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Master Thesis

Mexico's Electricity Reforms: Effects of Private Electricity
Generation and Their Role to Enhance a Sustainable
Electricity Industry

By

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Abstract

In 1992 the electricity structure of Mexico changed from a fully monopolized sector to a more diverse one. Private electricity generation was allowed to participate on different modalities: self-supply, cogeneration or as independent power producers that could sell electricity to the Federal Commission of Electricity (CFE). The outcomes of such reforms had significant effects on electricity generation, the development of new technologies and use of resources. All this together imply economic, social and environmental effects. However, the current energy policies are focusing in fossil fuels, while there is a huge potential for renewable energy there are not enough support or incentives for its development. Mexico's economy is energy intensive oriented, its development and economy heavily relies on the electricity sector, which is the basic support of the productive activities. Because of the country's large of oil and natural gas reserves, the most utilized primary energy source in Mexico are fossil fuels, and is expected to increase in the future. Unfortunately consumption of fossil fuels sources harms the environment, polluting the air, affecting the health of humans and nature. Furthermore, climate change is an increasing concern where burning of fossil fuels is the major problem. In addition to this, population growth, industrialization and other human activities increase energy demand, and therefore more energy consumption.

Mexico requires a strong electricity sector for its economic growth, in order to maintain and drive industrial expansion, which requires strong energy inputs¹. The previous and new government expected high private participation in electricity generation, but the response has been slow and low. It is thought that the legal framework limits the development of private electricity generation, especially for renewable sources because of its intermittent properties cannot compete with conventional technologies. After a decade of these reforms, the outcome is still debated, sovereignty concerns, risk and, fuel supply are some of the problems to solve. The current president Vicente Fox and previous president had several attempts to modify the electricity law. Future electricity reforms are still uncertain; the congress has not been able to decide for the future of the energy sector in Mexico. Due to the unsteady political situation in the energy sector in Mexico, this thesis is based on the current legal framework and what is the outcome of the electricity reforms to date.

Renewable energy development and energy diversification are considered as a possible solutions, for the future electricity sustainability of the country, but different constrains are still to over come. While analyzing the potential for a sustainable electricity industry, recommendations for the development of renewable energy in Mexico are suggested.

¹ SENER (on line): Electricity

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1 Introduction

Electricity reform is a common phenomena all over the world; structural transformation, modernization and institutional change are part of electricity reforms. Drivers of such reforms differ from country to country depending on their development status. As developed countries look after energy efficiency, technological change, expansion, renewable energy and market liberalization; developing countries confront electricity demand, expansion of services and market liberalization concerns. At the same time governments have to ensure adequate use of its energy sources, protect their environment and avoid depletion of them; and to look for the future sustainability of its energy sector and electricity services.

Electricity is considered the most efficient energy service provided – especially for lighting, cooling and industrial activities. Electricity as an energy source is central to modern life. Energy is also essential for economic and social development and improving quality of life.²

Mexico's economy is energy intensive oriented, its development and economy heavily relies on the electricity and petroleum sector, which is the basic support of productive activities.

However, the implications energy production and consumption of primary energy sources has environmental impacts. Fossil fuels are the most utilized primary energy source in the world.

Unfortunately, burning these sources is harming the environment, polluting the air, affecting human health and nature. Furthermore, climate change is an increasing concern where burning of fossil fuels is the major problem.

Pollution concerns are not the only problem, population growth, industrialization and other human activities increase energy demand, therefore more electricity production and energy source consumption. Issues such as electricity availability and access to all are a special concern in developing countries and Mexico is not the exception. Mexico is now under pressure to satisfy its electricity demand.

At present 95% of the country is electrified, and about 6 million people do not have access to electricity.³ Mexico requires a strong electricity sector for its economic development, in order to maintain and drive industrial expansion, which requires strong energy inputs⁴.

A past solution to the problem was amendments on the Electric Public Service Law of 1992 that allowed private participation in electricity generation. This reform changed the previous electricity structure of the country, from a fully monopolized sector to a more diverse where participation private electricity generation is allowed under the modalities of independent power producer, self supply, and cogeneration. They are only allowed to sell electricity to CFE, to share it with industrial partners, co-owners or associations or for exportation. Still the government holds the exclusivity to provide public services.

The previous and new government expected high private participation in electricity generation, but the response has been slow and low. It is thought that the legal framework limits the development of private electricity generation. Reason why the current Mexican president Vicente Fox, and the previous president had several attempts to modify the electricity law in order to bring more private investors to the electricity sector, but the senate rejected the proposal. The debate of electricity reform is still uncertain; the Federal Government is going through changes in almost all sectors related to energy and electricity reforms, the political situation is also uncertain, after the elections (last summer 2003) the political situation is changing, no one knows what is going to happen after the selection of the new energy commission. Political Parties are now recruiting advisors.

Due to the un-stable political situation in the energy sector in Mexico, this thesis will be based on the current legal framework, the effects of electricity reforms and the development of renewable energy by private electricity generator.

² World Energy Assessment (2000): Energy and the Challenge of Sustainability. p 21

³ SENER (on line): Overview of the Power Sector

⁴ SENER (on line): Electricity

The objective is to find the link between reforms, public and private participation and development of renewable energy systems in electricity generation. A multidisciplinary approach aims to link all relevant economic, environmental and social effects of energy policies.

1.1 Background to the research

It is widely recognized that electricity reforms are necessary to satisfy the increasing electricity demand, especially for developing countries that need to ensure energy inputs basic to their economic development. The call for of a structural change, modernization and shift from state own (monopoly type) and vertical model to a decentralized horizontal model, is a matter of relative significance, especially to those countries that need a modern competitive electricity industry.

The importance of restructuring the electric sector is because electricity is considered a public good, its access and availability is basic for the satisfaction of basic needs and has the ability to improve social status.⁵ Therefore, it is necessary to find a way to protect the public service that the electric sector provides, ensure its sustainability, avoiding emission of pollutants and depletion of energy sources.

Mexico has large oil and natural gas proven reserves, because of that, the country has been energy intensive oriented, and its main energy policies are hydrocarbon oriented. The Mexican economy heavily relies on the petroleum sector; one third of the government's revenues come from oil sales. Every US dollar that the barrel of oil drops in price per annum costs the Mexican government US \$9.2 billion in lost revenues.⁶

Just in the electricity sector, oil-fired power plants make up the largest share of Mexico's electricity generation accounting for 73.94%⁷. Fuel oil has been the main fuel that dominated power generation but the situation is beginning to change in favor of natural gas⁸. According to the Ministry of Energy (SENER) the electricity sector accounted for about 29% of total natural gas consumption in Mexico in 2001, and this is expected to increase to about 36% by 2006.⁹

Electricity consumption has increased an average of 5.1% per year during the last five years, and demand is expected to increased at a yearly rate of 6.3.% in the following 10 years¹⁰. While electricity demands increased, economic growth declined. In addition to this electricity consumption is heavily subsidized in all sectors (industrial, residential and rural). The government has to confront all this and soon Mexico's power supply would not have the capacity to cope with the increasing demands and subsidized at the same time. At present, Mexico is lack on capital to do all; generation, expansion and maintenance at the same time.

Therefore, in order to complement public investment, the Federal Government encourages participation of private electricity generation. Activity that was previously reserved to the state until December 1992, when limited private participation was allowed under the Electric Energy Public Service Law (Ley del Servicio Público de Energía Eléctrica – LSPEE). Since then, private electricity generation participates under three main modalities: self-supply, cogeneration and independent power producers (IPPs). Private participation augmented 20.42% of the total electricity capacity of the country. Out of this, Independent power producers (IPPs) represent the 48% of the private electricity generation¹¹. Most of the IPPs utilize natural gas as energy source, the rest -cogeneration and self supply- differ on its primary energy sources, which are mostly from fossil fuels.

⁵ Wamukonya Njeri. (2003): Electricity Reform, Social and Environmental Challenges, p 8

⁶ Cueto Preciado Luis (2002): Negotiations and Legislative Strategies...

⁷ CFE (March 2003): Generation.

⁸ Islas Jorge, et at (2003): Cost-Benefit Analysis of Energy Scenarios for the Mexican Power Sector.

⁹ EIA DOE (2003): An Energy Overview of Mexico.

¹⁰ SENER (online): Overview of the Power Sector.

¹¹ CRE (2003): General Characteristics of the Permits Given.

An appealing remark is that Mexico has a huge potential for the utilization of renewable energies, but the current policies are not focusing on it and it seems that there are not incentives or support from the government towards the development of renewable energy systems.

Mexico has a potential for conventional and non-conventional renewable resources: hydro-power and geothermal power, solar (photovoltaic), wind, mini-hydro, biomass, and biogas. Unfortunately, the lack of national capital for investment, and the current monopoly status of the electricity in Mexico reduce the interest of private sector to investment in electricity generation. These are some of the barriers for the development of renewable resources that could be developed and contribute to increase the electricity capacity and at the same time enhancing the environmental sustainability of the country.

Despite the fact that environmental sustainability concerns are in the political agenda, Mexico's path to cleaner energies is through the shift from their current oil/coal electric plants to natural gas. Mexico's industrial energy policy calls for the conversion of many oil-fired power plants to natural gas by 2005. Therefore, most of the new power plants will be run on natural gas.¹²

However, the Ministry of Energy claims to need large amount of investment in the energy sector. Nowadays foreign investors are invited to participate on bids for electricity generation and resource exploitation; particularly oil and natural gas, which are also needed for electricity production.

The Federal government has proposed significant changes designed to encourage the involvement of foreign firms in Mexico's natural gas sector in an effort to meet the country's growing demand¹³

The electricity sector – as a public service – is the sole responsibility of the government. Now this is under consideration, new initiatives for electricity reforms are now in dispute.

The political debate keeps going, none of the initiatives for electricity reforms have been accepted, though, private participation is gaining place in the energy sector.

1.2 Research problem and hypotheses

Research question:

- ◆ What is the outcome of the precedent electricity reforms in Mexico from the sustainability stand point? Link the effects of electricity reforms with private electricity generation and renewable energy development and sustainable development.

The outcome of electricity reforms implemented to date in Mexico has had an effect of the electricity generation of the country, having a significant impact on the use of resources, technology choice and future sustainability of the electricity industry of the country.

Private electricity generation has been responsible for the majority of these changes; their development path and technology choice is closely linked to the reform. The legal framework and market mechanisms influence the development of conventional and non-conventional energy, where renewable energy is gaining importance. Thus far, renewable energy use is still at early stages. However, renewable energy development is pointed out as mechanisms for enhancing the sustainability of country in all aspects: social, economic and environmental.

Therefore, an analysis of their development from private electricity generation stand point is the purpose of this thesis. On the other hand, drivers of such reforms must be addressed in order to evaluate if the reform has achieved its goals.

¹² Ibid

¹³ Ibid.

Supplementary questions:

- ◆ Is the electricity reform compatible with social economic and environmental sustainability? How these reforms affect the future sustainability of the country? Are environmental and social benefits in the agenda?
- ◆ Is privatization the formula for the development of more sustainable energies sources?
- ◆ Which are the barriers for the development of renewable energies in the electricity sector in Mexico? How to develop strategies for the development of renewable energy systems in Mexico?

1.3 Justification

Since the 1930s, the electricity sector in Mexico is configured as a vertical monopoly. Though, in the last decade, the energy sector lacked on its capacity to cover the increasing electricity demand and it was forced to open its monopoly to independent power generators.

Although, private generation has some limitations in regards to electricity distribution, they are likely to gain weight in the future. At the same time they are growing faster than the state facility (CFE).

The federal government is appealing to bring more private investment in the energy sector and electricity generation. But the country it does not want to lose its sovereignty over their assets and resources, which are considered national wealth.

For the last five years, Mexico is holding a debate on reforming/restructuring their electricity sector. The given reasons are that the government and CFE itself cannot invest on the energy sector for expansion, development, and maintenance of their infrastructure. It is estimated that the country will need \$65 billion in investment by 2010 to meet the country's growing electricity demand.¹⁴ Money that the country cannot allocate because it has already committed most of its public resources to a national bank bailout (know as FOAPROA), bill that will take 25-30 years to pay¹⁵.

The importance of future sustainability of infrastructure reforms, like the electricity sector, is because of the services electricity provides; *“electricity has the ability to improve social status and quality of life... yet a successful reform needs to ensure universal access to electricity”*.¹⁶

At present, electricity demand is covered, but because of low investments on electricity generation, the status of electricity is becoming an increasing concern. *“Mexico's electricity producers expect programmed power outages for industrial customers in 2003 owing to both the country's insufficient transmission system and two consecutive years of low rainfall. And although about 95% of Mexican households currently are electrified, many thousands of rural towns are still without electricity”*¹⁷

Since the Energy Ministry announced the lack of capital for investments in the electricity sector, private participation seems the only option, therefore, is it a good opportunity to analyze their potential for the development of renewable energy sources.

For some reason, renewable energy systems do not have an important impulse in the country yet, but due to its future competitive value, if not utilized now, certainly is going to be in the near future. Recent media publications make mention of the end of the Oil Age: *“the Stone Age did not end for lack of stone, and the Oil Age will end long before the world runs out of oil”*.¹⁸

¹⁴ EIA,DOE (2003): Country Analysis Briefs

¹⁵ Cueto Preciado Luis (2002) op cit.

¹⁶ Wamukonya N. (2003): Electricity Reform

¹⁷ EIA, DOE (2003): Country Analysis Briefs

¹⁸ The Economist (2003): The Oil Age October, 25th-31st 2003

Lots of constraints are still to overcome, the current energy policies, regulations and management practices delay the development of renewable technologies in Mexico. Therefore, solutions to address the future electricity demand in a sustainable way should be found. Utilization of clean and efficient technologies should be included in political agendas and regulations; utilization of renewable sources is a way out for environmental pollution and resource depletion, and in consequence a sustainable energy future.

As the current legal framework allows private electricity generation, the need for mechanisms to enhance development of renewable energy systems shall be improved. Mexico's potential for the use of renewable sources relies on public and private participation as well as the social sector should be involved, coordination among them will contribute to the success of renewable energy for electricity generation. Since Mexico is opening its electricity generation to private investors, therefore, and they can be used as an option for development of renewable energy, some private generators are already undertaking this task but without enough support or incentives, they still have to compete with conventional technologies. Therefore, if assumed that Mexico heading to privatization anyway, therefore, environmental, social and economic effects should be considered in order to ensure the sustainability of the electricity industry and the country.

1.4 Methodology

The basic steps to answer this thesis were done through collection of relevant information based on literature review, data-base analysis, and deep interviews related to the research question.

The first step consisted on literature review of all relevant information related to the research question. Initially, the study collects data about Mexico's energy situation with a focus on the electricity reforms, including parent disciplines that interact with the problem.

After delimitation and key assumptions more specific literature review continued during all research process. The multidisciplinary approach of these thesis made the research wider, though due to space and time constraints some aspects were not included.

When all relevant literature was gathered, then data-base search started, except from some booklets collected in governmental institutions, most of it was from governmental institutions that share the information over internet. The data-base found was first gathered in a single excel file and later filtered and scrutinized by categories and after analyzed. All graphs and tables presented in this paper are product of this process. Figures might differ from the available over official figures; this is because this research took recent data that has not been yet up-dated on the internet sites. At the same time, some figures were fragmented in order to find the real participation of the private sector.

Since many answers could not be found within the literature review, external outputs were necessary. That was the goal of performing deep formal and informal interviews. The kind of answers seek during the interview process was about information not available on literature or media, therefore, no specific questions were made, but discussion of topics related to the research question depending on the interviewee function.

The selection of interviewed people was based on a variety of relevant stakeholders, mainly to governmental non-governmental and academic institutions with different functions connected to the electricity generation, environment and renewable energy systems.

The interview process took eight weeks in five different cities. Total of 17 people were interviewed or contacted,¹⁹ most of them located in the center of Mexico. Other references were taken from personal telephone conversation and electronic mails.

¹⁹ References and details at the end of this paper.

The interview process helped for gathering more specific and useful literature or personal points of view and publications from same interviewee. This led to further literature and database research.

The original plan was to interview about 10 different key actors, whom usually were not so easy to reached, or sometimes impossible, then the opportunity of being in Mexico City led to more unscheduled but as well important and interesting interviews which strengthened the purpose of this research. Though, in many cases, the outcome of such interviews was sometimes redundant, the objective was to find clues or simple views on the topic.

The analysis of data collected, was through identification of drivers of reforms, the reform itself and its effects or outcome, followed by discussions and recommendations.

The research was based on the following sketch, as a support axe for the better organizing of this paper:

<u>Drivers</u>	→	<u>Electricity Reform</u>	→	<u>Outcome</u>
Energy demand/consumption	→	Electricity development	→	New Infrastructure?
Technological change	→	Modernization	→	Efficiency, etc.
Financing problems?	→	Private intervention	→	IPPs, S-S, Cog
Energy services (electricity)	→	Competition	→	Free Market?
Environment	→	use of energy sources	→	Depletion
Risk	→	use of resources	→	Diversification
Stakeholders	→	groups of pressure/lobbying	→	ESBs, Private

To begin with, a general overview of the electricity sector is given, then, a historical reform process is introduced together with the drives of correspondent reforms, and later the effects are listed and analyzed.

Every chapter contain elements accordingly to the multidisciplinary approach of this thesis: power generation, private participation, reforms, institutional changes and legal framework, economy and market, technology used, renewable energy status and social environmental aspects.

1.5 Definitions

From a holistic view, power sector reforms consist on a series of institutional and structural transformation within the electricity sector. Although, most of the reforms done in the last years has been the shift of old-power structures – in which governments monopolized electricity generation, transmission and distribution – to the transfer of energy assets and services from the public to private sector.²⁰

Electricity reforms include changes that go through technological and institutional transformation to market liberalization and addition of necessary mechanisms to regulate the new market. In the case of Mexico, after the 1992 electricity reform, three aspects are more relevant:

1. Modification of the Federal Constitution: the partial opening of electricity services allowing partial to private participation on electricity generation limited to three modalities: self-supply, Independent Power Producer and Cogeneration
2. Institutional reforms: creation of new mechanisms to regulate the participation of the private sector. This includes market mechanisms, utilization of energy sources and power infrastructure (transmission and distribution).

²⁰ Wamukonya Njeri (2003): Electricity Reform, p 9

3. Modernization of infrastructure: due technological change. The modernization path of the country was the shift to more efficient and clean technologies, where the private sector had the opportunity to participate.

In regards to sustainability: the aim of the Mexican government is to satisfy the increasing electricity demand and to ensure the proper management of its energy sources and avoid depletion of them in order to ensure the future sustainability of its energy sector and electricity services. Mexico has a National Development Plan, where the main goal is the economic development of the country with the purpose of improving the life standards of the Mexicans. The National Development plan is based on the Mexican constitution, and describes the strategies for the welfare of the Mexicans; the plan is made for six years, the normal period of an elected president. The way Mexico's sees its development is through economic growth. The development of the energy sector is crucial for the economic development of the country. Mexico is an energy intensive economy, its competitiveness on this sector, improves Mexico's competition with the rest of the world.

The participation of private electricity generators in Mexico is not an open electricity market, so far, it has only been a way for optimization of the electricity industry and aimed on reduction of electricity prices, while shifting to more efficient and clean energy sources and processes.

The technological competition in power generation that has been developed in the rest of the world, gave the country the opportunity to take-off some responsibilities that previously could only be taken by the state. Thanks to the development of new technologies made possible the change from large scale and capital intensive power plants, to modular and low capital intensive power plants as is the sample of the improvement of the gas turbines that let to the development of an extended family of gas turbines (simple heavy –duty, aeroderivaty, combined cycle, and cogeneration).²¹

Clean technologies comprised both conventional and non-conventional energy sources. In regards to renewable energy in Mexico, it is important to define what is considered renewable energy in Mexico. According to the National Energy Association (ANES), renewable energy is divided in two groups²²:

1. Conventional technologies: hydropower, geothermal and combustion from cane biomass;
2. Non-conventional: solar, wind, small-hydro, mini-hydro, and tidal.

Environmental and Social Benefits (ESBs) is a concept that initiated because power sector reforms brought drastic social and environmental changes, when the public service was on the hands of the private sector “*diminished prospects for advancing goals of environmental protection and social benefits that where already achieved*” therefore, “*power sector reforms may be better aligned with ESBs*” to be included in the energy policies and framework of actions at all levels: governmental, institutional as well as international agency donors.²³ Social benefits include employment, access and affordability that might reflect on subsidies.

1.6 Delimitations of scope and key assumptions

The electricity sector is a state own monopoly in all its sectors (generation, transmission and distribution). Electricity reforms are taking place since 1992 and the private investment is gaining place in the generation sector.

²¹ Islas Jorge. (1999): The Gas Turbine

²² ANES (Online)

²³ Wamukonya Njeri (2003): Electricity Reform, p 227

Since electricity generation is the part where most of the reforms have been done, therefore, focusing in private electricity generation is a propitious sector for analysis. Within this category Independent Power Producers (IPPs), self-supply and cogeneration are included. The reason to hold all in the same category is because all of them produce electricity and sell it to CFE or give it to other consumer through an energy service, which is conformed by industrial and Municipal associations, where all share energy services (within the same company or association). The importance of focusing on them is because of the significant amount of electricity they generate and add to the National Electric System (SEN- Sistema Electrico Nacional), and their possibilities to use renewable energies.

Analysis of the framework and how the framework affect the electricity sector, the economic sector and if the social and environmental benefits are included in the agenda. The outcome of the legal framework in regards to private generation, and the importance of augmenting the use of renewable energy in the electricity sector.

Nuclear power is not within the reform package, only the government is responsible for its use, therefore, it may be mentioned as a general reference but it will not be discussed in this paper. Because tidal energy is still at research stages it will not be discussed in this paper.

Due to space constrains energy saving efficiency will not be disused in this paper.

Both, conventional and non-conventional technologies are described in this paper, but the focus of this thesis is on the participation of the private sector in electricity generation, with a focus on renewable energy.

2 Mexico's Energy Sector

The energy sector has played a key role in Mexican economic development by providing sufficient, reliable and low cost industrial inputs, as well as goods and services for consumers²⁴. The energy sector provides important input to the Mexican economy. The energy sector alone generated 3.0% of the GDP – 1.7 from hydrocarbons and 1.3 from electricity – and contributed with one third to the total public revenues. In 2000 the whole energy sector contributed with 56.4% of the total public sector investment budget.²⁵

Mexico has a strong energy sector due to its high oil and gas reserves. In the world, Mexico ranks on the 9th place of proven oil reserves, 21st on proven natural gas reserves, and 7th and 8th in oil and natural gas production respectively.²⁶

According to the Mexican constitution, all natural and energy sources are state-owned, and the nation has exclusive rights for the exploitation and use of its national energy sources²⁷. The oil and gas sector is managed by the Mexican petroleum company (PEMEX); and electricity generation is responsibility of the Federal Commission of Electricity (CFE) and Light and Power Company of the Center (LyFC), both utility companies are state-owned.

PEMEX is responsible for the supply of fuel to CFE and LyFC; both are responsible for the provision of electric public services.

By March 2003 the total electricity rated capacity was 40,354.24MW. This includes eight external power producer plants, which are included in the generating plant section of CFE and accounting for a total capacity of 3,495.03MW,²⁸ Additional capacity from private electricity generators has approximately 7,368.27MW. All together makes a total electricity generation capacity of 48,172.52.²⁹

²⁴ SENER (online), Energy sector/English home.

²⁵ SENER (online) Highlights

²⁶ SENER (online) Highlights

²⁷ Political Constitution of the United Mexican States (2003). Article 27

²⁸ CFE (March 2003). Generation.

²⁹ Estimates made by the author from CFE (online) Generation and CFE(online) Permits Given.

The electricity sector heavily relies on hydrocarbon sources, oil-fired power plants make up the largest share of Mexico's electricity generation accounting for 73.94% and thermal (oil, gas, and coal) electricity generation by March 2003 accounted for 82.68% of total generation.³⁰

Electricity consumption:

Three sectors are the main consumers and demanding electric power services: The Federal Commission of Electricity (CFE) reported electric power services sales to 20.42 million customers, out of this, the 87.81% are residential customers, 10.42% commercial, and 0.63% industrial³².

Although, then number of consumers is bigger in the residential sector, the industrial is the one that consumes most of the electricity generated. The consumption ratio between the industrial and residential sector is 61.17% over 23.44% of the total electricity generated. The commercial sector consumed 6.65% and the rural by 5.28%, the service sector is the last on the list with 3.46% of the consumption sales.

By 2001, the electricity consumption increased an average of 5.1% during the previous ten years, both, the industrial and domestic consumption increased 5.8 and 5.7% respectively. This growing path is superior to the country's economic growth of 3% during the same period.³³

Electricity Consumption by Sector

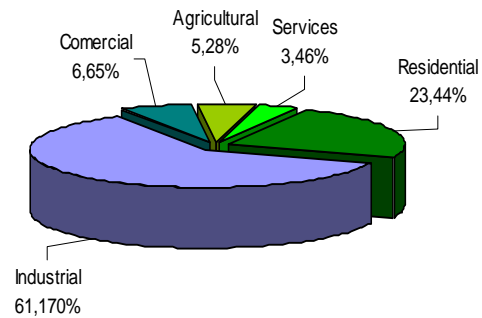


Figure 1: Electricity consumption by sector³¹

Electricity demand:

The GDP affects electricity consumption of the country; the global economic recession affected the Mexican economy with a .3% GDP (gross domestic product) reduction. Furthermore, the economic situations in Mexico declined, in 2002, Mexico's real domestic product (GDP) grew by only 0.9% Despite the economic recession of the country; factors such as population growth, industrialization and electricity expansion, increase the electricity demand. The Ministry of Energy has three electricity demand scenarios – which are linked with the expected GDP of the country – an average growth of 4.5%, a high growth of 5.6% and a moderate growth of 3.4% annual growth during the period 2002-2011.³⁵

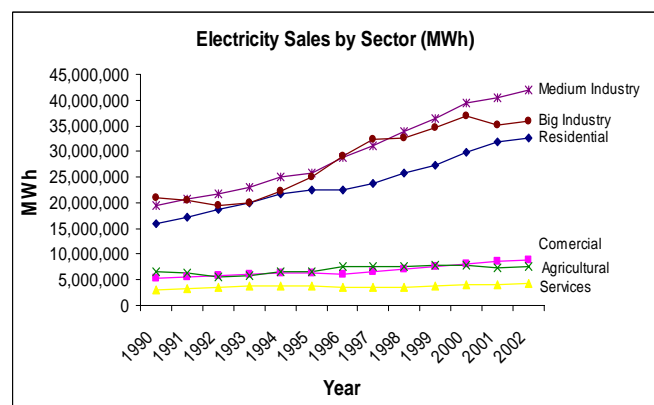


Figure 2: Historic CFE electricity sales (2002)³⁴

Electricity Services (supply):

In a country with more that 100 millions inhabitants, 95% of the population has access to electricity.³⁶ Still many rural areas do not have access to electricity, it is calculated that five

³⁰ CFE (March 2003). Generation

³¹ CFE (online). Costumers and Sales Volume

³² CFE (Dec 2002) Costumers and Sales Volume

³³ SENER, Prospectiva Del Sector Eléctrico, data taken and translated by author, p 38/120

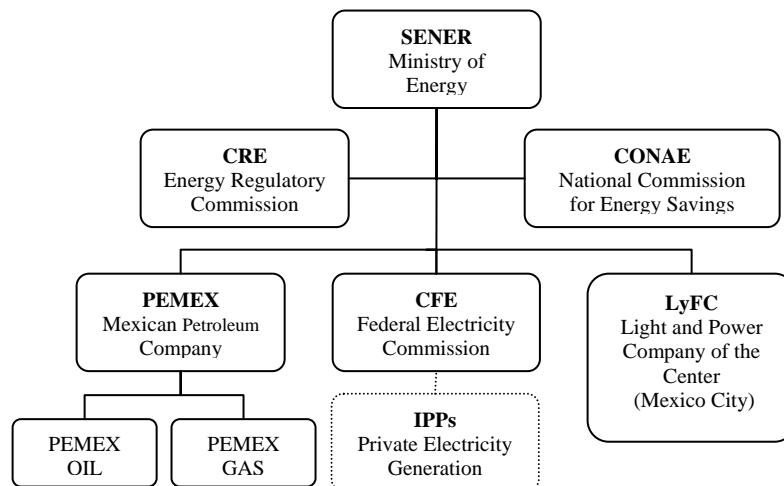
³⁴ SENER (online): Data, National Electricity Sales

³⁵ SENER (2002). Prospectiva p56

million people are without electricity. Most of these populations are in isolated areas or in the mountains and/or the population is not big enough to worth the expansion of the electricity grid to those regions. The rural electrification projects are based on decentralized and renewable energy systems, this is still in early stages; the National Development Plan foresees progress in these areas. According to the OLADE (Energy Sector Development In Latin America And The Caribbean), the average electricity consumption per capita in Mexico was 1,574 KWh in 2001. Unfortunately is not equally distributed, although, the electricity balance shows the consumption per capita by State, it does not show the huge consumption difference between industrial parks and the surrounded towns, in some regions the proportion is 1,000 times more than the consumption in neighboring poor towns; some Municipalities consume an average of 2,000Kwh and near by towns near consume an average 350 KWh per capita.³⁷ In terms of basic needs, from the Human Development report 2003, countries that consume electricity above 4,000 kwh per capita have basic services for well-being. The Mexican government planned to reach this level through an increase on industrial activities, which will improve the population's life standard³⁸.

2.1 Electricity Sector Structure: main players

Figure 3: Structure of the Mexican Energy Sector



The Mexican power infrastructure is conformed by sectors that act together for the adequate provision of energy services. The power sector is a sub-sector of the energy sector where different institutional actors interact. The energy sector in Mexico is conformed by several decentralized institutions under the Ministry of Energy.

*“The Energy Ministry (SENER) is in charge of conducting Mexico’s energy policy, making decisions relative to exploration and development activities according to the National Development Plan, and surveying the operations of industry-related agencies”*³⁹ – such as the hydrocarbon and electricity sub-sectors.

In regards to electricity generation, five are the main actors: four governmental institutions and private sector participation. The Energy Regulatory Commission (CRE), the Mexican Petroleum Company (PEMEX) and the two electricity utility companies: the Federal Commission of Electricity (CFE) and the Light and Power Company of the Center (LyFC).

³⁶ SENER (online): Overview of the Power Sector.

³⁷ Caldera Enrique (ANES), interview

³⁸ SENER (2002): Prospectiva

³⁹ CRE (on line): Background.

The petroleum company is responsible for the supply hydrocarbon resources, responsible for the exploration, production, distribution and commercialization of hydrocarbon products such as fuel, and natural gas. CFE is responsible for other type of combustible fuels such as nuclear. The Federal Electricity Commission (CFE) and the Light and Power Company of the Center (LyFC) are stated-owned but de-concentrated administrative organs in charge of generation, transmission and distribution of electrical power and electricity services.

The Energy Regulatory Commission (CRE) is a de-concentrated organ of SENER that oversees the operation of the sector and is responsible for granting permits for private electricity generation.⁴⁰ The CRE was created in 1994 as a consultative body reporting to SENER, and its original role was purely advisory and limited to the electricity industry. “An enactment in 1995, assigned regulatory duties to the CRE, transforming its role to an independent regulator with technical and operational autonomy and provided the CRE with a legislative mandate to regulate the activities of both public and private operators in the electricity and gas industries”⁴¹.

The CRE commands a series of regulatory activities subject to the legal frame work, Miguel Breceda explained a short version of CRE function:

“CRE’s powers include enforcement of regulations, inspections of facilities, issuance of permits, regulation of prices, overall supervision of the industry, ensuring an adequate supply, security, the promotion of competition, and the elimination of cross-subsidies. Private-sector participation in these areas currently is subject to permits granted by CRE for 30 years, based on competitive bidding”.⁴²

In addition to Breceda’s points, the CRE the following activities:

The CRE has the following jurisdiction:⁴³

- I. Verify that entities responsible for electric public service purchase electricity at the lowest cost and also offer optimum stability, quality and safety in the provision of such service for the national electric system (SEN)
- II. To approve the methodologies for calculating payments for the purchase of electricity used in public service;
- III. To grant and revoke permits and authorizations, pursuant to applicable legal provisions, necessary for the regulated activities
- IV. To regulate the transmission, transformation, and delivery of electricity between entities that provide electric public service, and between those entities and the holders of permits for generation, export and import of electricity.

Private electricity generators can also participate through different bidding mechanisms under CFE and CRE, where the electricity generated is sold to CFE, export or transported for self-supply use.

2.2 Electricity Markets and price mechanisms

As pointed out by the Federal Law, and the Electric Energy Public Service Law (LSPEE), CFE and LyFC have exclusive rights to sell electricity to particulars. The LSPEE does not allow private electricity generators to commercialize electricity among particulars, they cannot freely commercialize their energy surplus but under their associations they can do what they want, though no official information is available, it is known that the companies make arrangement them selves, and CRE does not intervene in those personal arrangements⁴⁴. They can also sell

⁴⁰ UNDP-GEF (2001). Action plan

⁴¹ CRE (online): Background

⁴² EIA (2003): Country Analysis Briefs

⁴³ CRE (online): Law

⁴⁴ Source from interviews: Gottfried Pablo. & De Buen Odon

their surplus to CFE. It is expected that this situation is going to change due to the development of high capacity power plants under the self-supply and cogeneration modalities.

Article 36-Bis of the LSPEE law state that CFE should buy at the least cost. Without discriminating and ensuring the optimal stability, quality and security of the public service.

Price mechanisms and electricity tariff:

The actual electricity market is national monopoly, within it, two electricity markets can be found:

1. Public: is integrated by state owned enterprises that provides all public services.
2. Private: integrated by private enterprises that generate electricity for self supply, or to sell it to CFE.

In regards to public tariffs, this are determined by the CFE and approved by the Secretariat and Public finance Dept (SHCP) together with and advisory committee conformed by representatives of SENER, CFE, LyFC and CRE. Tariffs and subsidies vary between sectors (industrial, residential, etc) depending on geographical zones, voltage level, time-of-day, and season. These tariffs are heavily subsidized in the residential and rural. Fuel price is also a determinant for electricity tariff, in Mexico fuel prices are based on inflation and international fuel prices.⁴⁵

For private Electricity generator the price of purchase is determined by the CFE and regulated by the CRE, depending on each case, taking into consideration different factors such as operation cost on the place of generation, capacity purchase contracts (CCCE) and Power Purchase Agreements (PPA). Most of the contracts given are planned in a long term – from 25 to 30 years – depending on the life of the power plant. Usually, the contract is made in dollars, or taking in consideration the national currency fluctuation with the US dollar.

For this, the Government has to guarantee that CFE will pay according to the contract. This assumes some risk to the increasing national dept, if CFE cannot pay.

Here is important to mention that most of the private electricity generator utilize natural gas as it primary energy source. Originally, the low cost of natural gas and efficiency of the technology that utilize it, like gas-turbine (GT) and combined-cycle turbines (CC), let to the development of this technology, but now the price of the natural gas has gone up in the last two years⁴⁶.

CFE has the responsibility for providing the fuel and assumes the risk of price. Since, the price is set by a special and complicate method where several national and international institutions intervene.

The binding process of CFE has three categories: IPP (>30MW), Small Power Production (>30MW) and Self-supply. Each of them is governed by a different set of rules for defining contracts and determining buy-back price⁴⁷.

- *“Prices paid are based on CFE’s marginal costs which are currently between 4 and 9 US¢/kWh depending on the region and time-of-day. These prices are discounted by 15% if electricity is purchased outside of the agreed-upon hours.”⁴⁸*
- *“In the case of IPP, when new capacity is required in a certain region, CFE sends out a request-for-proposals, and selects the producer(s) offering the lowest long-term cost/kWh,*

⁴⁵ UNDP-GEF (2001). Action plan

⁴⁶ CRE (online): Gas Prices.

⁴⁷ Ibid

⁴⁸ UNDP-GEF (2001). Action plan

as long as the electricity source has been included in SENER's official planning document.”⁴⁹

- “For Small Power Production, the producer first signs a power purchase agreement (PPA) with CFE (once it has been granted a permit from the CRE) and then attempts to sell its electricity to CFE through a regional electricity auction. Once again, CFE buys from the lowest bidder, in accordance with dispatching regulations. The PPA does not guarantee that CFE will buy any electricity from the small power producer; however, it does obligate the power producer to only sell to CFE. There are currently no small power producers in Mexico.”⁵⁰
- “Self-Supply and cogeneration producers can sell their electricity surplus to CFE, under the terms of a previously signed (PPA), again CFE can only buy electricity, following dispatch rules.⁵¹ In this case, no call for tender is required: the project is clearly private in nature and the plant owners may not market their power. For such permit holders, the regulation provides that the CFE may purchase up to 20 MW of capacity as well as all surplus, provided that its price does not exceed the marginal cost to the CFE at the point of delivery.”⁵²

From the interview process and unofficial literature it was found that the price of purchase is still good enough for the private generators to have marginal returns. The issue here is that IPPs are not interested on further investment if they are not allowed to generate more. They cannot generate more, because of the current regulatory framework. As long as the market remains in the public sector, the state will have to guarantee that will purchase from them. The situation can change if the private sector can sell directly to particulars, situation not possible due to the current regulations.

Market opportunities of private electricity generators:

Openness to private electricity generation opened electricity market to some extent, since private electricity generator cannot sell their electricity to particulars, is the CFE who purchase the electricity from them, and is regulated by the CRE. The state retains the monopoly of CFA as sole purchaser of electric power. The electricity generated is for being sold to the utility or for exporting⁵³

Power plants with capacity greater than 30MW must participate in a bidding process carried by CFE. CFE has two bidding schemes: Build, Lease and Transfer (BLT) and Independent Energy Producer (productor Independiente de Energia- PIE). Here the main parameters are the cost per KWh and the capacity needs of CFE.

Breceda Miguel, explained the main characteristics of the two schemes:

- “Built-Lease and Transfer (BLT): Consist in the design, financing, construction and commissioning of a power plant financed by private investors to CFE technical specifications. Once in Operation, the plant is leased to the CFE for a Period of 20-25 years at the end of which the ownership passes to CFE. During the leasing period, the CFE is responsible for operations and maintenance of the plant;
- Independent Energy Producer (PIE): the project developer designs, finances, builds the plant and deliver the energy generated to the CFE. The associated capacity and energy are purchased by the CFE for a period of 20-25 years through a bidding process. The plant retains the property of the private investors”.⁵⁴

⁴⁹ibid

⁵⁰ibid

⁵¹ibid

⁵² Breceda Miguel (2000): The Debate On Reform Of the Electricity Sector in Mexico

⁵³ CRE (online): Guide to Request Power Generation, Export and Power Permits

⁵⁴ Breceda Miguel (2000): Op cit.

An advantage for private generators is that the same project may be defined to allocate part of the electric energy generated to be sold to the CFE, another part utilized for self-supply and the rest for export purposes.⁵⁵ Plants with a capacity of less than 30 MW is called small production, and the electric energy is to be sold to the utility or to be exported.⁵⁶ For Self-supply and cogeneration, the electricity surplus up to 20MW of can be sold to CFE. The delivery of surplus production to the utility shall be subject to the rules of dispatch and operation of the National Electric System (SEN), which is established by the CFE establishes.⁵⁷

2.3 Mexico's electricity generation

Structure and percentage of the electricity industry by sector:

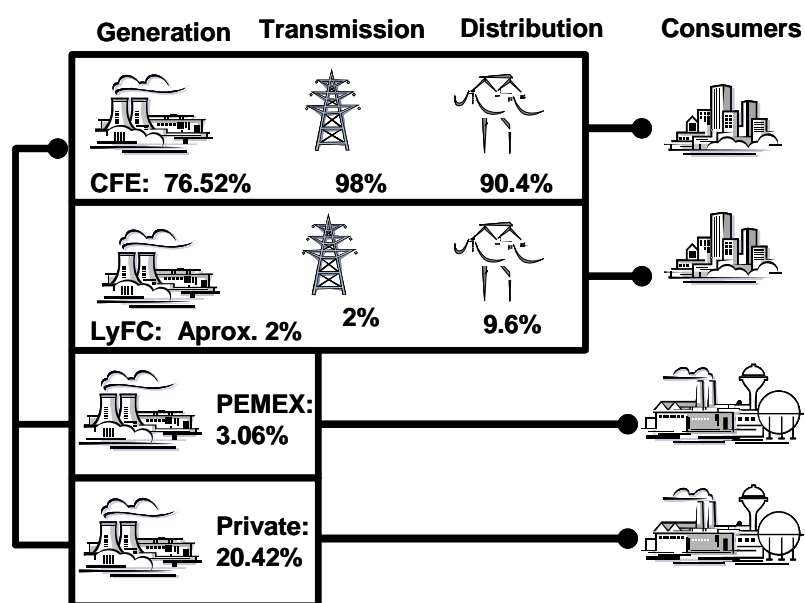


Figure 4: Structure of the electricity Industry⁵⁸

The Federal Electricity Commission (CFE) and *Luz y Fuerza Centro* (LyFC) are Mexico's two state-owned electricity companies. CFE has enjoyed a monopoly in the electric power sector for decades, although reforms instituted in 1992 allow independent power producers (IPPs) and cogeneration with limited involvement. From CRE and CFE data, estimates show that CFE generates about 76.52% of Mexican electricity, out of this LyFC contributes with approximately 2% with most of its customers in Mexico City. PEMEX generates 3.06%, while the remainder is generated by the private sector accounting for 20.42%.⁵⁹ The connections on figure four, shows the path of electricity generated by PEMEX and private generators, who sell and give the electricity to CFE or their associates on the industrial sector.

⁵⁵ CRE (online): Guide to Request Power Generation, Export and Power Permits

⁵⁶ Ibid

⁵⁷ Ibid

⁵⁸ Estimates made by the author from CFE, CRE and SENER data

⁵⁹ Estimates made by author from CFE (online): Generation; CRE (online): Permits Given; and SENER (2002): Prospectiva.

According to CFE the estimated rated capacity, at the end of March 2003, was 40,354.24 MW installed capacity, out of this 9,378.83 MW⁶¹ are from hydropower, 26,160.46 from thermal power plants that consume hydrocarbons, 2,600.00 MW of coal power plants, 1,364.88 MW from nuclear plants and 2.18 MW from wind power⁶².

At the end of March 2003 hydrocarbon power plants make up the largest share of Mexico's electricity generation with 73.95% and thermal (oil, gas, and coal) 73.95% + 8.74 = 82.68%. Hydropower accounted for 8.29%, nuclear power 6.08%, and wind, for 0.003%.⁶³ This figures include some private electricity generators but not all, if included the total capacity will be 48,172.52MW, with and increase on thermal power.⁶⁴

As Mexico's energy policy calls for the conversion of many oil-fired power plants to natural gas by 2005,⁶⁶ most of the new power plants will be run by natural gas. Figure five, shows the capacity rate, which differ from the percentage utilized after generated, this is explained in figure six.

Nowadays, 24.26% of the new power generation plants use natural gas, representing the 18.19% of the total installed capacity. Adding the plants that are currently under construction, the average capacity will increase natural gas use up to 30.26%. Still combustoleum (oil fuel) and diesel occupies the 43.69% of the fuel utilized.⁶⁷

2.4 Private electricity generation

The authorized private electricity generation in Mexico is classified into five modalities: Independent power producers, Self-Supply, Cogeneration, Export and Import. All of them are allowed to utilize the national transmission system for sharing or import and exporting electricity.

In the CRE report, the authorized capacity under independent power production was for 19,430.70 MW⁶⁸ by August 2003. Out of this 195 plants are in operation accounting for 11,834.39 MW (60.63%), and 7,000.29MW (35.86%) under construction and the rest were inactive.

Electricity Generation Rated Capacity

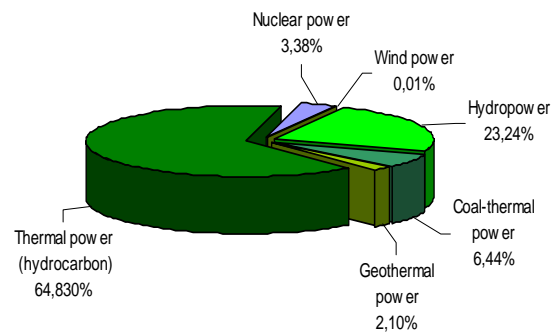


Figure 5: Electricity Generation (CFE 2003)⁶⁰

Electricity Generation by Source

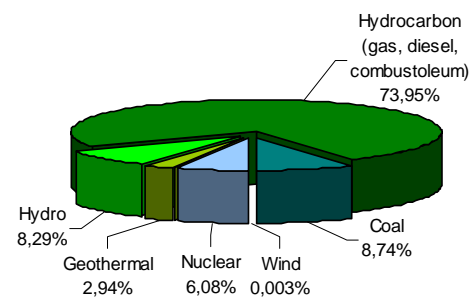


Figure 6: Electricity Generation by Source (CFE 2003)⁶⁵

⁶⁰ CFE (2003), Generation

⁶¹ Estimated made by author from CFE (online): Generation and CRE (online): Permits given

⁶² CFE (2003), Generation

⁶³ Ibid

⁶⁴ Estimates made by author. from CFE (online): Generation and CRE (online): Permits given

⁶⁵ CFE (2003), Generation

⁶⁶ SENER (2002): Prospectiva

⁶⁷ Estimates made by the author, form CRE (online) Permits Given.

⁶⁸ Calculation made by the author from the CRE(online) Permits Given

Under the current legal frame work, total of 230 permits⁷⁰ have been given to private electricity generators that are separated into five modalities.

Table No. 1 shows the quantity of permits given by category and capacity. The percentage besides is just a reference to highlight the difference in quantities of each modality. (Figures include all authorized permits; many of them are still under construction.).

	Permits given		Average rated Capacity	
	Qty	%	MW	%
IPPs	17	7.39%	9,277.11	47,74%
Self-Supply	165	71.74%	5,785.79	29,78%
Cogeneration	33	14.35%	2,115.58	10,89%
Export	6	2.61%	2,186.37	11,25%
Import	9	3.91%	65.85	0,34%
	230	100%	19,430.70	100%

Table 1 : Permits given by modalities (source CRE 2003)⁶⁹

Independent Power Producers:

In regards to energy capacity, the most important are independent power producers (IPPs). Figures in table No. 2 consider projects that are still under construction. Independent Power Producer can only sell their electricity to CFE or export it. Their main energy source is natural gas.

Self-supply:

The majority permits registered are under this modality, accounting for 165. The use of electric energy under this category is to satisfy own needs, or the needs of co-owners or partners. They can sell their surplus to CFE or give to another company through associations. Perhaps because self-supply is the more abundant category, they show more diverse energy sources.

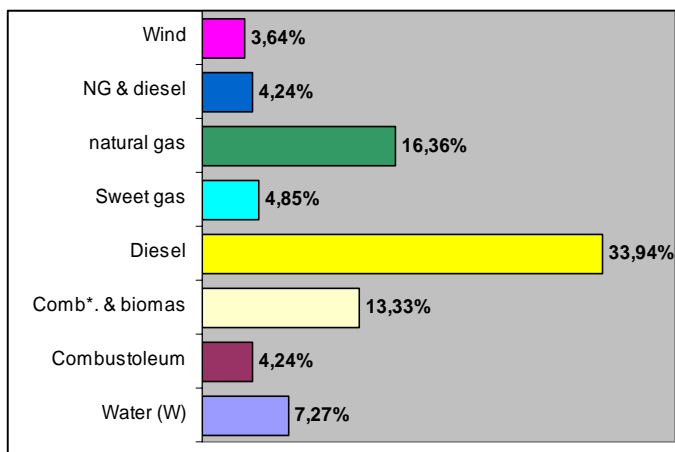


Figure 7 : Energy sources under self-supply ⁷¹

For Self-supply electricity generators utilize eleven different types or energy sources in 19 different combinations, but the most utilized sources are diesel and natural gas, followed by a combination of combustoleum and biomass. Figure seven shows percentages of primary energy sources utilized under the self-supply modality. So far, the total authorized capacity under self-supply is calculated to generate 35,354.95 Gwh/year⁷². From this figures many projects are still under construction.

⁶⁹ CRE (online): Permits by Modality.

⁷⁰ CRE (online) General Characteristics of the Permits Given

⁷¹ Estimates made by the author form the CRE report of permits given

⁷²CRE (online) General Characteristics of the Permits Given

Cogeneration:

Under the cogeneration modality, the electricity generator utilize in most cases its own energy sources product of production process or they use the steam or any other type of secondary thermal energy provided by the process that leads to the cogeneration, or the generation of electric energy by using the fuel produced in the process that leads to cogeneration.⁷⁴ In some cases, the thermal energy is brought from other production process which is closed to the plant, but these types of power plants require a back-up/support from the public service or CFE.⁷⁵

From statistics data of the permits given so far, six are the types utilized in Mexico so far⁷⁶ shown in figure eight.

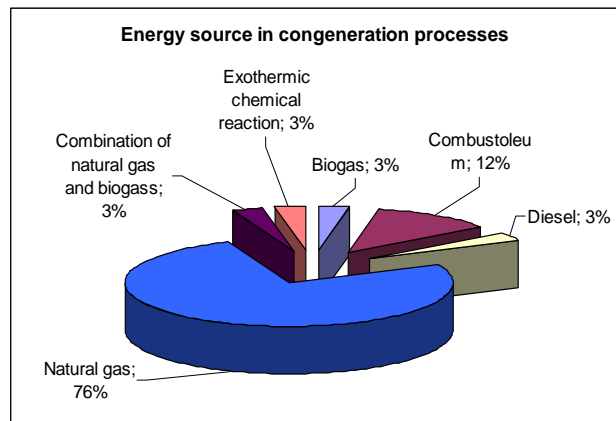


Figure 8: Energy sources in cogeneration⁷³

Exporting: This is the generation of electric energy in national territory to be used abroad. The energy source utilized for export is natural gas accounting for 83.33% (1,886.37MW). Out of this 556 MW is under construction. A wind power plant is about to start its construction, its capacity is estimated on 300 MW.

Importing: The purchase of electric energy from generating plants located abroad to be used inside national territory. For electricity imports there is no data available of energy sources utilized.

2.5 Status of Renewable energy in Mexico

Mexico has a considerable amount of renewable energy sources, conventional technologies such as hydropower and geothermal are the most utilized. As previously mentioned hydropower accounts for 23.24% and geothermal for 2.10 % of the total effective installed capacity of the country⁷⁷; on this regard Mexico is the 3rd electricity producer from geothermal electricity generation after United States and Philippines.

Although hydroelectricity can be considered renewable, due to its high impact in to the environment, only the ones that fit into the non-conventional renewable criteria⁷⁸ are considered renewable on this paper.

Geothermal power plants have existed since, 1973 growing from 75MW to 847.90MW and hydroelectricity plants has increased from 2,149MW to 10,000.39MW until 1996, after that, the capacity has decline approximately 6%. Two consecutive years of low rainfalls have also diminished the hydropower electricity generation⁷⁹. Still new projects with great capacity are currently under construction.

Solar:

As for the photovoltaic potential in Mexico, the Mexican territory receives solar radiation with an average density of 5kWh per square meter a day, potential that has been exploited on a very

⁷³ Estimates made by the author form the CRE report of permits given

⁷⁴ CRE (online): Guide to Request Power Generation, Export and Power Permits

⁷⁵ Ing. Gustavo Diaz (PEGI) interview

⁷⁶ CRE (online): General Characteristics of the Permits Given. Analysis made and translated by the author

⁷⁷ CFE (online): Generation

⁷⁸ See Definition section 1.5 of this paper.

⁷⁹ EIA,DOE (2003): Country Analysis Briefs

small scale, especially in rural areas or isolated areas not reached by the national grid, and for communication, traffic signs, and water pumping. The total installed capacity of photovoltaic cells was 12.9MW in 1998⁸⁰ and 14.2MW by 2001.⁸¹ There are several manufacturing companies but utilization of this technology is only competitive in rural areas.⁸²

Wind:

Wind energy development is the energy source that has more attention to the private sector, this is because of its competitive value towards conventional electricity technologies.

The public sector (CFE) operates two wind-power plants: 1.5 MW in the south of the Isthmus of Tehuantepec (Oaxaca) and 600 kW in Guerrero Negro on the Baja California Peninsula.⁸³

CRE data shows seven wind power permits to the private sector: two small scale permits to private electricity generators; a 550 kW installed wind turbine is operated by the company Cementos Apasco, under self-supply modality⁸⁴; and another wind plant with capacity of 5MW to be operated by Fuerza Eólica de Guerrero Negro.⁸⁵ Five new large scale permits with capacity between 60.5MW and 300MW have been authorized. According to CRE four are currently under construction and one is about to start construction works⁸⁶. The latter is the one with the highest capacity and is going to operate under the export modality.

There are several points of view of the Mexico's potential for wind power, some have estimated a potential of 30,000MW⁸⁷; this is almost the world wind power installed capacity to date. The national Institute for Electrical Research has confirmed a wind power potential of 5,000MW in the following areas: Baja California, Zacatecas, Hidalgo, Quintana Roo, Veracruz, Zacatecas and Isthmus of Tehuantepec.⁸⁸

Mini-hydro:

Water as primary energy source, is mainly utilized by private electricity generators, data from the permits given by the CRE shows six private generators in service and nine under construction. All of them utilized hydro-turbines; three of them use additional fuels. The capacity of these plants will be 183.85MW.⁸⁹

México has also a mini-hydro potential with a capacity up to 5MW, according to CONAE and the CFE, México has a potential of 3,000MW. By 1997, a study made by CONAE, revealed 83 operational mini-hydro plants, accounting for total installed capacity of 76MW. Private generators have the majority of the plants accounting 57% of the installed capacity. The table No. 2 shows more details:⁹⁰

Table 2: Mini-hydro installed capacity

Institution	Number of plants	Number of Units	Installed capacity (MW)	(%)
CFE	13	30	21.7	28.4
LyFC	9	14	11	14.4
Independent producer	61	77	43.5	57
Total	83	121	76.2	99.8

Source: Mini-hydro plants by 1997 in Veracruz and Puebla (CONAE)

⁸⁰ CONAE (online): Renewable Energies

⁸¹ SENER, (2001): Balance Nacional de Energía 2001

⁸² Martinez Strevel Rodolfo (Ovonics), interview

⁸³ UNDP-GEF (2001). Action Plan

⁸⁴ Ibid

⁸⁵ SENER (online): Prospectiva

⁸⁶ CRE (online): Permits given

⁸⁷ Information collected through interviews

⁸⁸ SENER (online): Prospectiva

⁸⁹ CRE (on line): Permits Given

⁹⁰ CONAE (online): Renewable Energies

Biomass:

Biomass has had a good impulse in Mexico, as previously mentioned is considered as a conventional energy source. Most of the biomass comes from sugar cane factories. The CRE reports 24 permits under the self-supply modality accounting for an installed capacity of 20.67MW. The technology utilized are steam-turbines using combustoleum as additional fuel. Only two of them do not utilize additional fuels, their power capacity accounts for 18 MW. Still there is more possible potential to be installed, CONAE estimates an additional potential of 3,247MW.

2.6 Energy and the environment

As described previously, Mexican electricity production is based on fossil fuels (82.69%), particularly from petroleum derivatives – natural gas, diesel, combustoleum and coal. Burning fossil fuels are known to have several environmental effects. The main environmental effects of are as follows:

“Soil and water contamination and ecosystem disruption by spills or accidents during exploration, extraction, processing and transport phase: Air pollution; Acid rain and deposition; Global climatic effects due to CO₂ emissions. Landscape and life pattern disruption in communities where extraction and processing of these fuels occur.”⁹¹

“The emission of energy generation in the power sector is considered the major emitter of the acid rain precursor gas, which causes acidification of farmlands, and lakes.”⁹²

Fossil fuel burning is known as the main green house gases precursor and a consequence of climate change. In regards to green houses gases in Mexico, the United Nation Environmental program (UNDP) and give the following CO₂ emission details:

“The energy sector constituted the most important source of this gas, with 297 Mt (67%) from which 68.3 Mt (23%) came from electricity generation (a level of 0.590 kg CO₂/kWh was estimated for 1990⁹³). From 1987 to 1993, CO₂ emissions associated with energy use increased by 14.06 %, but on the other hand, per capita CO₂ emissions fell by 7.1% (from 3.75 to 3.48 tonnes). Although Mexico’s per capita emissions in 1994 ranked 17th in the world, Mexico’s emissions were much lower than those of the developed countries. Intensity relative to Mexico’s GNP decreased by 6.1% from 1987 to 1993, indicating that decoupling of energy consumption and output has already begun, due to the results of specific actions to this end. It is clear that the more developed countries are the ones that emit greatest quantities of greenhouse gases, which supports the principle of a common, but differentiated, responsibility in the face of Global Climate Change (GCC)”⁹⁴

3 Electricity Reform

México like other countries is moving forward to the modernization of its electricity sector, the electricity requirements of the country and the lack of capacity of the two national utility companies. This entails structural changes of the electricity and energy sectors, and for this private participation was needed.

⁹¹ Breceda Miguel.(2000): Op cit.

⁹² Islas J. Manzini F. & Martinez M. (2002). Renewable Energies in Electricity Generation...

⁹³ Sheinbaum P. Claudia (1996): Inventario de gases Invernadero en México

⁹⁴ UNDP-GEF (2001). Action Plan

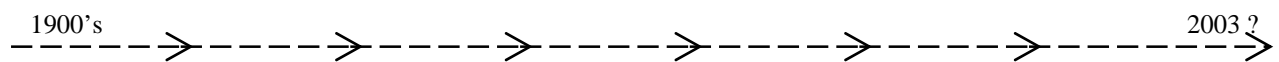
At the beginning, private electricity generation was allowed in small scale if infrastructure was not available on the area. Later, allowing private sector to participate in construction of electricity infrastructure, on the generation sector, the private sector could participate through two schemes: build, lease and transfer (BLT), and private electricity generator (IPP).

The modernization of the sector started first with financial mechanisms that opened private participation on the development of electric infrastructure of México: Build Lease and Transfer and Independent Power Producers (IPPs). BLT projects started in 1989, before the electricity reform, but under a program called PIDIRIEGAS⁹⁵, at that time these projects were regulated by the Accountancy and Federal Public Spending Law.⁹⁶

3.1 Mexico's drivers of reform (historic outline)

Mexico structural transformation of its electricity industry has happened during the last hundred years, the drivers of such reforms differ according to the electricity needs of the country and the international events at a different time.

The main changes occurred when electricity was considered a public service necessary for the economic development and the required electricity expansion required for the country's development. The following outline (Table 3) shows a brief time outline of events.



1880 -1920's	1930s	1940's	1060 – 1970's	1992	1994	1995
Private electricity industry for mining and industry. More than 100 companies, most of them localized in the center of the country	Only 3 private but foreign companies, Electricity as public service. Creation of CFE as regulatory body for foreign companies	Halt of private investments from abroad due controls and war	Electricity and nationalization decree; CFE purchase 95% of private industries Creation of LSEEP	Private electricity generation allowed	Creation of CRE as regulatory body	Private participation on gas sector (limited)

Table 3: Historic Outline of Electricity Reforms in Mexico

Drivers of electricity reforms in Mexico have changed over time. The electricity industry in Mexico was first developed by private industries that need it electricity of their own industrial process, “*who sold their surplus power to the surrounding areas for commercial and residential use*”⁹⁷.

By 1910 “*more than 100 Mexican light and power companies came into being, almost all of them located in central Mexico—thus configuring the subsequent pattern of industrial concentration*”⁹⁸. By the 1930's three private companies (foreign in its majority) acquired the majority of small private companies in the area, expanding its distribution lines and providing services to the most attractive markets, especially in urban areas. The negative side of this was that expansion to rural areas was not included in their plans⁹⁹. Therefore, in 1937, the government realized the importance of the electricity and gave it the status of a public service, creating the Federal Commission of Electricity (CFE) as a regulatory body to control the foreign companies, which by then had most of the electricity market. During the 1940's private

⁹⁵ Accountancy and Federal public spending law regulates PIDIRIEGAS (Proyectos de Impacto Diferido en el Registro del Gasto)

⁹⁶ Islas Jorge. (2000): The Financing of the Mexican electrical Sector

⁹⁷ Breceda Miguel (online) Op cit.

⁹⁸ Ibid

⁹⁹ See CFE (online) History of the electricity industry.

investments from abroad slowed down. Reasons for this were the creation of the CFE and also the world “war that consumed the energies of England, Canada and the United States from”¹⁰⁰. Electricity distribution was un-even in the 60s only 44% of the population had electricity. It was then, when the President Adolfo Lopez Mateos nationalized the electricity industry in 1960 the Federal Government and purchased the 95% of the existing power plants from the private and make an electric public service monopoly. *“The nationalization of the electric industry responded to the need to integrate the National Electric System, to extend supply coverage and to accelerate the country’s industrialization.”*¹⁰¹

Originally, the Mexican constitution pointed out that all electricity as public service comprised the generation, transmission and distribution of electricity, sustaining that the natural resources and energy sources shall be at the service of the commons and the improvement of the life standard of the Mexican people¹⁰².

Later in 1975, The Electric Energy Public Service Law (LSPEE) was created, and allowed the private sector to generate electricity for its own use if electric infrastructure was not available.¹⁰³

Another important factor of electricity reform was technological competition initiated throughout the 1980s. Due to its own technical and economic characteristics, the development of the gas turbine offered strong competition to the diesel engine, the internal combustion engine, and small steam turbines.¹⁰⁴ The process of competition decreased the price to build power plants. The technological change introduced the materialization, perfection and economical viability of the gas turbine machine in the power industry.¹⁰⁵

This led to changes of the World Bank policies, which originally lend money to governments that need large capital intensive investments for their economic development. But the evolution of less capital intensive technologies in the 1980’s gave the opportunity to the private sector to invest the electricity industry that used to require huge capital investment that could only be guaranteed by states. At the same time, the World Bank found, that national enterprises were not as efficient and competitive as the private sector, and in 1992 their new policies recommended structural transformation in the electricity sector, promoting competition and removal of monopolies.¹⁰⁶

As consequence of the world bank recommendations, on December 9th 1992, the then Mexican President Carlos Salinas de Gortary, proposed a new electricity initiative, with the purpose of modernizing the electric public service, with the purpose to satisfy an efficient and reliable service to the consumers and future consumers, and to add additional forms of production to improve the actual electricity plants and reach a major productivity of the country¹⁰⁷. The initiative was approved 20 days after.¹⁰⁸

In 1992 the electricity structure changed from a fully monopolized sector to a more diverse one, where, self-supply, cogeneration and independent power producers were allowed to sell electricity to the Federal Commission of Electricity. *“Here is was when the real opportunity opened up for private-sector participation in the market. This is still restricted to certain forms and subject to direct control by the Ministry of Energy.”*¹⁰⁹

¹⁰⁰ Breceda Miguel (online) Op cit.

¹⁰¹ CFE (online): History

¹⁰² See Article 27 of the Constitution of the Mexican United States.

¹⁰³ CFE (online): History

¹⁰⁴ Islas Jorge (1998) The Gas Turbine...

¹⁰⁵ Ibid

¹⁰⁶ World Bank (1993): World Bank’s Role in the electricity Sector

¹⁰⁷ D.O.F (1992): Diario Oficial de la Federación (23-Dec-1992)

¹⁰⁸ Ibid.

¹⁰⁹ Breceda Miguel (2000) op. cit.

During the same period, the negotiations of the North American Free Trade Agreement (NAFTA) between, USA, CANADA and Mexico, opened the opportunity to initiate the deregulation and modernization of the electricity generation in Mexico. In one of the agreements was established that Canadians and Americans could acquire, build and operate power plants in Mexico, this was restricted to self-supply, cogeneration.¹¹⁰

3.2 Legal Frame work for Independent power producers

The Electric Energy Public Service Law (LSPEE) was created in 1975, and this law had some additional reforms through the decade 1980's, but it was not until 1992 and 1993 when significant reforms were done in regards to private electricity generation.

Prior to the 1992 and 1995 reforms, all activity in the electric and gas industries were operated through three public governmental entities: Comisión Federal de Electricidad (CFE), Light and Power Company of the Center (LyFC), and Petróleos Mexicanos (Pemex) and with limited participation of the private sector in gas distribution.

The LSPEE recalls Article 27 of the federal constitution, "it correspond to the nation generate, conduct, transform, distribute and supply electric power that look upon public services. All energy public service activities are public order."¹¹¹

The following electric activities in the chapter are not considered electric public service¹¹²:

- *Electricity generation for self-supply, cogeneration and small electricity production;*
- *electricity generation by Independent power production that sells it to the CFE;*
- *electricity generation for exportation, that is produced from cogeneration, self-supply and small production;*
- *imports of electricity destined for self-supply;*
- *and electricity generation destined for emergency use due to interruptions or failures of electricity public service".*

The current legal framework allows the private sector to participate in activities previously reserved to the state and is not considered a public service. The legal reforms explicitly permit the private sector to construct, operate, and own systems of electric generation and natural gas transportation, storage, and distribution¹¹³

*"To carry out these activities, the private entities require a permit. The Law and the Regulations define six types of permits for the activities that are not considered public service: self-supply, cogeneration, independent production, small production, importing and exporting, and establish the conditions under which each one of the permits shall be granted"*¹¹⁴

The CRE is the only institution that can grant permits to private generator, the role of the CFE is to evaluate the need and offer binding for private electricity generators. The granting of the permits is subject to the following provisions (Art. 36 of the Law)¹¹⁵:

- *"The authorized exercise of the activities of electric energy generation, exporting or importing may include the conduction, transformation and delivery of electric energy according to the specifics of each case;*
- *The temporary use of the national electric system's grid by permit holders may only take place after signing an agreement with the utility, if doing so does not jeopardize the rendering of the public service, nor the rights of third parties. Such agreements must stipulate the compensation in favor of the utility, that is the responsibility of the permit-holders;*

¹¹⁰ Reyes T. Marcial (2002). La Participación Privada En La Industria Eléctrica Nacional...

¹¹¹ LSPEE (online)

¹¹² See Article 27 of the constitution and the LSPEE Law, op cit.

¹¹³ See CRE (online): Law.

¹¹⁴ CRE (online): Guide to Request Power Generation, Import and Export Permits.

¹¹⁵ Ibid

- *The permit-holders may not sell, resell or via any other legal act alienate capacity or energy, except in the cases provided expressly by law, and*
- *If the ownership of a generation plant corresponds to several persons, the permit is granted to all the interested parties, who must designate a common representative. The multiple owners shall be responsible for complying with the law, the regulations and the conditions that are established in said permits”.*

3.3 Regulations related to renewable energy.

The federal constitution calls for the conservation and appropriate use of energy resources, only mention use of resources for electricity generation as a public service. The constitution does not make difference or preferences between energy sources¹¹⁶. In both, the constitution and the Electric Energy Public Service Law (LSPEE), there is no specific mention of renewable-energy services.

It was until 2001 – nine years after the creation of the CRE – when the CRE approved a new methodology to determine charges for interconnection and transmission services, making difference between intermittent power plants (like wind power) and steady conventional power plants.

In a conventional power plant the electricity generations is available at any time, therefore, can be programmed. In the CFE energy system this is call dispatch electricity (the energy known to be available for uninterrupted consumption). In the case of renewable energy – since is an intermittent electricity generator – is not considerer dispatch however the contractor – CFE or other associate – will take it when is produced.

Since all electricity has to be programmed or scheduled, the electricity generator will have to comply with the contracted capacity electricity. Usually, all private electricity generators that require the use of the transmission and distribution lines of CFE have to pay for interconnection services, which is a fixed amount related to the installed capacity of the power plant. In the case of renewable energy, the generator will only pay for the electricity generated; this entails an approximate 50 – 70 percent reduction of the usual interconnection charges.

The same applies to transmission charges, where the generator will only pay effective energy transmitted, and unlike steady power plants that pays a fixed amount.

However, these regulations are subject to the following three conditions: the generation capacity must be bigger the 0.5MW; it must be an intermittent energy source; and is only applicable to wind, solar and hydropower plants.

The United Nations Development Programme in Mexico analyzed the institutional, political and legal barriers for the development of renewable energy pointing out the following remarks:¹¹⁷

- *“The current legal framework does not favour the commercial development of renewable energy (hydropower notwithstanding);*
- *CFE is legislated to buy the cheapest electricity available, without considering external costs, and to give preference to firm capacity for new power installations in order to ensure the reliability and stability of the national grid;*
- *Buy-back prices for electricity do not allow for any increment for renewable energy and buy-back prices for non-programmed electricity production are discounted;*
- *CFE is under no obligation to purchase renewable energy production;*
- *Renewable power access to the electrical system is allowed by law, but not necessarily encouraged, in part because the effects of intermittent sources on the national grid have not been adequately explored”.*

¹¹⁶ See Article 27 of the Federal Constitution, op cit.

¹¹⁷ UNDP-GEF (2001): Action plan

3.4 Are environment and social benefits in the agenda?

Environment:

The Mexican energy policies on the subject of environmental concerns and use of resources are more inclined toward the use of clean and more efficient technologies rather than strategies for the development of renewable energy. The Energy Ministry has three main strategies: ¹¹⁸

- Improve combustibles: substitution of solid combustibles; convert garbage into electricity (like fluidized bed technology);
- to foment energy saving and energy efficiency;
- incite and foment the use of renewable energies;

An interesting point here is that both the National Development Plan and energy policies and any other program proposed by the federal government is just a plan and it does not imply any commitment unless ratified by the congress and subscribed in the LSPEE law and Federal Constitution.

However, the Federal Constitution withholds several environmental regulations and norms, and, environmental regulations must be pursued.

CRE and CFE collaborate with the Ministry of the Environment and Natural Resources (SEMARNAT), and no electricity generation permit can be granted to private generators if they do not comply with the environmental norms.

In regards to the environment, the LSPEE law recalls federal norms which include environmental norms. The following norms are contemplated in the law:

- Energy efficiency norms of extractive activities with regulations to protect the environment.
- Norms for emissions of pollutants such as NO_x, SO_x, and CO₂.
- Norms for exploitation and management of national resources are comprised in the environmental norms.

SEMARNAT is the ministry responsible to issue Official Mexican Standards establishing the maximum emission limits of pollutants; to develop and implement programs for reduction of pollutants; and to demand the compliance of the law.¹¹⁹ These norms apply to all sectors: private and public.

In terms of climate change, Mexico has ratified the Kyoto protocol, but as a developing country does not have reduction commitments, but this could be a good opportunity for Mexico, to let foreign countries – that have ratified the Kyoto protocol, like EU Countries - to exchange carbon emissions or utilize carbon sinks in Mexico. Mexico has more Environmental responsibilities with multilateral trade agreements.¹²⁰

Internalization of externalities is mentioned in the energy modernization programs, but it seems that the government is aware of environmental strategies and mentions them in their energy programs; however such strategies are not implemented.

The electricity price does not consider externalities, what is keeping the renewable energies out of competition is the competitive advantage that fossil fuels provide, but internalization of externalities in the price may well change the current position of renewable energy sources. Unfortunately, this step is in early stages worldwide, and with fewer possibilities for Mexico. However, SEMARNAT is currently undertaking a research to evaluate externalities of the electricity sector.¹²¹

¹¹⁸ Fernandez Zayaz Jose Luis (SENER), interview

¹¹⁹ SEMARNAT (online), Mexico Environmental Law

¹²⁰ Mata Sandoval Juan (SENER), interview

¹²¹ Torres Carlos (SEMARNAT), interview

Social issues:

Since electricity service is a basic good for improving economic status and quality of life, access and affordability is one of the country's priorities. Reason why electricity tariffs are heavily subsidized, specially residential and rural sector. Still about 5 million people do not have access to electricity. 80,000 towns do not have access to the electricity grid, either they are too far or because of geographical constrains that make more expensive to bring the infrastructure there.¹²² Another problem is that such towns are much dispersed and the size of the population is not big enough to worth infrastructure expansion there. In addition to this, the people in those areas are too poor to pay for the utility service.

The ministry of energy has a rural electrification program focused in communities with more than 100 inhabitants. According to the Energy Ministry, Mexico has 2,200 towns with more than 100 inhabitants that do not have electricity at all. Moreover, 3,000 towns are without potable water and 5,600 without sanitation services because they lack on electricity services.¹²³ Some of the benefits of rural electrification have been done through decentralized programs using renewable energy: solar, biomass, wind and mini-hydro. The services these sources provide are mainly for water pumping, water purification, community services (TV-schools, health clinics), basic home illumination, food preservation and communication systems (photovoltaic phones).

Some urban areas are not properly electrified as well, especially slums and periphery areas. A problem here is that people cannot afford the electricity connection service and in other cases the electricity service has not been expanded to those urban areas. Sometimes it is just a simple electricity pole that will cost approximately 500 USD, but because it was not planned by the municipality or the utility company. When these communities request the service, they are asked to pay for the infrastructure (or part of it). In consequence, they make the connection themselves, taking it directly from the grid¹²⁴. This happens in almost every Mexican city, just in Mexico City countless amounts of people living in slums steal electricity - they just take it directly from grid. The Power and Light Company of the Center (LyFC) is broke because this and un-paid bills.

Despite the benefits electricity service provide, electricity generation also have environmental and social impacts. Unfortunately none of them are considered on the energy policies or environmental norms.¹²⁵ At this moment, technology choice is not is not an option for regular consumer.

3.5 Renewable energy actors

For a long time the Mexican energy policies where focused on expansion and supply of its energy services, but it as not until the end of de 1980's decade, when the government realized their high consumption and dependence on petroleum. And in 1989 – under the Ministry of Energy- the National Commission of Energy Savings (*Comisión Nacional para el Ahorro de Energía*—CONAE) was created in order to promote and foment action lines in energy savings, energy efficiency and to develop the use of renewable energy sources of the country. CONAE is also responsible to give technical advice to the public, private and social sectors.

The National Solar Energy Association (*Asociación Nacional de Energía Solar* – ANES), is the oldest organization working on the promotion renewable energy sources, formed in 1980 as a national representative of the International Solar Energy Society (ISES)¹²⁶.

¹²² Huacuz Jorge. - IIE (2001) ISES forum.

¹²³ SENER (online) Rural Electrification program.

¹²⁴ Personal conversation with a non-connected electricity user

¹²⁵ Torres Carlos. (SEMARNAT), interview, op cit.

¹²⁶ ANES (online). www.anes.org

The cooperation of CONAE and ANES made possible the first national forum on non-conventional energy sources in Mexico, where a wide diversity of public and private institutions participated. This led to the creation of the Advisory Council for the Promotion of Renewable Energy (*Consejo Consultivo para el Fomento de las Energías Renovables en México* – COFER) in 1997. This council is formed by representatives of the industrial, commercial, academic, governmental and financing institutions.

On the technology side, the Mexican Electric Research Institute (*Instituto de Investigaciones Eléctricas* – IIE), has a department on alternative energy sources, which undertakes research and development of renewable energy technologies. Their major input have been the evaluation of Mexico's wind power potential and other non-conventional energy sources as well.¹²⁷

The United Nations Development Program (UNDP) in conjunction with the Global Environmental Facility (GEF), have several projects for the development and removal of barriers of renewable energy systems. They are currently undertaking an “*Action Plan for Removing Barriers to the Full Scale Implementation of Wind Power*”¹²⁸

There are several international and national governmental, non-governmental and private institutions participating in coordination with COFER, all committed to enhance technology development on the one hand, and the development of renewable energy markets in the other.

The most relevant international meeting – as described by UNDP – was held in Cocoyoc, Morelos:

“The event was organised by SENER, through CONAE, IIE and CFE, with support from the IEA¹²⁹ Secretariat and the Renewable Energy Working Party. The meeting included participation of the GEF¹³⁰, UNDP, and UNEP as well as renewable energy specialists from Mexico, Spain, Netherlands, and United States. Bilateral and donor agencies from several countries were also present, as well as officials from a number of Mexican government agencies.”¹³¹

This convention tightened the relationship of the government and the private sector and investors. The meeting was the threshold for sharing experience level for the barriers for the development of renewable energy markets at a national and international level.

The meeting brought up commitments from lending, donor and developing agencies, as well as governmental institutions. The purpose was to facilitate the access to soft loans, and clarification of terms and conditions. Market mechanisms incentives where also proposed, mechanisms than would augment the development of renewable energy markets.

Concerning involvement of the private sector, several private enterprises and industrial association have constant participation at all levels – lobbying at the congress and negotiations with the Energy regulatory commission. So far, two wind power companies are in continuous negotiations with the government to develop better electricity market mechanisms that will improve their competition towards conventional energy sources.¹³²

4 Effects and Analysis

From the 1992 reform, ten years have already passed, as mentioned previously, those reforms let to institutional and structural changes that transformed the electricity sector structure to a certain extent, allowing a limited private participation on electricity generation.

¹²⁷ IIE (online): Alternative Energy Division

¹²⁸ UNDP-GEF(2001): Action plan

¹²⁹ International Energy Agency (IEA, DOE)

¹³⁰ Global Environmental Facility

¹³¹ UNDP-GEF(2001): Action plan

¹³² Gottfried Pablo (Fuerza Eolica del Istmo), interview

On the one hand the purpose of such reforms was to augment the electricity capacity and satisfy the increasing demand,¹³³ and modernized the electricity industry at the same time. This supposed to increase competition and lower electricity prices. On the other hand, a bilateral purpose was to diminish the fiscal burden from investments on electricity infrastructure, and to divert it to social development. The fact is that the expected participation of the price sector was low, the electricity prices increased and the fiscal burden also increased.

The outcome of such reforms has had significant effects on electricity generation: the development of new technologies, the use of resources, and the development of a new electricity market. All this together had economic, social and environmental effects. Description and analysis of them are described in the next following segments.

4.1 Electricity Generation

The development of on installed capacity after the reform increased by an average of 5.2% per year. According to CFE figures, the installed capacity in 1992 was: 27,068MW and by 2002 was 40,354MW.

The national power generation (Figure No. 9) shows how private electricity generation is growing slowly, while CFE practically stopped its power generation after the year 2000.

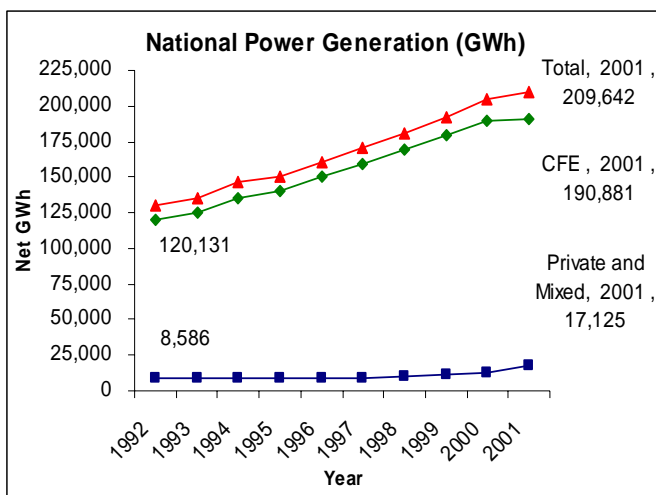


Figure 9: National power generation by year

According to new CFE figures the private electricity generation increased from 17,125.00GWh in 2001 to 34,657.00Gwh in 2002.¹³⁴ Within the CFE generation capacity some private electricity generation is included but under the build lease and transfer (BLT) and PIDIRIEGAS programs.

Within private electricity generators, the independent power producers (IPPs) are IPPs are the ones generating the majority of the new electricity capacity, followed by self-supply. Since CFE generation capacity has diminished, therefore more private participation is required.

The Government stated that the public resources are not enough for further investment in electricity generation; therefore, investments from the private sector will be required. According to Ministry of Energy, the expected private participation has not been as expected and nowadays private investment is strongly recommended by the federal government. The lack of interest of private investors in electricity generation during the period 1993-2000 is related to the market opportunities limited by the legal framework.

4.2 Private electricity generation

Effects of the 1992 law in regards to private generation has been as follows:

Just right after enactment of the new law (1992), private participation started first under two CFE binding schemes: Built lease and transfer, some of them started in 1989 under the PIDIRIEGAS program.

The first permits given by the CRE were registered until 1994 with participation of cogeneration and self-supply modalities. The development of independent power producers took more time than the expected. The first permit granted to an independent power producer

¹³³ SENER, (2001): Programa sectorial de Energía 2001-20506

¹³⁴ INEGI(online): Generación

(IPP) was in 1997. It seems that another reform on natural gas sector was necessary, reform that took place in 1996. Still it was until the end of 1998 when private participation had more impulse.

Besides the already existing electricity generator for self-supply, participation of private generators under all modalities had a slow progress.

Independent Power Producers (IPPs):

Independent power producer is the group that generates the majority of the installed capacity from the private sector.

After the reform, IPPs participation had low impulse and only the projects that were already committed by CFE where the ones that started, such projects were in the mind of the government before changing the reform, under the Build Lease and Transfer (BLT) and PIDIRIEGAS.

According to J. Islas, the PIDIEGAS scheme “...became the main private financial source for development of new electricity generation during the first five years of 1992...In 1997 the CFE bidding program for BLT projects represented 2.1GW.”¹³⁵

The first IPP granted by CRE was registered in 1997, apparently there were some problems regarding fuel supply, and no more projects were given until the end of 1998. According to the CRE five year report 1999 and 2000 were the years with more capacity and investments. Nowadays, IPP electricity generation accounts for 5,860.41MW and 3,416.70MW under construction (total 9,024.41MW). According to figure No. 9 – at the beginning of this chapter – CFE stopped investments on electricity generation; therefore, it can be assumed that the BLT and PIDIRIEGAS investment mechanisms of CFE have been discontinued. This assumption could be possible, because of the CFE gained a huge debt with this kind of investments mechanisms.¹³⁶

So far, all IPPs plants use combined-cycle turbines, which use natural gas as primary energy source, based on official information use of this technology will increase by 70%.

Self-supply:

Self-supply is the modality with major number of permits (165), but the major contributor as a sole enterprise is PEMEX, which is registered as a private electricity generator but is a state-owned enterprise. With 35 permits generates 43% of the total energy generated under the self-supply modality. So far they produce the majority of the electricity because of 19 private projects are still under construction. Most of the technology utilized under the self-supply modality is internal combustion (66), and followed by steam-turbine (40), then hydraulic-turbine (40). Combine-cycle, wind-power and fluidized-bed are other technologies utilized. In regards to primary energy use, once again fossil fuels occupy the first place, but in this case diesel is in first place, followed by gas and combustoleum.

In regards to renewable energy, self-supply is the modality that utilized more renewable sources as primary energy source, but most of them are hybrid-plants. From the data-base is difficult to know which is the primary energy source (the renewable or the fossil fuel). Hydraulic turbines are utilized in mini-hydro projects, but once again from the CRE data is difficult to determine which one is mini-hydro. But according to the geographical area given in the data-base, it is more likely to be mini-hydro. Out of 15 permits nine are under construction. All the mini-hydro projects together will have a capacity of 183.73MW.

Biomass is the second most utilized renewable source utilizing hybrid steam-turbines: biomass from cane and combustoleum. Only two of them are 100% from renewable source (biomass-cane).

¹³⁵ Islas Jorge (2001). The Financing of the Mexican Electrical Sector

¹³⁶ op cit.

There are only two biogas projects, using internal combustion technology. Last but not the least, six wind power projects are planned, all except one, which is inactive, are still under construction stage.

Cogeneration:

In regards to cogeneration, the original initiative started in 1995 when CONAE analyzed the cogeneration potential in Mexico, the purpose was to save fuel, make an efficient use. CONAE detected 1,700 industries that could make use of cogeneration. Despite the amount of potential enterprises that could participate, it is recognized that there are still economic constraints, for investment, fuel price volatility (especially natural gas) and electricity prices. Under these considerations CONAE estimated a feasible potential between 3,000MW and 5,500WM¹³⁷.

So far, CRE report shows 33 cogeneration permits (August 2003), plus 10 expired permits. All together account for a total installed capacity of 2,115.58MW this include projects in construction. The data available shows considerable inputs from cogeneration, but the government explained that cogeneration has had low impulse.¹³⁸

CONAE identified at least 83 industries with major cogeneration capacity, and out of this identified 33 perfectly economically viable. The major implementation occurred during 1997 and 1998¹³⁹. Most of the cogeneration projects use gas-turbines, steam-turbines and combined-cycle turbines; technologies that utilized natural gas, diesel and combustoleum. All except one generator use biomass as primary energy source, which is considered renewable (only 7MW).

¹⁴⁰

The importance of utilizing cogeneration is because of its high efficiency levels estimated at 60-70%, actually, in CONAE's analysis, they found a higher potential without adding more combustion fuels to the system.

4.3 Renewable energy sources

Development and evolution of renewable energy in Mexico:

According to the Energy Ministry and CFE the effective capacity of renewable energy decrease form 29.7% (1996) to 25.4% (2002). This only reflects the decrease of hydro-power and not all renewable sources together. Also drought is related to the decrease of hydropower generation.

Regarding renewable energy use by the private sector, in August 2002, CRE reported 68 permits that generate electric from renewable primary energy and in some case as secondary energy source, 54 permits are in operation and 13 under construction, and one about to start construction works.¹⁴¹

Investment cost, electricity potential and average electricity cost, are the major factors that influence the technology choice. The following table (4) shows major differences between different renewable technologies:

Table 4: Investment cost for renewable energy

	Estimated potential	Cost per KW	USD cents. /Kwh.
Photovoltaic	5 KWh/m2 per day	3,500 to 7,000	25 - 150
Wind	5,000 MW	1,000	5 - 11
Mini-hydro	700 MW	800 - 6,000	3 - 45
Biomass	150 MW	630 - 1,170	4 - 6

¹³⁷ SENER (2002): Prospectiva

¹³⁸ SENER(2002). Prospectiva

¹³⁹ CRE (2001). Five-Year Report 1995-2000

¹⁴⁰ Estimates made by author. from CRE (online): Permits given

¹⁴¹ SENER(2001). Prospectiva

Source: SENER (2002)¹⁴²

According to J. Islas from the Energy Research Center (*Centro De Investigaciones en Energía – CIE*), the situation is going to change, the high gas prices will make renewable energies more competitive and it will also decrease the investment cost.¹⁴³

Solar:

There is no a single project registered under the energy regulatory commission, although application of photovoltaic cells are utilized by small number of private companies, and some residential. The rural areas are the main sectors of photovoltaic applications or where transmission or distribution does not exist. Projects in Mexicaly (north of Mexico) are going on, apparently they will sell their electricity surplus to CFE, this project is under research stage.

Application of solar power increment from 7.1MW to 14.3MW (1993-2001) representing an average 9% growth¹⁴⁴. According to ANES the market increased 30% in solar and wind.

CFE has one hybrid project in operation: a wind-solar-diesel with capacity of 17kw-100kw-80kw. Another hybrid project is under construction, is going to be a Combined-cycle and thermo-solar with a capacity of 40-50MW.¹⁴⁵

Wind:

The 5,000 MW potential estimated by IIE, is now within the UNDP, GEF development plants; they have and action plan for the development of 3,000MW wind power in Mexico. Right now they are mainly engaged on capacity building.¹⁴⁶

Although price competition is a barrier for the development of wind power, the main success regarding wind power was after eight years of negotiations and lobbying wind power generator finally got a fair agreement with CFE, CRE and other authorities. And finally construction works are beginning.

Nowadays, more international companies are getting interested on wind power investments. (Iberdrola, Endesa, Gamesa).

In regards to wind power, there is good acceptance of foreign investment, from the government sector and non-governmental organizations. They believe that bringing the technology to Mexico will have the same effect as in Spain: were first Dutch companies started development works, and the Spaniards took over and now they are spreading all over the world.¹⁴⁷

Biomass:

Most of the biomass uses are under hybrid-projects, a combination of steam turbines and internal combustion where the biomass is burned. Only two power plants utilized biomass as a primary energy source with a capacity of 18MW and 38GWh/year. The capacity of hybrid projects is 220.57MW and 389.51GWh/year. All biomass permits are under the self-supply modality.¹⁴⁸

Mini-hydro:

From the power plants utilizing this technology, only three does not use other source than water accounting for 114.99MW. Power plants utilizing other fuels account for 24.44MW.

¹⁴² SENER (2002) Prospectiva

¹⁴³ Islas Jorge (2003) Cost-Benefit Analysis

¹⁴⁴ SENER (2002): Prospectiva

¹⁴⁵ SENER (2002): Prospectiva

¹⁴⁶ UNDP-GEF(2001) Action Plan...

¹⁴⁷ Data collected from interviews, All

¹⁴⁸ Estimates made by author. from CRE (online): Permits given

Nine more Mini-hydro plants are under construction, all of them utilize water as a primary energy source and will have a potential of 138.86MW. All mini-hydro permits are under the self-supply modality.

4.4 Social aspects

The country's aim is to expand its electricity services (generation, transmission and distribution), in order to improve the economic status of the country and therefore quality of life of the Mexicans, and for that, Mexico will need to increase its energy/electricity capacity per capita. At present, per capita consumption is between 1,500 and 1,800KWh/y, the goal for good life standards is 4,000 KWh/y. The fact is that in some electrified regions the per capita electricity consumption is less than 500kwh/y. The Human Development Indicator stated that in 1980 the electricity was 856Kwh and in 1,655Kwh by 2000.¹⁴⁹

Rural electrification projects have decreased, the electricity infrastructure investment on the rural areas is now less than the amount allocated in previous years. However, the previous amount of beneficiaries from new electricity infrastructure in the rural areas and slums has had significant decrease, from 122,610 in 1996 decreased to 49,258 of new rural homes in 2001. The same applies for electrified towns: from 1,782 in 1996 to 778 by 2001.¹⁵⁰ According to Enrique Caldera, rural electrification for water pumping dropped almost to zero¹⁵¹.

According to J. Islas. Electricity prices have decreased: *"The evolution of real tariffs for the agricultural and domestic sector dropped in real term 25% and 12%, respectively, between 1993 and 1995 and later become more stable. However, at present these tariff benefit from a high subsidy (70% and 32%, respectively)"*.¹⁵² Islas points out that the stabilization of electricity prices can be linked with the 1992 electricity reform.

In an analysis requested by the congress evoke that electricity is part of the basic consumption net of Mexican homes (average income). The expenses percentage on electricity increase from 6.8% (1989), 7.8% (1992) and 9.0% (1994)¹⁵³. In families with less income the 1994 percentage fluctuates between 9.31% and 10.97%.

The remarks of J. Islas point out that electricity prices stabilized after 1995, but evidence from CFE show that prices have increased. The data given by CFE mismatched with the data provided by the ministry of energy (SENER). The price increase showed in figure 10 (next page) are given by CFE, within their records a small remark mention that the prices include maintenance fee. Though the charges are per Kilowatt hour, there is consensus among users that electricity prices have increased. But this also linked with economic inflation.

It is difficult to link the maintenance fees with electricity reforms. At the same time, the subsidy scheme for electricity services changed in February 2002, which added a new electricity tariffs scheme for domestic high consumption. The Scheme is quite complicated and depends of high consumption that differ from 250KWh to 2000Kwh, depending on the region, climate and season (summer).

These changes are more linked with energy saving measures and electricity consumption, since the consumption on the domestic sector can be easily controlled by increasing the price. The figure eleven (following page) shows the effect of price increase in the domestic sector.

¹⁴⁹ UNDP (online): Humand Development Indicators 2003

¹⁵⁰ CFE (2001) Informe Annual 2001

¹⁵¹ Caldera Enrique (ANES), interview

¹⁵² Islas Jorge. (2001). The financing

¹⁵³ Sandoval de Escutia J.M. (1999). La Reforma del Sector Eléctrico

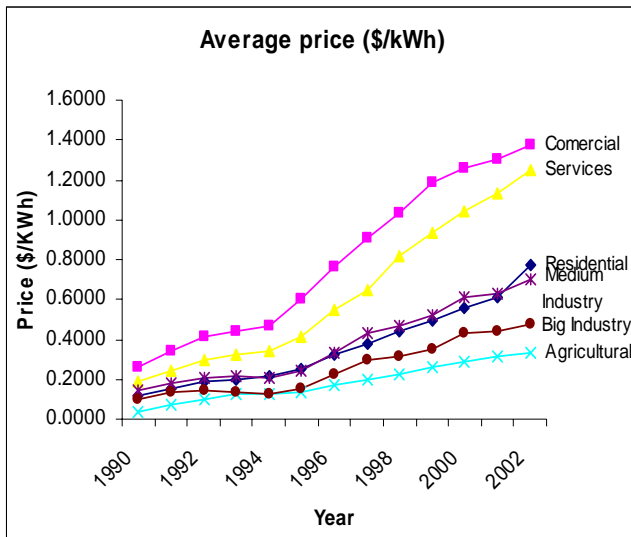


Figure 10: Average electricity price by sector

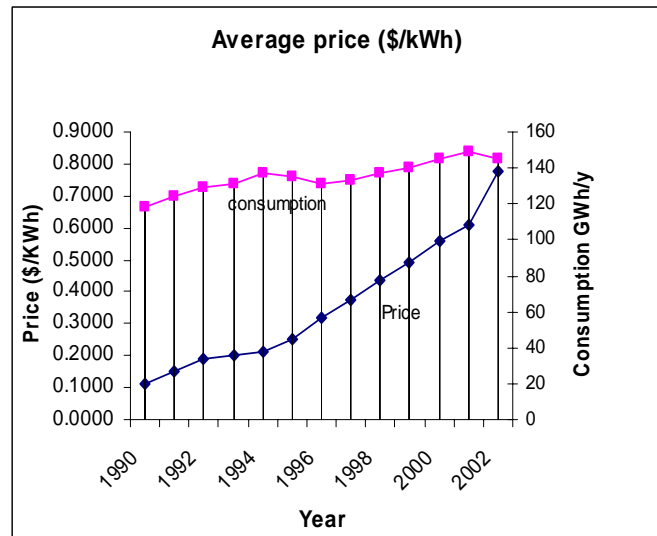


Figure 11: Residential electricity price and electricity consumption

The social effect regarding electrical employees after the 1992 reform, data from the Energy Ministry show that employment decreased during 1992-1996¹⁵⁴. But the numbers of employees started to increase again 1996; from 102,620 in 1996 to 114,674 employees by 2001, according to CFE those positions were needed.¹⁵⁵

4.5 Economic impact

CFE decayed because of the political debate that has undergone for more than five years, and no decision is taken and CFE does not have liberty of action¹⁵⁶.

As pointed out by J. Islas, CFE is gaining fiscal burden from PIDIERIGAS and BLT financing mechanisms: "According to the Energy Ministry from 1998 to 2005 CFE will have to pay a yearly USA 1997\$ 616 millions in leasing agreements in the BLT projects. In 2006 and 2007 this amount will be reduced to USA 1997\$ 109 millions yearly. Moreover, in the next years the cash flow of the CFE has to integrate the financial compromises with the IPPs"¹⁵⁷

The Mexican government has estimated that the nation will need \$5 billion in electricity investment over the next 10 years. "The president of Mexico hopes that private investor will add an electricity capacity of 30,000MW over the next 10 years, which would nearly double of Mexico's current capacity".¹⁵⁸

The partial opening to private investment has been the major change and/or debated aspect of electricity reform in Mexico. However, Private generation: the presence of private investors in electricity generation is practically all the new installed capacity invested. Exact figures are difficult to extract from CRE reports because this companies operate under national associations. But a CRE workshop booklet from the congress also show that the governmental plan is that private generators will put 98% of the capital by the year 2011¹⁵⁹

On the other hand, the country lacks of financial capacity for big investments on it electricity sector, the country has already committed a large sum of the country's revenues to pay a national bank bailout (FOAPROA), which will take 30 years to pay, and actually three time

¹⁵⁴ SENER (online) Statistics, Employees in Electrical Sector

¹⁵⁵ CFE (2001) Annual Report. Informe Annual.

¹⁵⁶ Torres JoseManuel (CFE), interview

¹⁵⁷ Islas Jorge (2001) The financing of the Mexican Electrical Sector.

¹⁵⁸ EIA, DOE (2003) International Energy Outlook 2003, p150

¹⁵⁹ Marcial Reyes Tepach (2002). La Participación Privada En La Industria Eléctrica Nacional

more than the investments required for electricity investments. And at the end that all Mexicans are paying the all cost anyway.

4.6 Institution and Political effects

Institutional:

In regards to the management problems at CFE, one of the major issues explained by Caldera is that the majority of latest directors have been appointed by the president and most of them did not know the enterprise before (specialist electrical, mechanic engineers) were managing the institution, and now they hardly have voice for decision in CFE. Another mistake was that Civil Engineers were thinking on “Big”, building huge power plants that need more capital and construction time, and leaving a side decentralized projects, that could also provide local employments.

Another disadvantage of CFE is that is controlled by SHCP (fiscal authority), and despite the collected revenues by the enterprise, all must go through the perusal of SHCP who decide how the profit will be distributed, SHCP is the authority that approves de budget of CFE (also LyFC). A disadvantage of this is that SHCP does not know the technicalities of the utility companies and many times the preventive maintenance was rejected by the Secretariat. (It has been a miracle that CFE is still standing for the last 30 years of bad management)¹⁶⁰

Perhaps, CFE could alone be a successful enterprise, but budget restrictions and controls of the government and SHCP, did not contribute to the development of CFE. Now after the latest electricity reforms, did not give much space for action to CFE, and nowadays CFE does not what to do, without money for future investments.

The new proposal (Fox initiative) offers autonomy to the public enterprise, with freedom of action and decisions. These suppose to make a competitive enterprise.

On the other hand, it should be clear that the reform, over all, has fiscal purposes, meaning that the concern to transform the electric sector is to break the state monopoly that has to be with the actual competition model that attracts the private sector¹⁶¹.

Political:

The neoclassical ideologies and macroeconomic policies stimulated countries to build electricity markets, and inconsequence moving towards energy efficiency and price competition on the electricity industry. Technological change, let to competition and the development of more efficient technologies, which open the opportunity to private investors to participate in the electricity industry.

Modernization of the electricity sector is still in the first stages, so far, private electricity generation is allowed, but this lead to further changes in the electricity structure.

Drivers of the reform are a like with the neoclassical ideologies and a technological paradigm that assume that modernization will create a more competitive market that will also let to a series of benefits, such as increase competition, reduce production cost and prices, more reliable electricity services and improved environmental protection.¹⁶²

In order to bring private investors México had to undertake responsibilities, because of its monopolized market in all energy sectors and sources. While Mexico is calling for investors for electricity generation, it has to guarantee that they will buy the electricity from them for at least 25 years and to ensure the resource supply (gas, oil, and diesel).

Political and institutional changes are also related to the government that controls it, depending who is heading those institutions has a direct effect on how this institutions operate. The executive power (president) appoint the directors of every ministry, this includes, SENER,

¹⁶⁰ Torres Jose Manuel (CFE), interview

¹⁶¹ De Buen Odon, (CONAE), interview

¹⁶² Breceda Miguel (CAC), Interview

PEMEX, CONAE, CRE, SEMARNAT, CFE. The country is divided by sectors and this makes coordination more difficult, their political and economic approach reflects on the decisions taking in each sector.¹⁶³

After the 1992 reform, three different persons have shared the president chair. Meaning three changes, however, the biggest change occurred in the last three years, when for first time, after 40 years, the opposition party won the Federal presidential elections, however the congress has the majority of the seats. This makes the political situation more difficult.

Three are the major political parties in Mexico: PAN (Partido Accion Nacional) – curent ruling party; PRI (Partido Revolucionario Institucional) – oldest party; and PRD (Partido Revolucionario Democrata). Their political and economic approach reflects on the political decision in the congress.

During the previous federal government the position of political parties changed, originally the PRI was in favor of electricity privatization, and the PAN and PRD was against. With the new ruling party, the situation changed ant then the PRI become against it.

4.7 Sustainability

Recalling the National Development Plan that look after the modernization of the electricity sector, in order to maintain a competitive advantage and be able to confront future development challenges.

4.7.1 Environment:

As regards to emission of pollutants where the sustainability of the environment is in risk, it has been demonstrated that most of the power plants built and planned utilize natural gas as energy source. This as a primary energy resource is cleaner and more efficient than oil fuels (such as combustoleum and diesel).

The analysis shows an increment of cleaner technologies, but still there a considerable increase on fossil fuel consumption, especially within private electricity generators utilizing combustoleum and diesel as a primary or secondary energy source. Both, diesel and combustoleum have high volumes of sulfur and combustion of them emits more NOx and SOx than natural gas.

It is clear that the shift to cleaner energy is happening but the still more power plants were built. See Figure 12 for details.

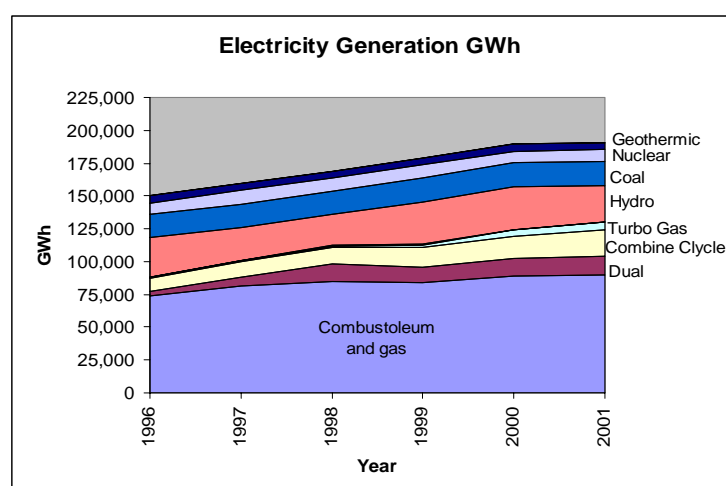


Figure 12: Electricity generation by source and per year¹⁶⁴

¹⁶³ Fernandez Zayas Jose Luis (SENER) Interview

¹⁶⁴ Source: CFE (2002). Informe Annual 2001. p 25

Documented data of environmental effects related to electricity generation can only be found as regard to CO₂ emissions. Information from UNDP shows that per capita emission has decrease. Unfortunately the index utilized there it does not say much of the effects electricity generation after the electricity reform.¹⁶⁵

In regards to the sustainability of energy sources, increasing natural gas consumption mean more natural gas exploration and exportation, here is when the energy resources are linked with the future sustainability of the electricity sector, if so many power plants depend on natural gas, and then the government has to ensure the gas supply.

While using natural gas, which is less harmful to the environment than other fuels and more efficient, still more constrains have to be solved: exploitation, transportation and price volatility of the fuels. At present, the gas sector is owned and managed by the state but the private sector is allowed to participate in transportation and distribution.

Since CFE is mandated to buy the cheapest electricity available, renewable generation must compete with combined cycle turbines on an economic basis alone. However, the price of natural gas has been rising considerably as a result of increasing demand.

Price volatility of natural gas became significant by the end of the year 2000 and SHCP has stated that it is not willing to intervene via subsidies to stabilize/reduce market prices for natural gas. Consequently, increased reliance on gas-fired technology is now on risk.

4.7.2 Risk

CFE as a public institution is good for Mexico and the Mexicans, as a public institution looks for providing public services and social benefits; in contrast the private sector looks for profit¹⁶⁶.

The national power utility company (CFE) is in risk in several ways; the number one problem is that no public investments have been done. The electricity industry is sui-generis and if it does not invest on time then it will not be able to cover the needs or demand. Therefore soon it will be in a big problem.

Another issue CFE has with private electricity generator is that it has to guarantee that will buy the electricity according to a purchase power agreement that is according to capacity and for about 25-30 years (usually the life time of the power plant). The contracts are also made in US Dollars or considering the inflation in case of national currency.

Another risk CFE is taking is that it has to guarantee the fuel supply, and the problem is that most of the new power plants are run by natural gas, this goes against the diversification strategy and put the company on danger and the government as well. Since at the present time, natural gas is becoming scarce and even more if more consumption. The price of gas has increased in the last two years, and there is not guaranty of stability.

If the new law is approved, the risk will pass to the private electricity generators: *“Price volatility of fuels –availability and price of natural gas, causes uncertainty among users”*¹⁶⁷

As Mexico occupies the first place of the world natural gas consumption per capita, Mexico should be careful, with its decision and commitments. The domestic sector also consumes gas for heating and cooking; and natural gas prices have already increased in the domestic sector. Mexico is now importing gas from USA de 20% of the total natural gas consumed.

Despite the reserves the country has, OLADE, figures point out that the left time for those reserves have decrease from 15 to 13 years¹⁶⁸. The government is positive for finding new reserves, and it also thinking about importing natural gas from Bolivia.¹⁶⁹

¹⁶⁵ UNDP-GEF (2001): Action Plan

¹⁶⁶ Enrique Caldera (ANES), interview

¹⁶⁷ Islas Jorge. (CIE): CO₂ Mitigation Cost In Mexican Power Sector

¹⁶⁸ OLADE (online)

¹⁶⁹ Fernandez Zayas Jose Luis (SENER), Interview

Renewable energy is convenient for several reasons:

First because is its diversity, which goes a long with diversification strategies that will ensure the sustainability of the electricity industry. Second, renewable energy is generally distributed energy, which is usually at small scale. Small scale projects do not interfere or harm the transmission system as is now, (longitudinal). This puts renewable energy in a better position toward large-scale generation, since this will require another type and capital intensive transmission grid. Also, the new and expensive technologies that does not employ many people. On the other hand, renewable energies mean distributed energy and will provide more local employment

Also renewable energy has no source scarcity problems and it does not have to worry for fuel supply and price volatility like petroleum derivatives and natural gas. Furthermore, renewable energy has, by far, less environmental impacts (if any) than conventional technologies.

Unfortunately, the renewable energy topic does not have enough attention from the government, and there is resistance at a high levels (governmental levels), specifically because of cost. The logic is to make electric energy cheaper and it has (kind of) become a politic compromise, an element within the reform.

5 Future reforms:

Initiatives for electricity reforms have also changed, first, in February 1999, Mexico's President Ernesto Zedillo submitted an initiative to the Senate, he propose to privatize the whole Mexican electric sector, *on the based on the "the impossibility of sustaining the pace of public investment necessary to expand and modernize generation capacity"* The proposal did not include transmission and distpatch operation as well as nuclear power plants.

"According to President Zedillo's original initiative, the reform proposal attempted to resolve a situation that is the result of two closely linked phenomena: 1) growing demand for electrical power and 2) chronic insufficiency of public resources to make the necessary investments to satisfy this demand" ... "The proposal asserted that the para-governmental power company, CFE—despite its operating surplus—could not finance the expansion without resorting to greater levels of indebtedness, which are backed in the final analysis by the federal government. In a reaction without precedent in the history of Mexico, the president's reform initiative met with widespread rejection".¹⁷⁰

The current Mexican president Vicente Fox have proposed several reforms to the electricity sector as a step towards meeting the country's growing demand. In its National Development Plan, private participation in electricity generation will account for the 98% of the total investments on electricity generation.

The modernization of the electric sector in Mexico, proposed the last 21st of August 2002, by the federal government, included a package of changes in the political constitution on electricity matters, with modifications to the Electric Energy Public Service Law (LSPEE), the Regulatory Commission Law and to create an Organic Law of CFE and a national center of energy control.¹⁷¹

The objectives of the electricity modernization exposed by the current government are: a) To supply the requirements of increasing electricity demand; b) Structural transformation to reach efficiency through deep modernization; c) To strength the public Institutions of the sub-sector (electric); d) To diminish the fiscal burden on of public resources.¹⁷²

In order to allow private sector participation in the electric sector, Articles 27 and 28 of the Constitution must be amended. Initiatives to reform the Constitution may be presented by either the Executive office (The President), or by the legislative branch represented by the two

¹⁷⁰ Breceda Miguel (Sept, 2000), Debate On Reform

¹⁷¹ Reyes T. Marcial (2002) La participación privada en la industria eléctrica nacional.

¹⁷² Reyes T. Marcial (2002) La participación privada en la industria eléctrica nacional.

chambers of Congress (deputies and senators). Since the Constitution is Mexico's supreme law, amendments must be approved by at least a two-thirds majority votes in both the chambers of the Mexican Congress. This means that in order to pass, constitutional amendments must have the support of at least 334 deputies and 86 senators.¹⁷³

Currently, a new electricity reforms are in the agenda, and reform initiatives are on the queue for the new senate, but electricity reforms in Mexico are in a continuous debate, and it seems to be that will take a long time to reach any agreement between political parties. The elections for the legislature have passed and this time the party of the president has fewer seats. However, the issue of electricity reform occupies the second place in the agenda.

5.1.1 Uncertainty

During the last months the staff of most federal institutions related to energy policies changed. The Secretary of energy has just changed, and now there is the former director of PEMEX (Mexican Petroleum); The Directory of the Federal Commission of Electricity also changed, the Director of the CONAE changed as well, and the group of renewable has been dismantled due to budget constraints¹⁷⁴. Moreover, the Director of SEMARNAT (Secretary of the Environment and Natural Resources) changed as well.

Some people are quite positive with the change of the Director of the Energy Ministry, since is well known that the new director has great power of bargain in the congress. The only concern as is for the Nation Solar Energy Association (ANES)¹⁷⁵ is that most of the changes gave the chair to people oriented to conventional energies, such as fossil fuels.

At the same time, there is a lot of pressure to accept the electricity reform initiative presented by the Federal Government (Vicente Fox). Still, the energy commission is not ready for any decision yet, the members were selected the last day of September 2003, and they still have to get assessors on the matter.

The problem now is with the privatization topic in the agenda, while waiting for any decision investments on the electricity sector have been halted, neither CFE is improved nor the private sector developed. Therefore, important topics are not solved. Though, the government and CFE have to guarantee all previous commitments of new power plants from the private sector.

The current mechanisms that let private generators to supply electricity to CFE is done through a long process of governmental financial commitment that reflects future decisions. The government has to guarantee its commitments, for this a series of financial mechanisms are required, commitments for loans and other financial mechanisms. This place the government on a financial concern, just the financing of the electric infrastructure is a general concern, then environmental, technology development and other possibilities for development are not even discussed¹⁷⁶. The Mexican society has an important role to push for this kind of discussion, but perhaps the society does not have enough knowledge need it to push for it.

6 Discussion

The major effects in regard to electricity reforms are more linked to the legal frame work, which influences on participation of private electricity generator and their technology choice.

In both cases, the present market mechanisms limits the development of electricity generation, and now the country is about to face black-outs and an industrial development shortage.

As long as the institutional a legal framework remains as it is – with slow and low private participation on electricity generation, the situation is less likely to change. The current legal

¹⁷³ Cueto Preciado Luis (2000) Negotiations and Legislative Strategies

¹⁷⁴ De Buen Odón (CONEA), interview

¹⁷⁵ Interview with Rincon M. Eduardo, President of ANES

¹⁷⁶ De Buen Odon (CONAE), interview.

framework reduces the interest of the private sector to participate; this includes the development renewable energy from private generators.

Right now renewable energies have hard competition with conventional energies (fuel, natural gas, etc) – especially with technologies that utilize natural gas- because the real cost is not included, this means that natural gas is subsidized and environmental externalities are not included. Although, the real cost is not in the electricity bill, the fact is that we all are paying for it in a different way, though taxes and our own health.

Therefore, the renewable energy topic should be pushed in to be included in the electricity reforms. As mentioned in the sustainability section of this paper, diversification strategies play an important role for the sustainability of the electricity industry. Where a combination of technologies, energy sources and more small scale projects rather than the conventional large-scale technologies, such as the typical natural gas or combine-cycle turbines with an average capacity of 200-500MW.

Electricity generation at such scales will eventually require further infrastructure investments from the government or perhaps (once again) private sector participation on the current transmission system. Then, once more, the country will have to compromise its assets (the left of its electricity infrastructure or CFE), therefore, more risk and most provably falling in vicious cycle of continuous indebtedness of the country and the loose of Mexico's sovereignty over its assets and energy sources.

Coming back to mention the risk of fuel supply and emission of pollutants from burning fossil fuels, also compromise the sustainability of the electricity industry and the economy of the country. This puts renewable energy in a better position; unfortunately, the renewable energy topic does not have enough attention from the government. The uncertain political situation and the resistance at high governmental levels due to the high cost that diversification strategies imply and the logic is to make electric energy cheaper.

However, private electricity generators can play an important role; their technology choice can be pushed from the legal framework or market mechanisms that will enhance the development of renewable energy and eventually reducing the cost of electricity production. However, reducing electricity prices does not seem to be the interest of the private sector but governments. Also CFE as a public institution looks for providing public services and social benefits; in contrast the private sector looks for profit.

Yet, the problem to satisfy the increasing electricity demand is still uncertain, since the state facility (CFE) halt new investments on electricity generation, the hope for increasing electricity generation is on private generators. As private electricity producers are key actors for the development of electricity generation, therefore their technology choice will result on the sustainability of the electricity industry.

7 Conclusion

- The government has currently two main problems: 1) to increase its electricity generation; 2) to ensure the sustainability of its electricity industry.
- The private sector can solve the problem of electricity generation, but the government must attend to social, economic and environmental benefits.
- Diversification is a good strategy for a sustainable electricity industry, because it will avoid dependence on a few sources. At the same time, the environmental pollution will be halted.
- Small-scale projects (quality of renewable energy) provides more local employment. A difference towards large-scale-technologies; investments on transmission structure would be less than the required by large-scale electricity generators.

- It has been proved that private electricity generators are willing to utilize renewable energy systems, however, more attractive market mechanisms should be developed for them. Once again, this can be connected to the legal framework or lending institutions, as well as the consumers.
- To enhance further private participation on more sustainable energy source, attractive market mechanisms should be developed for them.
- The lack of interest from the governmental sector or its political bodies is reflected on its political agendas. In none of the electricity initiative mentions inclusion of renewable energy system into the legal framework.
- Action plan or clear guide lines for the development of renewable energy should be included in the legal framework. The point is that regulations should be instruments to facilitate the development of long term energy policies that should include renewable energy. Mention of them will not be enough, mechanisms has to be develop for them.
- If market mechanisms favor the development of renewable energy technologies, development of these technologies will be slow. A good sample of technology development is the case of natural gas turbines that let to technology competition, and made production cost lower, which is the goal of governments for providing affordable public services.

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Acronyms:

BLT	Build, Lease and Transfer	
CFE	Federal Electricity Commission	Comisión Federal de Electricidad
CRE	Energy Regulatory Commission	Comisión Reguladora de Energía
SEN	National Electricity System	Sistema Eléctrico Nacional
Pemex	Petróleos Mexicanos	Petróleos Mexicanos
CONAE	National Energy Efficiency Commission	Comisión Nacional para el Ahorro de Energía
COFER	Advisory Council for the Promotion of Renewable Energy	Consejo Consultivo para el Fomento de las Energías Renovables en México
COSEN	Centre of Operations for the National Electrical System	Centro de Operación del Sistema Eléctrico Nacional
DOE	[United States] Department Of Energy	
DOF	Official Gazette of the Federation	Diario Oficial de la Federación
ESB	Environmental and Social Benefits	
FIDE	Electrical Energy Savings Trust	Fideicomiso para el Ahorro de Energía Eléctrica
GEF	Global Environment Facility	
IEA	International Energy Agency	
IPP	Independent Power Producer	Productores Independientes de Energy
LGEEPA	General Law on Ecological Balance and Environmental Protection	Ley General del Equilibrio Ecológico y la Protección al Ambiente
LyFC	Luz y Fuerza del Centro	Light and Power Company of the Center
LSPEE	Public Electricity Utility Law	Ley del Servicio Público de Energía Eléctrica
NGO	Non-Governmental Organization	
NOM	Mexican official standards	Norma Oficial Mexicana

OECD	Organization for Economic Cooperation and Development	
OLADE	Energy Sector Development In Latin America And The Caribbean	Organización Latinoamericana de Energía.
PIE	Independent Energy Producer	Productor Independiente de Energía
R&D	Research and Development	
SUTERM	Union of Mexican Electricity Workers	Trabajadores Electricistas de la República Mexicana
UNFCC	United Nations Framework Convention of Climate Change	
USAID	United States Agency for International Development	