new supply chain. There is a need to strengthen competitive advantages of local companies, as well as to establish regulatory improvement programmes in states and municipalities to facilitate the opening of companies linked to this industry.

There is a challenge in land rights: half of the territory is common property.[86] It represents an unfavorable negotiation scenario with the indigenous people who live in these areas. However, there is the opportunity to train for proper negotiation: fast, fair and safe for both parties. It is necessary to give the correct information to owners.

There is a challenge in innovation and technology: there is an insufficiency of research centres, researchers and scientific laboratories linked to industry. Also, there is insufficient support to companies for the development of new technologies and processes. However, there is the opportunity to expand research and technological development capacity with properly equipped and certified centres and laboratories and to accelerate training of teachers and researchers.

4.1. Environmental perspective

Mexico's energy mix is one of the most oil-dependent in the world, with oil products still accounting for more than half of total primary energy demand. With the Energy Reform,

86 Ejido (agricultural) lands in Mexico are lands that have been or still are owned by a community

Figure 15. Mexico primary energy demand in the Energy Reform scenario

						Shares		CAAGR
	2000	2014	2020	2030	2040	2014	2040	2014-2040
Fossil fuels	131	170	168	176	186	90%	83%	0.3%
Oil	89	96	91	95	95	51%	42%	-0.3%
Natural gas	35	61	68	74	86	32%	38%	1.4%
Coal	7	13	10	7	6	7%	3%	-3.1%
Renewables	17	16	19	25	31	9%	14%	2.7%
Hydro	3	3	3	4	5	2%	2%	1.4%
Bionergy	9	9	9	9	9	5%	4%	0.6%
Other renewables	5	4	7	12	17	2%	8%	5.9%
Nuclear	2	3	3	5	7	1%	3%	4.2%
Total	150	188	190	206	225	100%	100%	0.7%

Own elaboration. Source: IEA.

Note: Compound average annual growth rate

the share of oil in the mix falls sharply, to 42 percent, but, at this level, it remains significantly higher than in the broader OECD. By contrast, the energy mix is one of the least dependent on coal. Coal is displaced almost entirely as coal-fired power plants have been all but phased out. Natural gas demand grows by 1.3 percent per year, resulting in a significant increase in its share in the mix (from 32 to 38 percent). The percentage of renewables in total demand, including bioenergy and hydropower, increases from 8 in 2014 to 14 percent, with the majority of the increase attributable to the strong growth in wind and solar power generation.[87]

The Reform visualizes in its secondary legislation the Law of Energy Transition, which creates the legal basis that the State will use in the practices and development of energy processes, the reduction of compounds and greenhouse gas emissions (GHG), the reduction of the carbon footprint of the processes of exploration, extraction, transformation, distribution, and commercialization of energy, as well as issues of efficient use, waste treatment, and efficiency in the use of natural resources[88] and in protection of the environment, all in compliance with the seventeenth transitional article of the Reform.

From the climate perspective, it is not a good sign that decision-makers are committed to continuing an energy model based on fossil sources,[89] as the most significant source of GHG in the country. However, if appropriate decisions are taken, some windows of opportunity contained in the proposal may be used. These opportunities could lead to a Reform of the energy sector that increases the generation of energy with a renewable source and generates the conditions that allow moving towards the development of a sustainable and low carbon energy model.

The severe hurricanes and prolonged droughts recently experienced in Mexico warn of the pressing and urgent need to change the causes of climate change, including the fossil fuel-based energy model. In this sense, moving to a low-carbon energy model is imperative. According to the Fifth National Communication on Climate Change in Mexico, the energy sector accounts for 67.3 percent of GHG emissions. Thus, a low-carbon energy model could bring up to 61 percent reduction in total GHG emissions by 2020 if appropriate and timely action is taken.[90]

The Energy Reform shows that one of the axes that underpin the Reform is precisely Sustainability and Protection to the Environment, which should mitigate the adverse effects of production and consumption of fossil energy and count with higher availability of clean energy. This recital resulted in legislation in the creation of the Agency for Environmental Control and Environmental Safety of the Hydrocarbons Sector, and the obligation of electricity companies to obtain certificates of clean energy.

With the Energy Reform, the generation and commercialization of electric energy are services that are provided in a regime of free competition. The activities of generation, transmission, distribution, marketing and Operational Control of the National Electrical System are of public utility and will be subject to public and

87 IEA (2015)

88 CEMDA (2013)

89 Conventional and non-conventional

90 Semarnat (2012)

universal service obligations regarding this Law and the applicable provisions, to achieve full compliance with the objectives established in this legal system. The following are considered to be public and universal service obligations:

- Provide and supply electricity to all those who request it, when technically feasible, in conditions of efficiency, quality, reliability, continuity, safety, and sustainability.
- Comply with the provisions of social impact and sustainable development.
- Comply with the obligations regarding clean energies and reduction of pollutant emissions established for this purpose in the applicable provisions.

Also, there are also political commitments that favour environmental care, in the context of the Energy Reform. One of them, perhaps the most notorious because of its importance, is associated with the construction of infrastructure for transport of natural gas, which will significantly reduce the presence of contaminants.

Finally, the 2014-2018 Special Climate Change Programme constitutes an essential document of commitments of the government, which must comply with the new guidelines of the Energy Reform.

4.2. Political perspective

President Peña Nieto started his administration pushing a series of reforms to strategic sectors of the economy, finance, and national politics. Those reforms constitute an ambitious political commitment to ensure adequate conditions that allow it to achieve its government goals regarding growth and competitiveness. Some of these reforms propose significant changes in the structure and operation of various sectors, including energy.

During the debate on the Energy Reform, some political actors considered oil as the main component of national growth and the primary guarantor of energy security, although the majority of politicians differed. Most of the political parties voted for the Reform to generate a series of legal changes that generate the conditions for a decentralized and low carbon energy model. It will transform the way in which energy is generated, distributed and consumed in the country.

The debate on the Reform[91] provided an excellent opportunity to make substantial progress in modernization and higher efficiency in the energy sector, providing more favourable economic and social conditions in the medium term. The challenge was twofold. First, the Mexican Congress overcame complicated political negotiations on the proposal, especially on oil issues, and passed a series of legal changes (Constitutional and Secondary Laws) to open the door to reforming the energy sector. The second challenge was to convince that these policy changes will transform into opportunities to make substantial progress in the sector to put Mexico on the path to meeting its goals.

If these two challenges were not overcome, there was an opportunity to discuss and approve the Reform until 2018[92], with the following severe limitation of the time and conditions.

With the Energy Reform, the Mexican government must provide energy security with a vision of the future and mitigation of climate change over any particular party interest. The Congress must leave behind short-term political ideologies and interests to bet on the most profitable option for the country. Moreover, the energy sector, with all actors involved, has the opportunity to redraw the global energy map.

4.3. Social perspective

The Energy Reform has a social impact with a multidimensional character, for instance, the generation of higher quality jobs brings with it an increase in income in the families that benefit, and thus a better quality of life. However, the Reform and its energy development projects might affect the inhabitants of indigenous regions through development projects in these areas, affecting their agricultural sources, and having repercussions for human rights and self-determination.

Since President Enrique Peña Nieto presented the initiative of this Reform to the Congress, there have been various types of criticism and opinions on the matter within society. Many protests occurred to stop the Reform. Many of them have focused on the issue of privatization, although the State has confirmed that the Reform does not imply any form of privatization and it is based on a shared utility model. In which private companies carry with them costs and risk. Moreover, if the project succeeds, the private investor will obtain utilities. This kind of explanation has calmed the social criticisms.

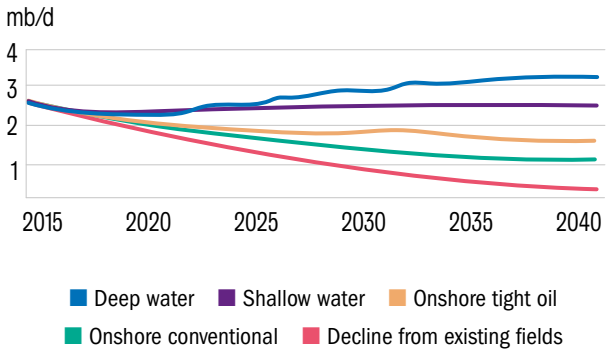
4.4. Economic perspective

The Energy Reform responds to the urgent need to increase the rate of economic growth and improve productivity. The proposed legislation brings structural changes to the hydrocarbon and power sectors. Mexico's Energy Reform provides a historic opportunity to revitalize its ailing energy sector, bolster the overall economy and redraw the global energy map.

91 Debate about the Constitutional Reform and Secondary Laws

92 2018 is the year of the next Federal Administration elections

Figure 16. Mexico oil production in the Energy Reform scenario



Own elaboration. Source: IEA 2016

Regarding the economic consequences, Mexico will receive massive amounts of investment. The Energy Reform reveals that international companies are investing in the Mexican energy sector, most of them being US companies. Some banks are discussing that the Reform is expected to bring between US$15–$20 billion in foreign direct investment to Mexico over a couple of years[93]. Those foreign companies have all the expertise and the technology needed to conduct big energy projects. The country will be able to exploit their reserves, and it will make natural gas even more accessible to industries in Mexico.

Also, it is about producing much more oil. Mexico has lost of MBPD of production per day over the last ten years. With the Reform, Mexico attempts to nearly double production which means more oil for markets, more oil for exports and more revenue for the government.

Moreover, perhaps more importantly in the medium term is the potential possibility of low electricity prices for industrial consumers in Mexico.[94] This means that Mexico's economy would become more competitive and it would help to integrate the production processes that exist in North America, helping not only Mexico but the US and Canada as well.

The Reform is expected to have a profound impact on the long-term production of oil and gas in Mexico. The EIA estimates that the Reform could generate a 75 percent potential for the long run increase in Mexico's oil production, opening up unprecedented opportunities for investors in the sector.[95] Over this view, this strategy paper provides an update on Energy Reform in Mexico, including an overview of drivers, indicators and critical elements of the transforming processes.

93 Additional investments coming as a result of the Reform

94 In 2016, the average for industrial consumers was around 49 percent higher than in the US

95 EIA (2016)

4.4.1. Energy Reform versus no Energy Reform scenarios

As the International Energy Agency[96] explains, the difference in projected oil production between the Energy Reform scenario versus the no Energy Reform scenario widens steadily over the period to 2040, by which time it will exceed 1 MBPD (2.3 MBPD versus the 3.4 MBD reached in the Energy Reform scenario).

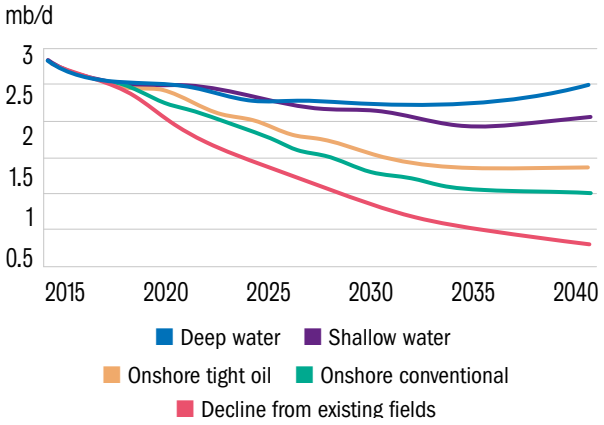
The Figure 16 shows the course of divergent trajectories takes some time to be evident; they reflect the deadlines of the projects for the Energy Reform scenario, but that is not carried out in the no Energy Reform scenario.

The main differences between the two trajectories deal with the amount of capital available for upstream investments. The investment in the Energy Reform scenario comes from diverse sources. On the other hand, in the no Energy Reform scenario, there is a lack of capital available due to Pemex budgets.

Mexico's oil output is back on a rising path in the Energy Reform scenario, however, it takes time for new projects to offset declines. On the other hand, in the no Energy Reform scenario, Mexico oil output remains lower for longer.

96 IEA (2015)

Figure 17. Mexico oil production in the no Energy Reform scenario



Own elaboration. Source: IEA 2016

4.5. Global perspective

Mexico is the world´s 15th largest economy and 2nd in Latin America. These positions are based mostly on macroeconomic indicators such as Foreign Direct Investment (FDI), strategic trade deals, and its demographic bonus. Nevertheless, as a developing economy, it still faces the challenges of modernizing its primary institutions, investment in education and research and development.

With the Reform changes, Mexico can be recognized internationally as a significant player in the global energy scenario, as one of the successful cases in moving to a sustainable model and aligned with the challenges facing climate change. The Reform has generated enormous international interest, and the reason is simple: the discovery of new unconventional gas deposits and the possibility of obtaining a lightweight and high-quality type trapped in the middle of rocks have made possible a rearrangement of the World.

Taking advantage of this situation would allow Mexico to become a significant global player, but would also prevent a worldwide decline in international prices from affecting a global scenario where energy supply seems to be increasing and, with them, the capacity of the government to face the enormous challenges that the country faces. The constitutional Energy Reform was approved amid a geopolitical context that will allow Mexico to become a valuable global player.

4.6. Strengths and weaknesses

4.6.1. Strengths

The opening of the energy sector allows the investment to be completed, to increase its productivity. Pemex's operations could become more transparent and efficient in behaving as an autonomous company, and also corruption could be eliminated to achieve competitiveness. The new Pemex autonomy in the administration and budget now acquired will allow the company to invest in activities essential to improve the competitiveness of the energy industry.

However, although Pemex attracts investment, the federal government is forced to reduce its dependence on oil revenues, and now it must raise finance efficiently, and spend more productively and transparently.

The creation of the Mexican Petroleum Fund to manage oil income with a long-term vision will allow an adequate pension for employees when nonrenewable resources are depleted. It will also provide financing for infrastructure, and investment in Pemex's human resources.[97]

The electricity market liberalization and the electricity market openness foster the creation of a wholesale electricity market and, in turn, the withdrawal of old plants to increase energy efficiency and decrease production costs.

The establishment of mandatory targets for energy with renewable sources will foster the investment in clean sources through the CELs (Clean Energy Certificates). Likewise, planning of the necessary infrastructure to evacuate energy from areas with high renewable potential is considered.

The establishment of the Energy Regulatory Commission as a decentralized body promotes an efficient regulation of the great economic powers in the energy sector, without being subject to any political power. However, there is a high risk of lack of accountability. Therefore, sophisticated transparency mechanisms must be envisaged.

4.6.2. Weaknesses

Below are listed specific weaknesses of the Energy Reform. Regarding cost reduction, as State Productive Companies, to generate profits and provide economic resources to the State, Pemex and CFE can generate profits by merely passing on their traditional costs; they do not have the explicit mandate to operate based on mechanisms to reduce costs. Part of the problem is a significant number of elements involved in the formulation of costs and the volatility of prices of various inputs. In the case of oil, the utility[98] will be the one that defines attractive projects.

97 Human capital, education and training

98 International price less operating expenses

Regarding emerging technologies, the risks of emerging technologies are closely linked to their intrinsic costs, their availability in the market and their positive or negative impact on the environment. Uncertainties arise when assessing the degree of security with which these technologies can respond to the desired objectives.

The priority of the energy sector puts at risk the other productive activities, among which are agriculture, livestock, community forestry, payment schemes for environmental and hydrological services, as well as conservation of ecosystems in different parts of the country. At the same time, they risk different habitats and ecosystems, as well as the communities and indigenous peoples that inhabit them.

Many countries have decided to prohibit or establish a moratorium on the exploitation of hydrocarbons using the technique of hydraulic fracturing as a method of extraction, due to the lack of studies to know their impacts in depth and the possible contamination of water sources and pollution of the subsoil by the action of harmful chemical additives. As well as methane gas emissions that are produced by inefficiencies in the extraction, processing, transfer, and distribution of hydrocarbons. It is crucial to carry out rigorous studies on the implications of exploitation with this technique, taking into account both economic costs and social and environmental impacts.

For the development of renewable energy in our country, it is mandatory to modernize and adapt the electricity grid. Although the CFE is solely in charge of energy distribution, the Reform establishes that it can carry out projects under service delivery schemes, where the network is increased and modernized, and developing new transmission lines to expand the infrastructure. So, a detailed programme for the evolution towards an intelligent transmission and distribution network should be created that extends to sites with high renewable potential.

The role of nuclear power remains forgotten, and the government has no resources to expand this industry. To promote this type of energy, private investment in the nuclear sector should be allowed under the management of resources by the State, or allocating own resources that come from a more efficient tax collection.

The public security is a concern for both inhabitants and investors. It is a high risk to have to deal with organized crime from these groups[99], especially the theft of hydrocarbons has raised dramatically. Eliminating impunity in the country is imperative.

99 Kidnappings of platforms, robberies, extortion, among other criminal acts

5. Policy Recommendations and Concluding Remarks

Mexico's Energy Reform is on the march and succeeding. The energy market already has open competition. The companies are recognizing the value of this Reform. This strategy paper shapes the complex subjects that are posed by the proposed upstream energy sector as well as the challenges of the changes in the midstream industry. The importance of the Reform in the industry for the broader economy is addressed. The Reform proposals have attracted much attention due to cost reduction, tariffs, and cross-subsidies.

The EIA[100] estimates that Mexico's oil production could stabilize through 2020 and then increase by 2040[101]. If the Reform is successful, it is estimated that Mexico's long-term GDP could increase by 1% to 1.5%.[102] The Reform could also increase Mexico's foreign direct investment inflows by between $20bn and $30bn per year.[103]

5.1. Policy recommendations

With the 2013 Energy Reform, Mexico loosened monopoly laws in both the oil and gas sectors. However, there are critical obstacles to producing energy in Mexico: a lack of knowledge on unique resources, higher costs, a small service industry, reduced regulatory framework, a dearth of pipelines, lack of security amid narco-trafficking, water shortages, and others.

The entry of new industry players in the sector requires that government decisions on these issues be clear, explicit and diffused widely. Thus, a further dissemination of Reform results would add to its legitimacy as well as reinforcing public opinion. The government needs to improve the sectoral communication to share the Reform vision with everyone.

Sener estimates that the country needs to form a minimum of 135,000 high-level experts, professionals and technicians in different specialties in the next four years to meet the direct demand of the sector.[104] On the other hand, it is necessary that new mechanisms contribute to adequately connecting the supply and demand of human resources, which becomes a challenge for Mexican education, science, technology and its institutions. The technological complexity of the production, transportation and transformation of hydrocarbons, the goal of achieving a diversified energy matrix with a higher proportion of clean and renewable energies, the generational turnover in State Productive Enterprises and a sector with a new growth dynamics generate new demands for talent and knowledge.

So, Mexico needs to take advantage of and enhance the training of talent to support the development of a more attractive, dynamic and competitive energy sector. The government should implement programmes for young people interested in the industry to attract and inspire them in science and energy.

Until 2016, the government awarded Postgraduate Scholarships with Sectoral Funds of Energy 1,903 Ph.D., Master's, Specialty and Courses scholarships, with an investment of 1,695 million pesos.[105] The Mexican government should increase economic support for postgraduate studies in any area of interest to the sector, improve talent training and develop a more attractive, dynamic and competitive energy sector.

The Mexican government has set some important goals to achieve the climate challenge,[106] especially with participation in the Paris Agreement. However, those commitments are conditioned to global financing and technology transfer, mainly focusing on renewables. Renewables present a significant opportunity for Mexico to accomplish emission reduction goals.

Mexico's potential for cooperation on renewables is considerable, so the region should encourage dialogue and collaboration. Mexican society must understand the urgent need for climate action, and also must work in partnership with the three government levels, NGOs, private sector, and universities to create a system to achieve its climate action potential.

The Mexican industry should continue its commitment to collaborate with governments to build public-private partnerships to incentivise interest in the construction of clean, innovative and sustainable energy infrastructure.

The Mexican government must keep working and evaluating their Paris Agreement goals periodically. Mexico should increase leadership in worldwide climate action to negotiate regional new financial products for clean technologies through innovation.

100 EIA (2014)

101 Assuming success in the implementation of the new Reform

102 As a result of the Reform

103 BBVA Research (2014)

104 Sener (2016)

105 Conacyt (2016)

106 KAS (2016)

5.2. Concluding remarks

This section concludes the findings of this strategy paper by answering the stated research questions. One of the aims of this study is to provide a thorough understanding of the historic regulatory changes of the oil sector in Mexico, and its implications, and analyze the potential near future of the Mexican oil sector regarding the energy system, Mexican economy, and global energy market. After analyzing the Mexican energy sector's current situation and its challenges and opportunities, some factors have stronger influence on the sector's development potential.

Regarding the first research question about the historic regulatory changes of the energy sector in Mexico, and its implications, the history of the energy sector is characterized by the state-run monopoly of Pemex. The Mexican government has not allowed the entrance for Pemex competitors or foreign investments. For the government, the oil sector has been the most significant source of revenues. However, it has been dominated by inefficiencies, lack of technology, and declining oil production.

Regarding the second research question, about the potential of Mexican energy sector development, Mexico could benefit vastly from the Energy Reform but only if the Reform is implemented correctly to attract investment, human resources, technologies, and infrastructure. If the Energy Reform is implemented well, it is likely that Mexico will improve its position in the international market as a principal supplier. It could increase oil production, and this represents substantial financial flows to the country.

Regarding the third research question, about the challenges and opportunities of the Mexican energy sector, Pemex needs to modernize its mindset and strategically invest in improving its position. Pemex also needs to increase its competitiveness through new technology in order to compete with the new players as they strive to get access to the Mexican oil fields. Through the open energy market proposed by the Energy Reform, Mexico might more efficiently explore and exploit its oil, and the country will once again soon be a significant oil producer and start to be competitive in renewables, to bring considerable economic growth to Mexico and increase the purchasing power of the people.

The energy sector has in the past been the driving force behind Mexico's economic development. Oil has been traditionally crucial in Mexico and is likely to be significant for the country's development shortly as the oil sector is expected to dominate the Mexican industrial climate.

Oil and gas are expected to continue as a principal energy resource up to at least 2030. However, it will lose significant shares because of renewables.[107] The plans and projects required to move forward in the transformation of an innovative and forward-looking energy sector would not only benefit the population but would also bring enormous aid to the environment. Climate change, the complexity, and inertia of the climate are factors that will continue to develop in the coming years.

The energy challenges facing Mexico are multi-faceted, but the country also has exceptional potentialities, both in supply and in energy demand. The reduction by Pemex and CFE of the domestic supply and the export of fossil fuels is directly related to the short- and medium-term plans.

The future will also require a secure supply of energy, and this impels the Mexican state – that is, the government, the entrepreneurs and society – to promote a long-term vision, for which unexplored resources and those exploited by Pemex are crucial to the future of the country.[108]

Only with an investment in training of personnel and a long-term policy will it be possible to count on the human capital and financing needed to provide the entire country, its sectors, its regions and its social groups with fossil energy, above all, renewable energy, which is an integrated sustainable energy security that takes care of the natural environment.

There are typical uncertainties in the international energy sector that need to be addressed to reduce possible negative impacts. However, there are also uncertainties typical of our country, such as insecurity and corruption, which must be taken into account to prevent them from affecting lower rates of productivity and efficiency in the energy sector. Quick identification and intervention encourage the development of the country, minimizing the negative externalities of the energy sector.[109]

The objectives of the Secondary Laws of Energy Reform should be to meet energy transition and emission reduction targets. Also, secondary laws should protect the environment, reduce the costs of energy supply, and lessen hydrocarbon dependence as the primary source of energy to promote the competitiveness of the electricity industry. Moreover, Secondary Laws should encourage the development of technology and value chains for the generation of electricity from renewable sources.

The Energy Reform opens up challenges, threats, and opportunities. Mexico and Pemex could see a new era of innovation, strategic development, and profitability. The country is facing a great opportunity to lay the foundations of sustainability. It would be disturbing to miss the current

107 Roland (2014)

108 Forbes (2017)

109 CEMDA (2014)

situation to promote a Reform that continues to give priority to hydrocarbons, and that responds primarily to economic objectives, rather than addressing it comprehensively. The collaboration between foreign companies and the Mexican energy sector could bring benefits, by using each other's comparative advantages.[110] Collaboration between government, the private sector, ONGs, universities, and society might help to improve the Mexican energy sector and economic growth.

It is undeniable that the Reform is a significant step to meet some of these goals, and that should be celebrated. However, its success may depend on the building of strong regulatory institutions. Moreover, the success may depend on its proper implementation; it provides an environment conducive to economic profitability and exploitation, but also broad indiscretion and corruption with the authorities. In 2018, the Reform is expected to be fully implemented, however it is imperative to seek new energy sources that along with the Energy Reform can drive Mexico forward in the 21st century a few steps up into a developed nation and redraw the energy map.

110 Such as energy resources, technological expertise, and finance

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