



# SE4JOBS CASE STUDY

## MEXICO

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in the MENA Region”

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## Abstract

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This study has been produced on behalf of the **Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH**, through its regional project **RE-ACTIVATE** (“**Employment Promotion through Renewable Energy and Energy Efficiency in the Middle East and North Africa**”) in the scope of the SE4JOBS project (“Sustainable Energy for Jobs”).

RE-ACTIVATE is working on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ) to help develop markets for employment-intensive renewable energy (RE) and energy efficiency (EE) applications in the countries of the MENA region.

SE4JOBS was launched as a collaborative effort and working platform of several GIZ projects dealing with different aspects of sustainable energy and socio-economic development promotion. RE-ACTIVATE serves as a coordinator and “secretariat” of the project.

Several GIZ sector projects have been actively involved in SE4JOBS, specifically those working on “Sustainable Economic Development”, “Innovative Approaches of Private Sector Development”, and “Employment Promotion in Development Cooperation”.

The project has been supported by a consortium of adelphi, a Berlin-based think tank and public policy consultancy for climate, environment and development issues, and the Centre for Environmental Policy Research (FFU) of the Free University of Berlin (FU).

SE4JOBS aims to identify and assess available worldwide experience and good practices in developing and emerging countries on how to strengthen the link between socio-economic development and sustainable energy. The focus is on employment and value creation.

The goal is to support international know-how exchange and policy dialogue by offering a set of specific, application-oriented instruments and recommendations that help policy makers and planners to develop better approaches and institutional settings for an optimal valorisation of the socio-economic benefits of sustainable energy applications while adapting them to the specific needs and conditions of their countries and organisations.

The following key deliverables have been produced in the framework of SE4JOBS:

- A set of good-practice case studies assessing in greater analytical depth and according to a single methodology the specific approaches and trajectories of six selected global front-running countries in Asia, Africa, and Latin America.
- The creation of an application-oriented toolbox based on the results of these studies as well as on available global experiences in this regard, including from MENA.
- A set of capacity building and training modules allowing for the targeted dissemination of the findings and the conclusive strengthening of local stakeholders.

A series of national and international outreach activities and expert workshops was organised by RE-ACTIVATE throughout 2015. Participants mainly included government representatives, technical experts, and practitioners from international organisations who provided insights and inputs that proved in fact instrumental for the success of the project.

These meetings allowed for the first-hand presentation of intermediary results, the collection and integration of comments and suggestions and the consequential refining of the SE4JOBS products. They also permitted an interactive exchange with local stakeholders, which moreover came at an auspicious moment as many of the involved countries are currently in the process of scaling up their RE/EE deployment, often in conjunction with ambitious industrial development and job creation schemes. The outcomes of these exchanges could therefore be used to support and enrich discussions and decisions on the ground.

The authors of the study are Klaus Jacobs and Holger Baer from the FFU. The text was re-viewed by Steffen Erdle from RE-ACTIVATE as well as by GIZ experts working in Mexico. Proofreading was done by Malte Forstat.

All contributions received in this context are gracefully acknowledged.

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## Abbreviations

<b>BAU</b>	Business as Usual
<b>CDM</b>	Clean Development Mechanism
<b>CENACE</b>	National Energy Control Centre - Centro Nacional de Control de Energía
<b>CERs</b>	Certified Emissions Reductions
<b>CFE</b>	Federal Electricity Commission - Comisión Federal de Electricidad
<b>CICC</b>	Inter-Ministerial Commission on Climate Change - Comisión Intersecretarial de Cambio Climático
<b>CNE</b>	National Energy Council - Consejo Nacional de Energía
<b>CONUEE</b>	National Commission for the Efficient Use of Energy - Comisión Nacional para el Uso Eficiente de la Energía
<b>CRE</b>	Energy Regulatory Commission - Comisión Reguladora de Energía –
<b>ENTEASE</b>	National Strategy for Energy Transition and Sustainable Use of Energy - La Estrategia Nacional de Transición Energética y Aprovechamiento Sustentable de la Energía
<b>FIDE</b>	Electricity Savings Trust - El Fideicomiso para el Ahorro de Energía Eléctrica
<b>IADB</b>	Inter-American Development Bank
<b>IFC</b>	International Finance Corporation
<b>INFONAVIT</b>	Institute for the National Workers' Housing Fund - Instituto del Fondo Nacional de la Vivienda para los Trabajadores
<b>LAERFTE</b>	Law on the Use of Renewable Energies and Financing of Energy Transition - La Ley para el Aprovechamiento de las Energías Renovables y el Financiamiento de la Transición Energética
<b>NAFIN</b>	National Development Bank - Nacional Financiera
<b>NAMA</b>	Nationally Appropriate Mitigation Action
<b>PEMEX</b>	Mexican Petroleum - Petróleos Mexicanos
<b>PRONASE</b>	National Programme for the Sustainable Use of Energy - Programa Nacional para el Aprovechamiento Sustentable de la Energía
<b>SENER</b>	Ministry of Energy - Secretaría de Energía
<b>SEMARNAT</b>	Ministry of Environment and Natural Resources - Secretaría de Medio Ambiente y Recursos Naturales
<b>SEP</b>	Ministry of Public Education - Secretaría de Educación Pública
<b>SWH</b>	Solar thermal water heating and cooling
<b>UNFCCC</b>	United Nations Framework Convention on Climate Change
<b>WB</b>	World Bank



# 1. OUTCOMES

## 1.1. FOCUS OF THE CASE STUDY

This study focuses on the deployment of wind and solar energy as well as on policies to foster energy efficiency in Mexico. In terms of installed capacity, Mexico is still a small, albeit rapidly growing, market for both wind and solar energy. It is an interesting case, as much of the installed RE capacity (for electricity generation) has been created outside of the market. The recent reforms of the energy and electricity sector, including the introduction of tradable Clean Energy Certificates (that will come into effect in 2018) are expected to drive investments and accelerate the deployment of RE in Mexico. Additionally, the proximity to the US market could become another factor in supporting the development of domestic manufacturing capacities and employment in the sustainable energy sector.

## 1.2. RENEWABLE ENERGIES IN THE MEXICAN ENERGY SYSTEM

### 1.2.1. Sources of renewable electricity production

The total electricity production of renewables in Mexico is – like in many other countries – dominated by large-scale hydroelectric power plants. The figure below also shows that large-scale hydroelectric capacity in Mexico has grown only slowly over the last few years. The growth in the RE generation capacity in Mexico primarily stems from other sources of renewable electricity, mostly wind power.

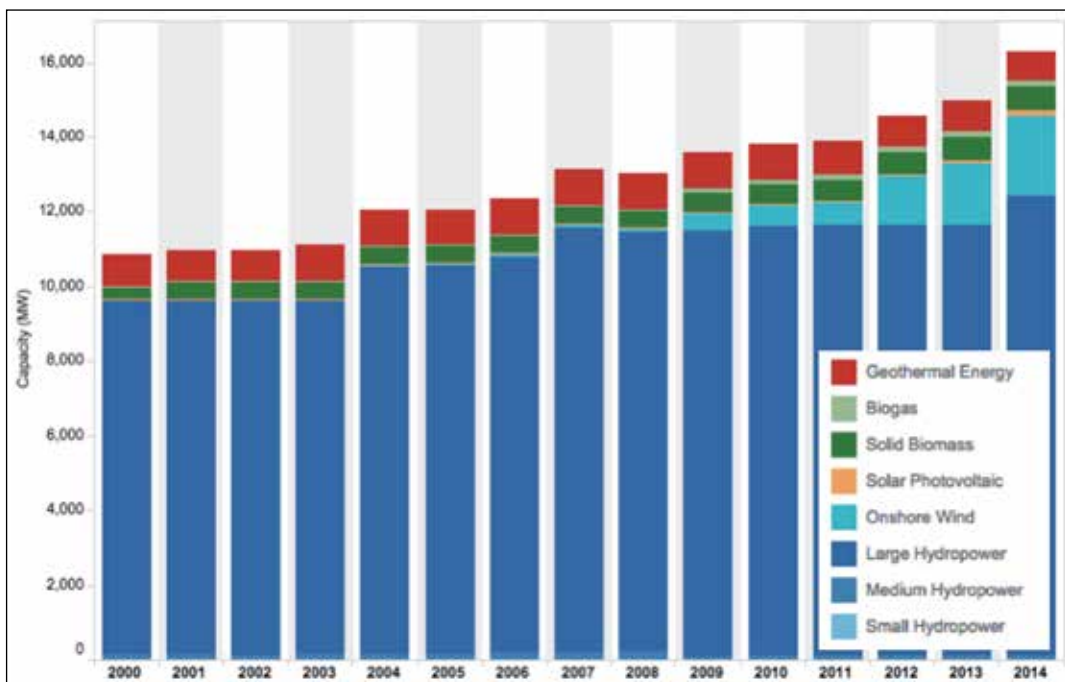
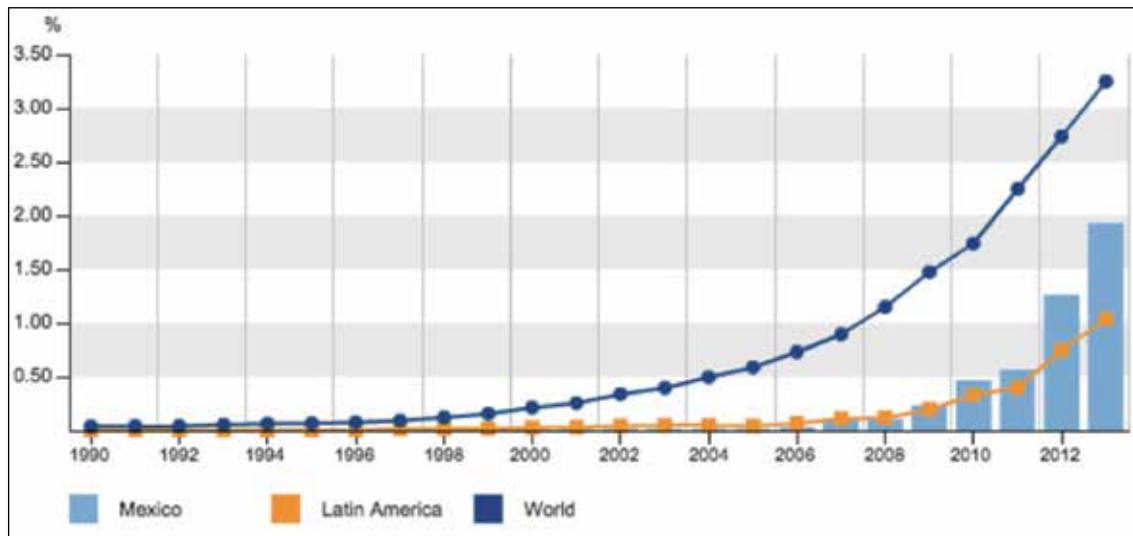


Figure 1: Installed renewable energy capacity, 2000-2014, in MW

Source: (IRENA, 2015b)

When looking at the installed capacity for wind and solar power in Mexico, one has to emphasise the time lag between the initial investments in new capacity and the time when these are connected to the grid and recorded in the statistics. Mexico has seen over US\$2.1 billion of new clean energy investments in 2014 – the overwhelming majority of which, namely US\$1.8 billion (out of a global total of US\$80 billion), was invested in wind power. US\$234 million were invested in solar PV power (**Bloomberg New**

Energy Finance, 2015; FS-UNEP Collaborating Centre, 2014). By international comparison, Mexico is still far below the global and Latin American average of installed capacity from wind and solar PV. However, as the chart below suggests, the rate of growth in both sectors is fast.

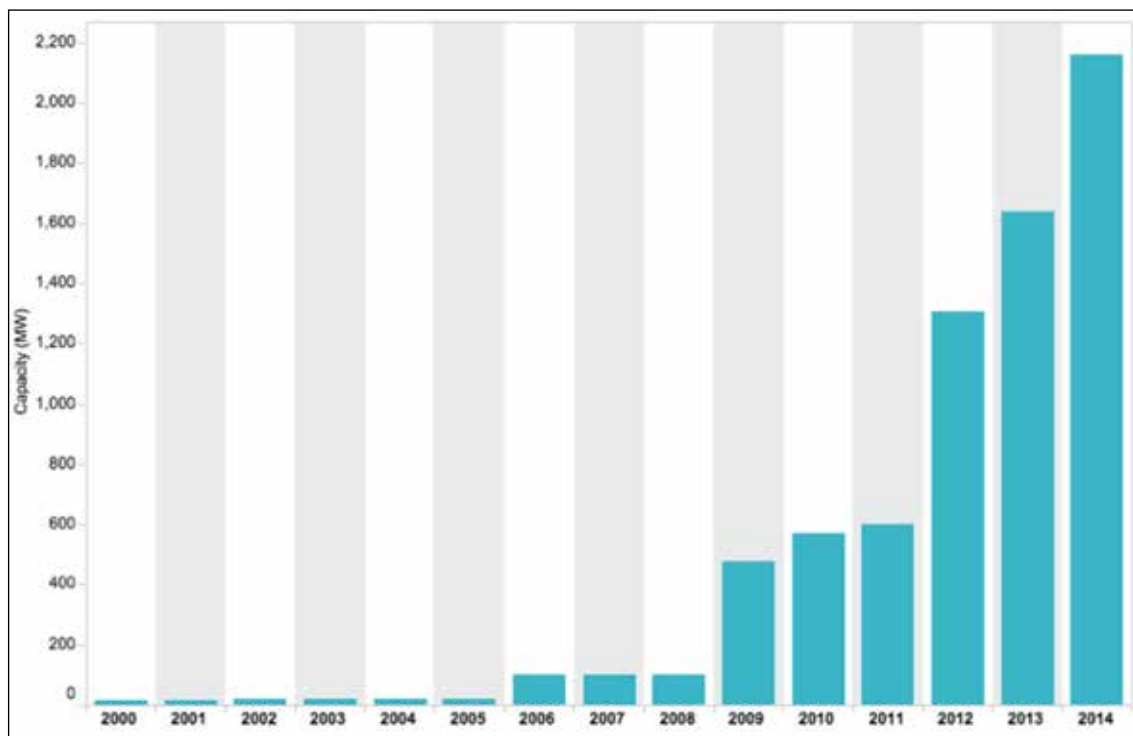


**Figure 2: Share of wind and solar in power production in Mexico, in %, compared to Latin America and the world average, 1990-2013**

Source: (World Energy Council, 2015)

### 1.2.1.1. Wind Power Development in Mexico

The Mexican market for wind power has only kicked off very recently, but thanks to the favourable natural conditions, the project pipeline is significant. The currently installed capacity is concentrated in the wind-rich state of Oaxaca, which has a very high share of self-supply projects (**New Energy Connections, 2014, p. 14**). Until 2014, a total of 2.2 GW had been grid-connected. Capacity additions last year alone amounted to around 600 MW.

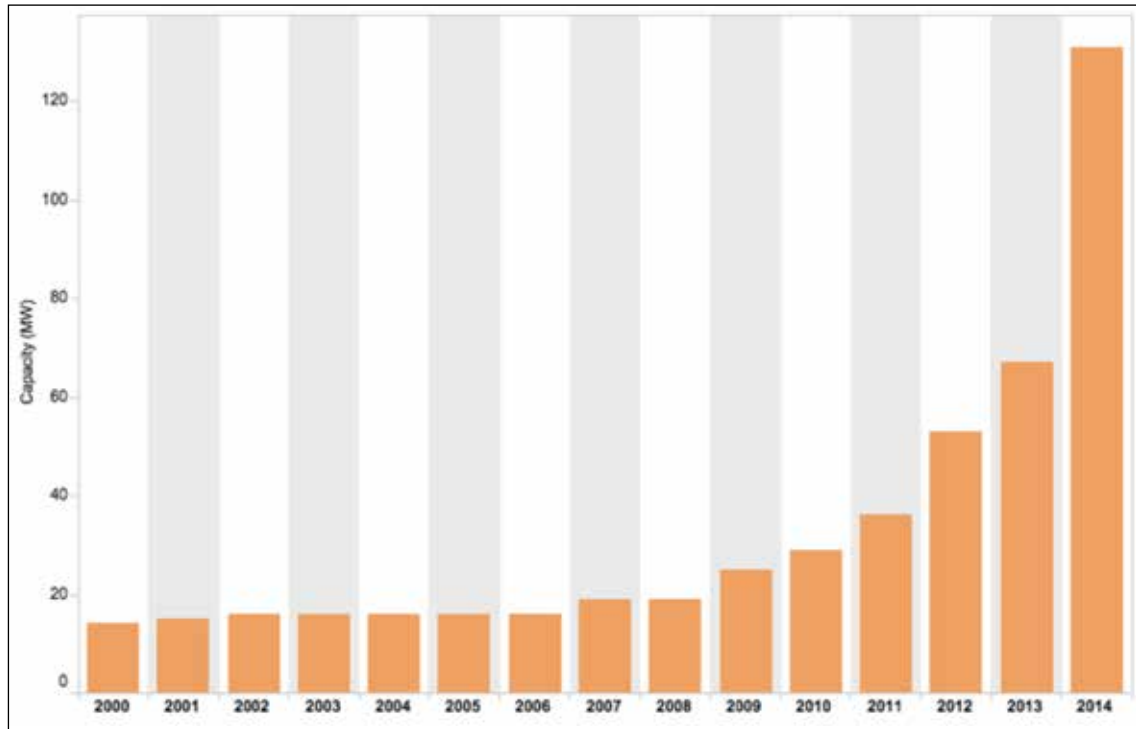


**Figure 3: Installed Wind Power Capacity in Mexico, 2000-2014, in MW**

Source: (IRENA, 2015b)

### 1.2.1.2. Solar PV dower development in Mexico

The Mexican market for solar PV electricity is still small by international comparison, with an installed solar PV capacity of 131 MW. Other sources, however, say that in 2014 alone, PV projects totalling 434 MW were awarded (**New Energy Connections, 2014, p. 15**). With that upward dynamic and falling system prices, new business models are emerging that do not require public subsidies or other incentives (**REN21, 2014, p. 50; Roselund, 2013**).



**Figure 4: Installed PV capacity in Mexico, 2000-2014, in MW**

Source: (IRENA, 2015b)

## 1.2.2. Development of solar thermal water heating in Mexico

Mexico constituted the 11<sup>th</sup> largest market worldwide for solar thermal water heating (SWH) in 2014 in terms of installed capacity as well as with regard to capacity added (REN21, 2015, p. 67). What makes the Mexican market unusual is that it is not dominated by one or two types of SWH technology like in most other countries (see figure below).

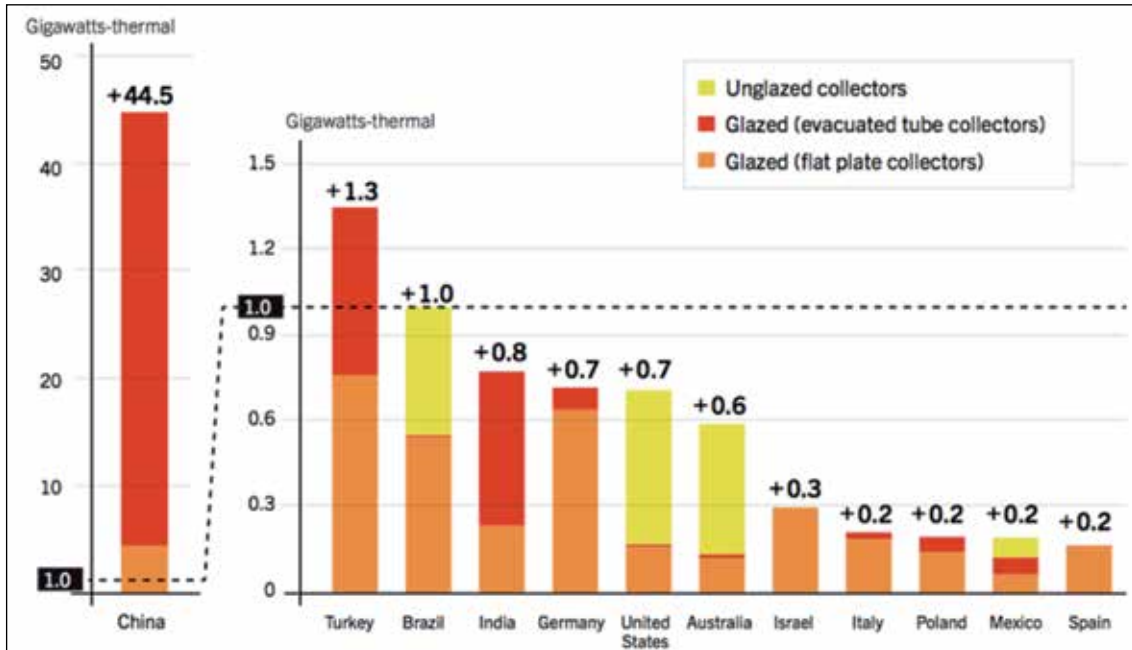


Figure 5: SWH capacity additions, top 12 countries worldwide, 2013, in GW<sub>th</sub>

Source: (REN21, 2015, p. 67)

The worldwide SWH capacity installations are dominated by the gigantic Chinese market, so it is not surprising that the Mexican capacity per capita is well below world average. However, it is on a par with the Latin American average (dominated by the strong Brazilian market) and per capita installations are higher in Mexico than in the neighbouring United States, for instance.

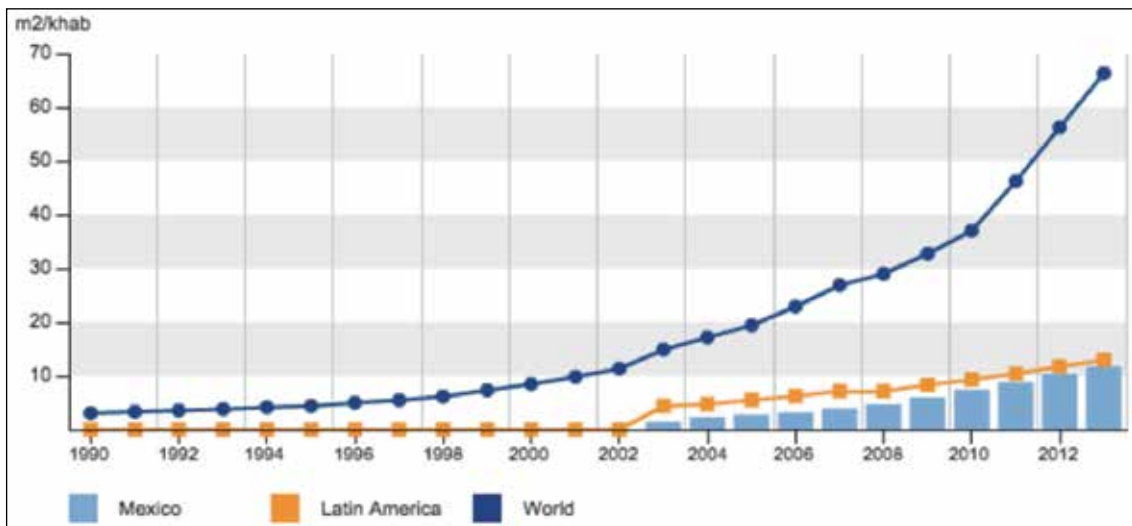
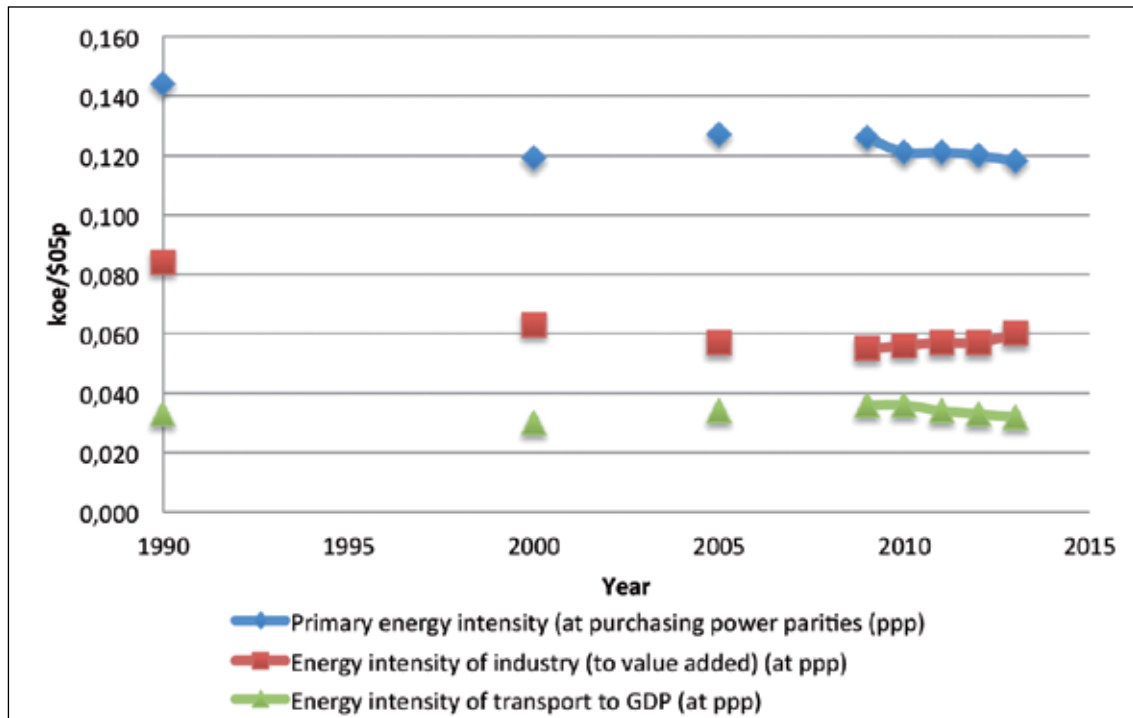


Figure 6: Solar thermal water heaters in Mexico, in m<sup>2</sup> per thousand inhabitants, in comparison to Latin America and the world average, 1990-2013

Source: (World Energy Council, 2015)

### 1.3. THE MARKET FOR ENERGY EFFICIENCY IN MEXICO

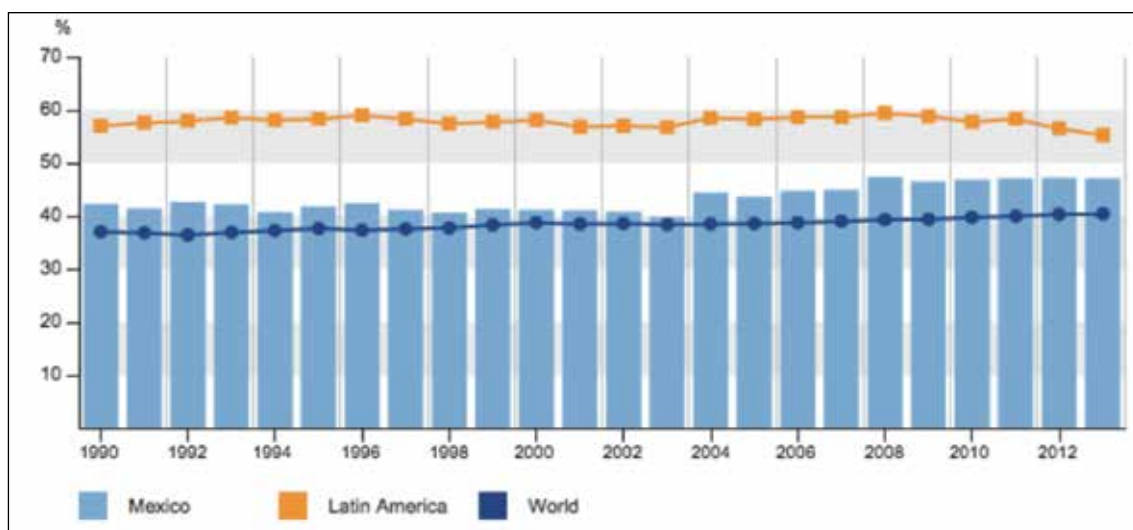
Overall, Mexico has performed quite well over the last decades in terms of its energy efficiency and represents a significant market for EE investments. The country's primary energy consumption per capita is 16% below the world average, and its electricity consumption is even 27% below the world average and ipso facto four times lower than per capita consumption in OECD countries (World Energy Council, 2015).



**Figure 7: Development of primary energy intensity, energy intensity of industry and transport in Mexico between 1990 and 2013 in koe/\$05p**

Source: (World Energy Council, 2015)

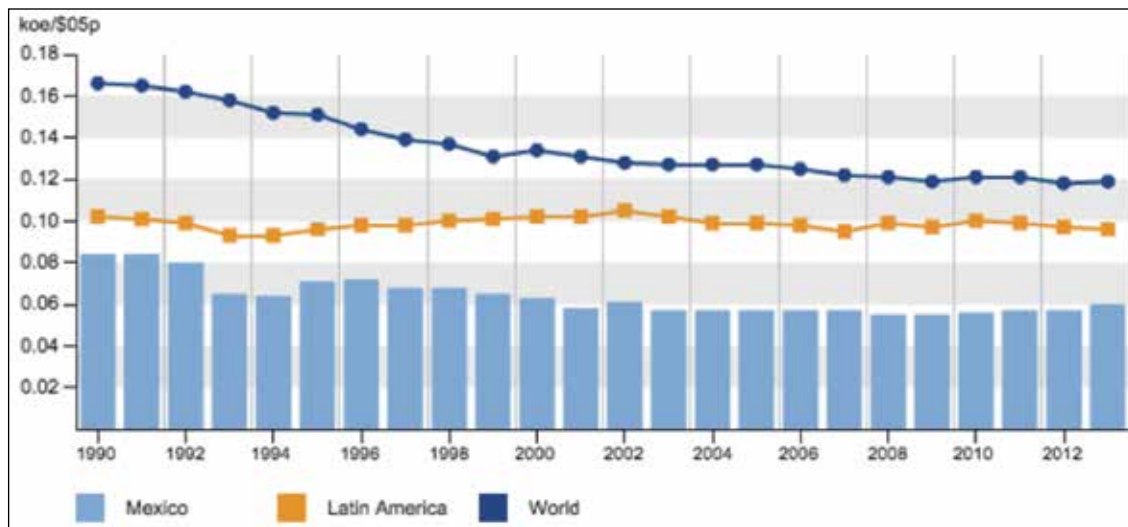
The efficiency in electricity generation in Mexico is above the global average and has steadily improved over time. It is, however, lower than the Latin American average. One reason why energy efficiency in power generation is higher in most other Latin American countries than in Mexico is the higher share of hydroelectricity in their supply mixes.



**Figure 8: Efficiency of Mexican power generation, in %, in comparison to Latin America and the world average**

Source: (World Energy Council, 2015)

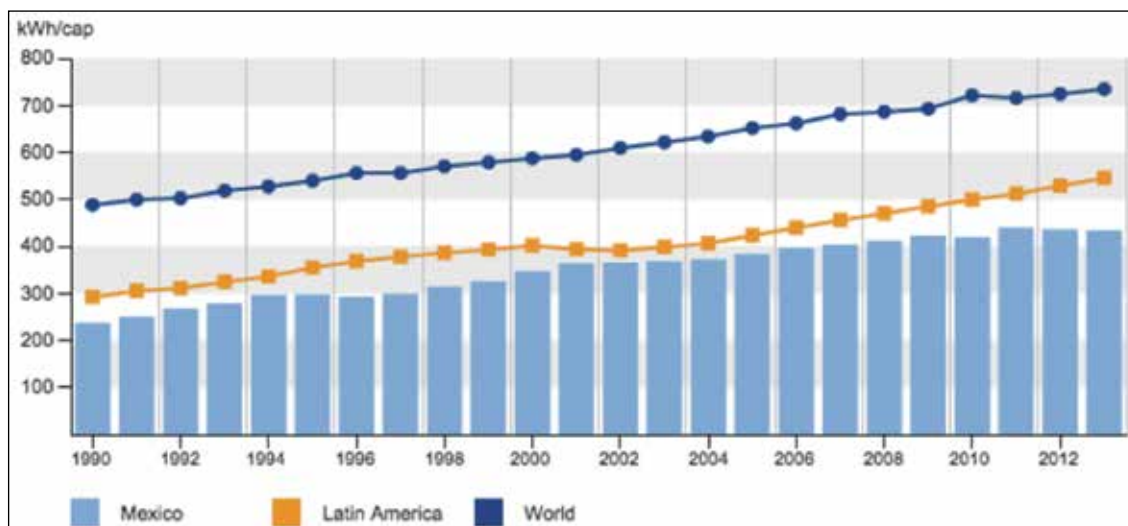
The development of energy intensity in Mexican industry shows both improvements between 1990 and the early 2000s, but also stagnation since then. Within industry, there are variations – for example, the chemical industry achieved annual improvements of about 6% in energy intensity between 2000 and 2010.



**Figure 9: Energy intensity of Mexican industry in comparison to Latin America and the world average, 1990-2013, in koe/\$05p**

Source: (World Energy Council, 2015)

Data on electricity consumption in Mexican households shows that per capita consumption has increased less than in other Latin American countries and is still far below the world and regional average. Part of the explanation for this is the mixed economic development of the country since 2000 (see section 2.4).



**Figure 10: Electricity consumption per capita of Mexican households in comparison to Latin America and the world average, 1990-2013, in kWh per capita**

Source: (World Energy Council, 2015)

In spite of this generally quite positive performance, the analysed literature does not provide specific data on the overall size of the Mexican market for energy efficiency, nor on the employment effects recorded in the various composite sectors.

## 1.4. DOMESTIC VALUE ADDED AND EMPLOYMENT

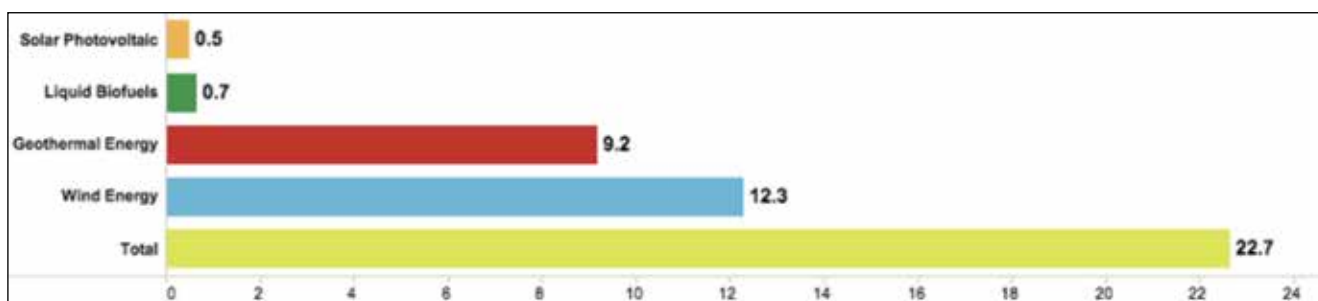
### 1.4.1. Investments in renewable energies

While the currently installed RE generation capacity is still relatively small, the country has become a destination of large investments in RE projects, which will become grid-connected in the next few years. In 2014 alone, Mexico saw RE investments of over US\$2 billion, which marked an increase of 19% over the previous year. 86% of these investments went into wind power. The 12% (US\$234 million) invested into solar PV marked a new record in Mexico, and about half of this sum (US\$105 million) went into small-scale solar installations (**FS-UNEP Collaborating Centre, 2015, p. 28**).

The increased investments are in line with the country's growing attractiveness as an RE market according to Ernst & Young. Key to this were the electricity sector and policy reforms that provide for greater security for investors (**Ernst and Young, 2015, p. 21**).

### 1.4.2. Employment in renewable energies

Data on the employment effects of renewable energies in Mexico is hard to find. The Ministry of Energy estimates that at least 135,000 positions will be required in total to implement the country's energy policy, 80% of which would be for technicians (**SENER, SEP, CONACYT, 2015**). The employment figures reported in IRENA's RE employment database show a tremendous dynamic, as the reported figures for wind and solar energy employment increased more than fivefold over the data reported for 2013. According to this data, about 23,000 people are directly employed in RE in Mexico – more than half of them (over 12,000) in wind power. Employment in geothermal power is also relatively high with 9,000 jobs, but the development of the sector is stagnating. With 500 jobs, employment in solar power is still very low, but accelerating fast.



**Figure 11: Employment in RE in Mexico (2015), in thousands of full-time jobs**

Source: (IRENA, 2015b)

While the Mexican solar market itself is still very small, from an employment perspective, it is noteworthy that foreign PV companies have in the last years heavily invested in establishing new PV manufacturing capacities in Mexico in order to benefit from the low local labour costs and the rapidly growing NAFTA markets. Solar PV exports from Mexico to the United States have grown by 26% between 2009 and 2013, from US\$349 million to US\$439 million (**Platzner, 2015**). After the punitive tariffs on PV modules from China put in place by the US government, it is more likely that Chinese companies, such as JA Solar, will build up additional capacities in Mexico (**Meza & Diaz Lopez, 2014**). Other examples include the US-based company SunEdison and Taiwanese Foxconn investing in a plant with the capacity to manufacture 350 MW per year (**Meehan, 2015**). Similarly, 2015 saw international power companies, such as SunPower and AES, starting joint ventures with Mexican companies to develop large-scale wind and solar power projects (**Ernst and Young, 2015, p. 18**).

The analysed literature suggests that these currently strong investments in PV production capacity for the US market are mainly driven by US trade policy towards PV modules from China, regardless of the fact that there is also a growing interest in the Mexican market. It is also not a one-way street as other PV manufacturers – such as the Japanese Panasonic or the Spanish Siliken – have recently closed their factories in Mexico (**Meza & Diaz Lopez, 2014**). The analysed literature does not hint at similar developments in other RE sectors.



## 2. MEXICO'S FRAMEWORK CONDITIONS

### 2.1. NATURAL CONDITIONS

#### 2.1.1. Wind power

Mexico is an excellent site for wind power. Its estimated wind power potential is around 50 GW with capacity factors as high as 40-50% according to SENER (**IRENA, 2015c, p. 37**). Given its favourable natural conditions, the state of Oaxaca has become a national centre for wind investments. A full wind energy map for Mexico is included in the annex (section 8.2).

#### 2.1.2. Solar energy

Solar irradiation in Mexico is on average 60% higher than in Germany, and given these excellent natural conditions, it is expected that Mexico can become a lead market in Latin America (**Ernst and Young, 2014**). The best conditions can be found in the states of Baja California Sur, Yucatan, and Sonora, which have also recorded the highest investments so far (**Roselund, 2013**). The country's potential for solar power is estimated by SENER to be 5,000 GW, and thus a hundred times the potential of wind power (**IRENA, 2015c, p. 37**). A detailed solar irradiation map for Mexico is included in the annex (section 8.3).

### 2.2. DEMOGRAPHIC INFORMATION

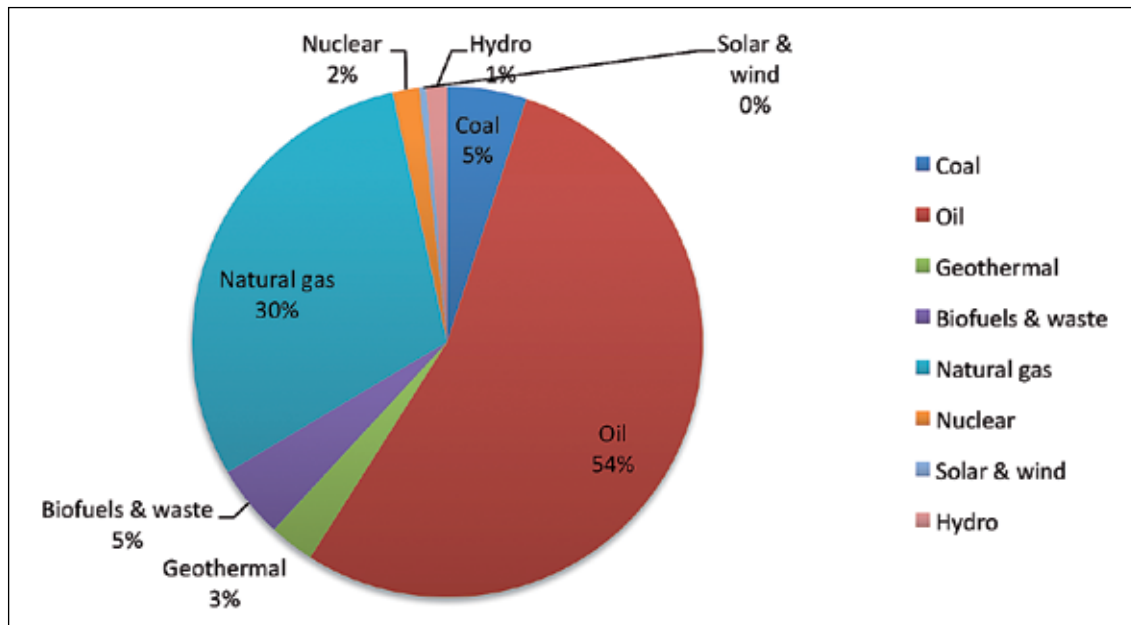
The growing demand for energy in Mexico is fuelled by a number of factors. Central among them are the fast increase in population size (growing from 103 million in 2000 to 122 million in 2013), the large share of young people (33.7 million Mexicans being under 15 years old) and the relatively sustained periods of economic growth in recent years (**OECD, 2014; World Bank, 2015**). Given these trends, it is not surprising that per capita consumption of energy has increased from 1400 kgoe in 2000 to 1588 kgoe in 2012 (**World Bank, 2015**).

An important factor to take into account are persistent pockets of income inequality in the country, with the bottom 60% of society earning 27% of incomes and the lowest 20% only 5% (2012) (**World Bank, 2015**). In order to reach these parts of society, policy must factor in the ability of low-income households to invest in future-oriented energy applications.

## 2.3. ENERGY SYSTEM

### 2.3.1 Structure and key properties

The Mexican energy supply is still largely based on fossil fuels. While coal has a relatively small share, oil accounted for more than half of it (54% in 2013)<sup>(1)</sup>. Natural gas accounted for about a third and the different sources of renewable energy added up to about 10%.

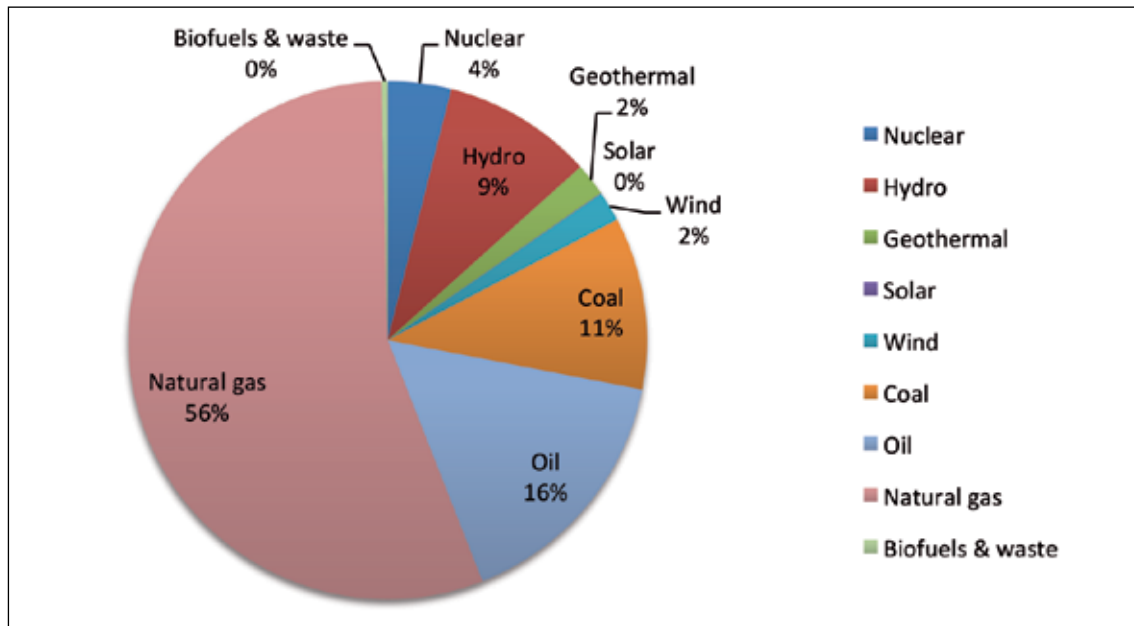


**Figure 12: Total primary energy supply in Mexico, by source, as share of supply**

Source: (IEA, 2014c, p. 487 f.)

Electricity generation data for Mexico shows that the supply over the last decade has increased by about a quarter and is still being dominated by fossil sources. Over the last decades, natural gas has become the dominant source of electricity and in 2013 accounted for more than half of total generation (166 TWh / 56%). Natural gas is likely to even further increase its leading position in the Mexican electricity supply in the short and medium term, due to its abundance and relative cleanness (compared to oil and coal). This trend is fuelled by several factors: the availability of cheap natural gas supplies from the United States, the expansion of deep water gas exploration and hydraulic fracturing in Mexico itself and, additionally, the fact that the new Mexican Law on Energy Transition (soon to be in force) fosters combined heat and power plants. The second and third largest sources of electricity are oil (48 TWh / 16%) and coal (32 TWh / 11%). Nuclear power accounted for a share of 4% (11.8 TWh). Of the renewable sources of electricity, hydroelectricity has the largest share with 9% (28 TWh), followed by geothermal (6.1TWh / 2%), wind (5.8TWh / 2%) and solar power (0.1 TWh / <1%) (IEA, 2014c, p. 487 f.).

(1) It should be also pointed out, that of the 150 million toe in Mexican oil production, nearly 45% (67 million toe) were exported in 2013 according to IEA data. See: <http://www.iea.org/sankey/#?c=Mexico&s=Balance>



**Figure 13: Gross electricity generation by fuel, in 2013, in TWh**

Source: (IEA, 2014c, p. 487 f.)

About two-thirds of electricity are currently produced by the state-owned Federal Electricity Commission (CFE). The share of privately produced electricity has reached 35%. There are six modalities through which electricity can be produced by private actors: for self-supply, through cogeneration, small power production, independent power production (IPP) as well as for the import and export of electricity (see **Ramírez-Camperos, Rodríguez-Padilla, & Guido-Aldana, 2013, p. 1098 f.**). With regard to the aforementioned 35% of private electricity supply, 23% are generated under the IPP modality, 6% as self-supply, 3% through cogeneration and 3% for export (**Clean Energy Information Portal, 2014**).

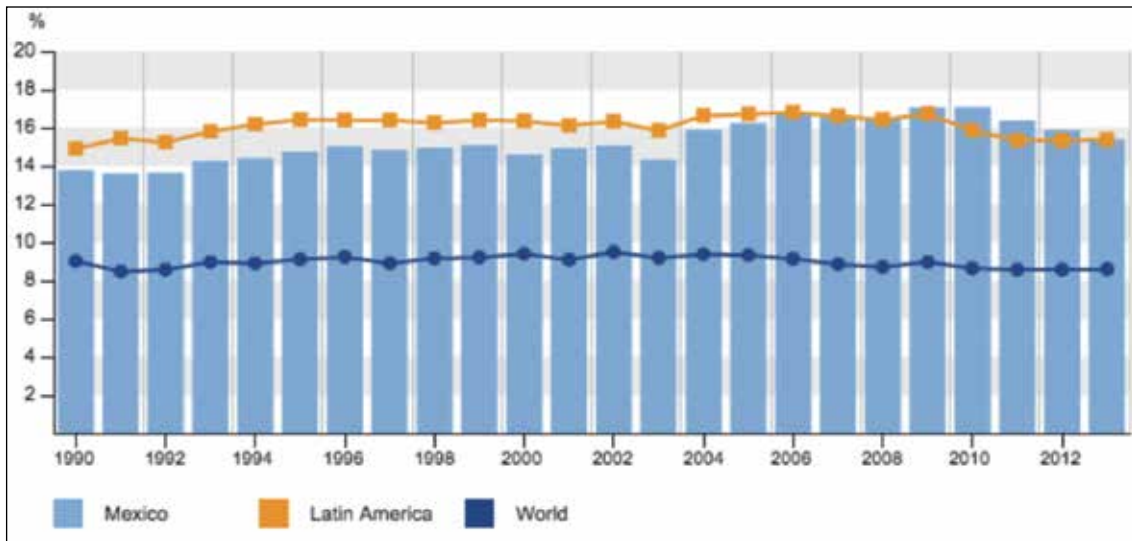
It is noteworthy that for RE investments, the share of the self-supply modality (whereby power is not sold to the CFE but used internally) is much greater. To illustrate its importance for RE power: Under the wind power investment component of the Special Programme for Renewable Energy, less than 100 MW were pledged to be installed by the CFE, about 500 MW under the IPP modality, but more than 1,600 MW under the self-supply mode. Beyond that, more than 1 GW were envisioned under the export modality – all located in Baja California and hence close to the US market (**Government of Mexico, 2009**).

### 2.3.2. Electricity infrastructure

Mexico provides nearly universal access to electricity, covering 97,6% (2011) of the population (**REN21, 2014**). The parts of the population not connected to the grid are mostly indigenous communities. The grid has so far been solely owned and managed by the state-owned CFE (and will continue to be so even after the energy sector reform of 2013). With the latter, however, private companies will now also be able to participate in the development of transmission capacity according to the plans of the newly established grid operator CENACE. Expanding the electricity grid fast enough to allow for the transmission of variable renewable energy sources will remain a crucial success factor for RE market development, particularly for the wind sector (**Global Wind Energy Council, 2014**). In the summer of 2015, SENER published a 14-year programme (2015-2029) on the development of the National Electricity System (Programa de Desarrollo del Sistema Eléctrico Nacional)<sup>(2)</sup>.

(2) For more information, see <http://www.gob.mx/sener/acciones-y-programas/programa-de-desarrollo-del-sistema-electrico-nacional-8397>

One significant problem regarding the performance and reliability of the electricity grid is the high transmission and distribution losses (about 15% of the electricity generated) that are not so much due to the quality of the grid, but more to theft of electricity (see below). In that, Mexico is on a par with the rest of Latin America, but the losses are significantly higher than the world average.

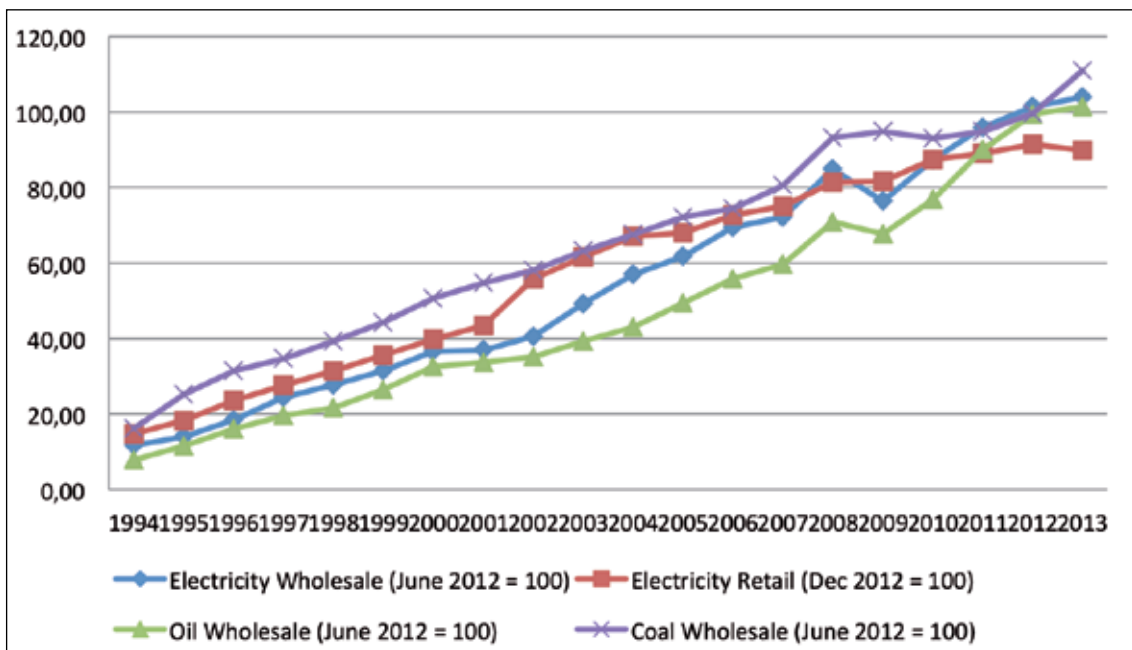


**Figure 14: Evolution of transmission and distribution losses in Mexico, Latin America and the world, 1990-2013**

Sources: (World Energy Council, 2015)

### 2.3.3. Electricity prices

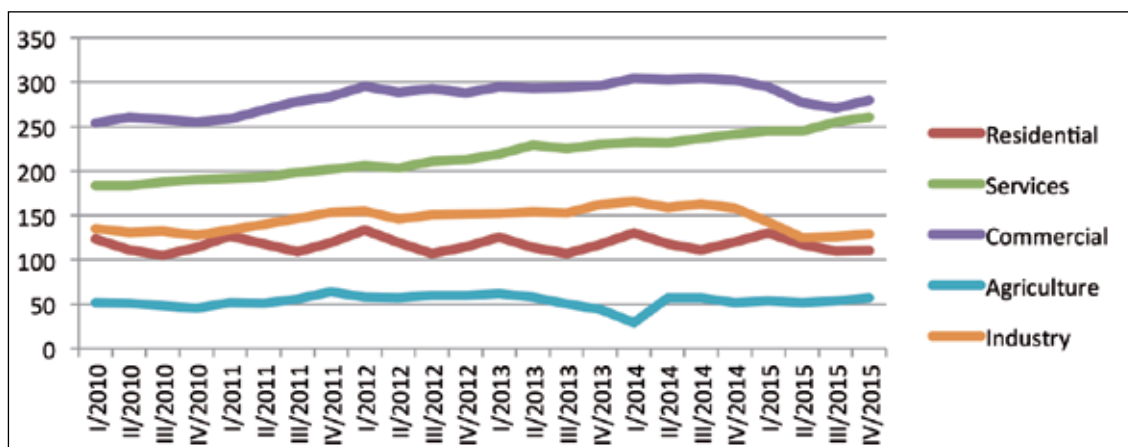
The development of energy and electricity prices (wholesale as well as retail) in Mexico over the last two decades has been strongly correlated, and they have shown a 6- to 13-fold increase between 1994 and 2013 (in current market prices). In some parts of the country, prices are up to a quarter above US electricity prices (Ernst and Young, 2014, p. 28).



**Figure 15: Indices of electricity and energy prices, Mexico 1994-2013 (IEA) (2012 = 100)**

Source: Own compilation based on IEA data: (IEA, 2014b, p. 189)

After the reform of the electricity market in 2013, electricity tariffs have mostly levelled out – and for some groups they have even slightly declined (figure below). This is not only affecting consumers of energy and electricity, but it is also contributing to the cost competitiveness of renewable sources of energy. Electricity prices in Mexico are regulated by the CFE, and tariffs paid by different consumers vary significantly as the figure below illustrates. Electricity tariffs for households (“domestic” in the figure) and the agricultural sector are benefiting from subsidies by the government and are therefore much less expensive and more stable compared to the tariffs paid by consumers in the services, commercial and industrial sectors (**Ramírez-Camperos et al., 2013, p. 1100**).

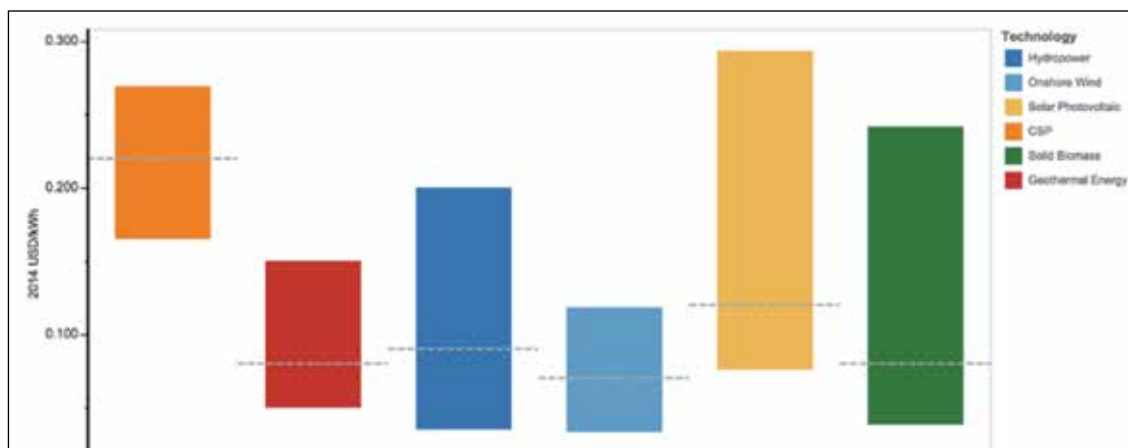


**Figure 16: Average electricity tariffs in Mexico for different groups of electricity consumers (I/2010–IV/2015), in US cents/kWh**

Source: Sistema de Información Energética <sup>(3)</sup>

RE investments along with CHP (cogeneration) are particularly attractive for commercial enterprises and service sector consumers, as their electricity prices are the highest in Mexico. For these, it is an option to use the self-supply modality to become independent of the constantly rising electricity tariffs in the Mexican power market.

Whereas electricity tariffs show a rising trend, the costs of generating power from renewable sources show a downward trend, and there are a number of examples for investments in RE by private investors that have been made without receiving subsidies. Examples are the wind power projects of Stipa Nayaa (74MW) and Zopiloapan (70MW) (**FS-UNEP Collaborating Centre, 2014, p. 41; REN21, 2013, p. 58**) (**Ernst and Young, 2014, p. 23**). Similarly, the Mexican Gauss Energia and Portuguese Martifer invested in a large 30 MW PV plant in Baja California (**Roca, 2013**). This trend is likely to continue and even to accelerate, as data on the levelised costs of electricity<sup>(4)</sup> from an increasing number of renewable sources is suggesting that they are close to reaching parity with conventional sources (see below).



**Figure 17: Levelised cost of electricity by technology in North America**

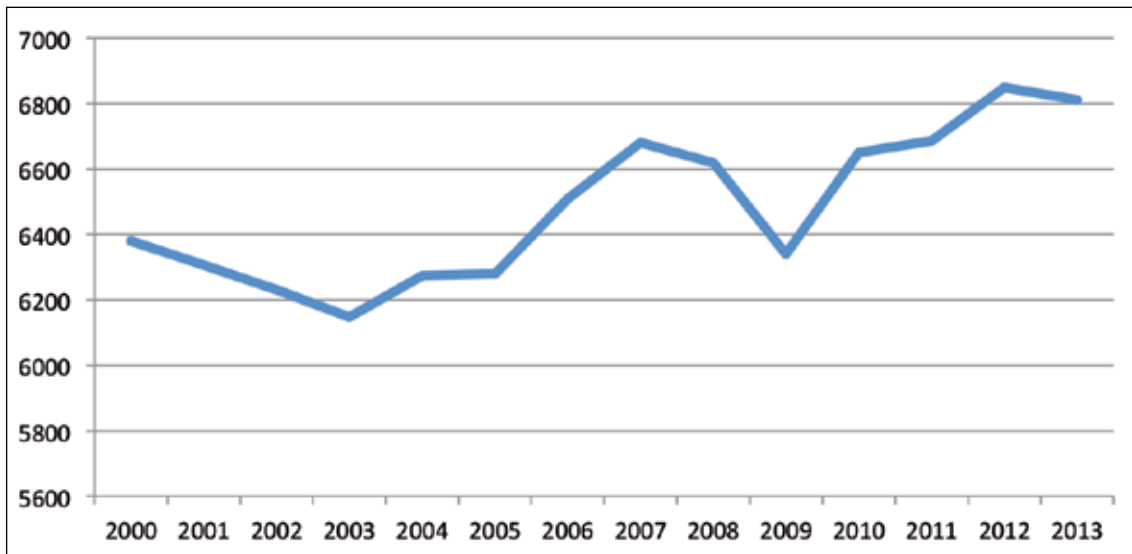
Source: (IRENA, 2015b)

(3) See <http://sie.energia.gob.mx/>

(4) Country-based estimates for levelised costs of electricity are not available.

## 2.4. ECONOMIC DEVELOPMENT

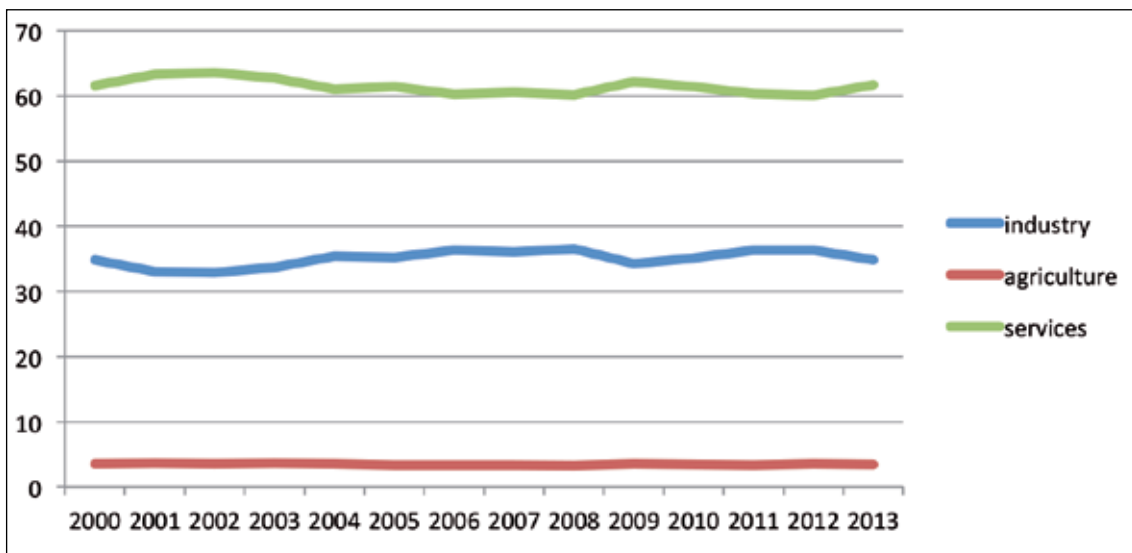
As a result of two economic recessions since 2000, per capita incomes in Mexico have only risen slowly in that time period (see below), and much less than in the previous decade.



**Figure 18: Adjusted net national income per capita in Mexico, in constant 2005 US\$, 2000-2013**

Source: (World Bank, 2015)

The by far largest economic sector in Mexico is services, accounting for slightly above 60% of GDP. The share of industry (around 35% on average) is high in comparison to most other countries, whereas the contribution of the agricultural sector (with 3.5% of GDP) is very low.

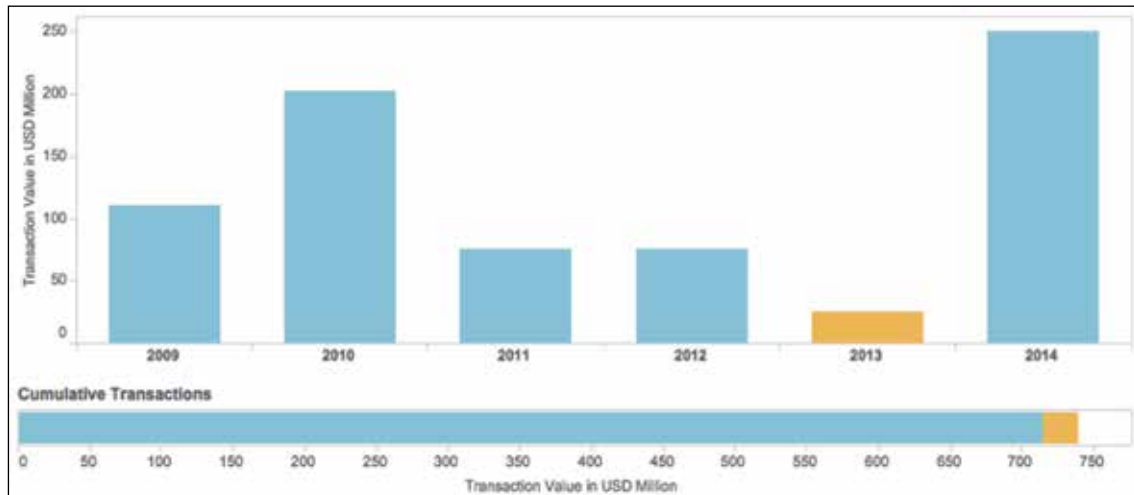


**Figure 19: Shares of economic sectors in the Mexican gross domestic product, in %**

Source: (World Bank, 2015)

## 2.5. FINANCIAL SYSTEM

Mexico's public development banks play an important role in providing the capital for investments in RE and EE. Beyond that, international sources of finance also play a role in this respect. As the figure below illustrates, international development finance institutions have provided US\$740 million for RE project finance between 2009 and 2014. The vast majority of this capital was provided for projects in wind power. Key financiers among them are the International Finance Corporation/World Bank, the Inter-American Development Bank, and the European Investment Bank.



**Figure 20: Renewable energy finance flows from development finance institutions**

Source: (IRENA, 2015b)

## 2.6. POLITICAL SYSTEM

The Mexican political system is federal. Energy policy is controlled by the national government with the publically owned energy (PEMEX) and electricity utilities (CFE). While their influence is likely to decrease after liberalisation, they will remain dominant actors in the market. Therefore, this case study focuses its analysis on the federal level.

## 3. POLITICAL STRATEGIES, ACTORS AND PROCESSES

### 3.1. GENERAL STRATEGIC FRAMEWORK FOR RE AND EE

The liberalisation of the electricity market started with the 1992 reform of the Public Electricity Services Act that aimed at opening up a market that was until then completely controlled by the CFE. Still, it took until 2000 for the first private electricity companies to effectively begin to participate in the market under power purchase agreements with CFE (**Ramírez-Camperos et al., 2013, p. 1097**). The initial reform aimed at a 70:30 share of the electricity generation market (70% for CFE and 30% for private producers).

#### 3.1.1. The Strategy on the Energy Transition and Sustainable Use of Energy and related medium-term implementation programmes

The 2008 Law on the Development of Renewable Energy and Financing the Energy Transition (LAERFTE) laid the groundwork for the Strategy on the Energy Transition and Sustainable Use of Energy (ENTEASE). It gives SENER the leading role in developing the strategy and in ensuring its implementation. Currently, the Law for Energy Transition is in the process of being enacted; it will set specific goals and objectives regarding EE, and different strategies and programmes will be derived from it to allow its implementation. This law complements the already enacted General Law for Climate Change, which sets national objectives regarding GHG mitigation. In order to implement the strategic goals for RE and EE policies, SENER has developed the medium-term Special Programme for the Development of RE as well as the National Programme for the Sustainable Use of Energy.

#### 3.1.2. The National Energy Strategy

The National Energy Strategy (NES) 2013-2027 aims at fostering economic growth while managing social inclusion and facilitating access to energy. The strategy pursues three objectives: making energy supply sustainable, using energy more efficiently and expanding supply to ensure security. It focuses on the entire energy sector and aims to create inter-linkages, for example by combining efforts in education, science, technology and innovation (strategic theme 17) or by outlining potentials for the integration of environmental and energy efficiency goals. For these themes, the strategy outlines possible lines of action and establishes responsibilities within the government.

#### 3.1.3. National Strategy on Climate Change and Special Programme on Climate Change

The National Strategy on Climate Change and its implementation plan – the Special Programme on Climate Change – were drafted by SEMARNAC and approved by the federal government represented by the Inter-Ministerial Commission on Climate Change (CICC). They outline priorities regarding adaptation to climate change and mitigation actions, and through the CICC they transfer the issue of climate change into other government ministries. The strategy also serves to coordinate measures with the state and municipal levels (see NAMBLA). However, the strategy or the special programme do not outline specific instruments or concrete policy measures.



## 3.2. KEY ACTORS AND THE INVOLVEMENT OF STAKEHOLDERS IN STRATEGY PROCESSES

**Ministry of Energy (SENER).** The central government agency in developing the country's energy strategy and coordinating its legal framework is the Ministry of Energy (SENER). SENER authors all long- and short-term strategies and oversees the expansion of the energy and electricity market through its regulatory bodies CRE and CENACE.

**Ministry of Environment (SEMARNAT).** The Ministry for Environment and Natural Resources (SEMARNAT) is the lead ministry for the National Strategy on Climate Change and is involved in the implementation and monitoring of a number of energy policy measures and objectives relevant for the purpose of this study.

**Federal Electricity Commission (CFE).** The state-owned Comisión Federal de Electricidad (CFE) retains a dominant position in the market even after the energy market liberalisation in the early 1990s and still is the dominant force in electricity generation with a share of over two-thirds (**Ramírez-Camperos et al., 2013, p. 1096 f.**). Until the 2013 energy policy reform, the CFE also held a monopoly in the transmission and distribution of electricity.

## 3.3. THE PROCESS OF STRATEGY DEVELOPMENT AND IMPLEMENTATION

### 3.3.1. Processes and capacities for strategy development in government

The strategies and their implementation programmes are each drafted by the respective lead ministry. SEMARNAT is in charge of the National Strategy on Climate Change; and SENER of the energy and energy efficiency policy strategies and programmes.

### 3.3.2. (Vertical/horizontal) integration of interests in strategy development

In 2005, the Inter-Ministerial Commission on Climate Change (CICC) was established as a platform to coordinate efforts among federal government ministries. The CICC is comprised of representatives from 13 ministries: in charge of Home and Foreign Affairs, Agriculture, Rural Development, Fisheries and Food, Communications and Transport, the Navy, Social Development, Tourism, the Economy, Public Education, Health, Energy, Environment and Natural Resources, plus the Treasury as well as the Presidency. The commission is chaired by the Ministry of the Interior and SEMARNAT.

### 3.3.3. Participation of non-governmental stakeholders in strategy development

Stakeholders participate in the planning and strategy processes through three institutions: the two advisory councils on RE and EE as well as the Inter-Ministerial Commission on Climate Change.

**Advisory Councils on RE and EE.** The two advisory councils on RE and EE, established by the Mexican government, are:

- the Advisory Council for the Development of Renewable Energy (Consejo Consultivo para las Energías Renovables) and
- the Advisory Council for the Sustainable Use of Energy (Consejo Consultivo para el Aprovechamiento Sustentable de la Energía).

Both councils are led by SENER and are tasked with the review and evaluation of the progress of implementing the state's energy policy. The composition of their membership differs significantly. The Advisory Council for the Development of Renewable Energy, for one, comprises a wide range of representatives from government, industry and civil society.

<b>Government Ministries</b>	Ministry of Finance and Public Credit	Ministry of Environment and Natural Resources	Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food
	Ministry of Economy	Ministry of Health	
<b>Government Agencies</b>	Federal Electricity Commission	National Commission for the Efficient Use of Energy	Energy Regulatory Commission
<b>Civil Society</b>	President of the Mexican Wind Energy Association	President of the Institute of Renewable Energy of Universidad Nacional Autónoma de México	Executive Director of the World Energy Council's Mexican Chapter
	President of the National Association of Solar Energy	President of the Mexican Network Bioenergy	Mexican Initiative for Renewable Energy

**Table 1: Membership of government ministries, state agencies and civil society representatives in the Advisory Council for the Development of Renewable Energy**

Source: Own depiction

The Advisory Council on the Sustainable Use of Energy, by contrast, is largely a scientific consultative body composed of six independent experts in the field of EE who are at the same time members of the Mexican "National System of Researchers" (Sistema Nacional de Investigadores). Both councils include a broad range of actors representing government ministries, state agencies, civil society and science, and thus insert many different perspectives into the development and implementation of RE and EE policies in Mexico.

**Participation in the Inter-Ministerial Commission on Climate Change.** The climate change strategy states that its review process shall be open to the public and allow it to provide input for its further development (**Government of Mexico, 2014a**). Beyond the core governmental membership, the commission welcomes the participation of representatives of civil society, businesses and academia to give testimony <sup>(5)</sup> on the implementation of climate change policy in their fields of expertise (**Government of Mexico, 2008**).

### 3.3.4. Institutions and capacities for implementation

**Energy Regulatory Commission (Comisión Reguladora de Energía, CRE).** The CRE is the main regulatory agency for the energy sector. It operates independently, but its members are named by SENER. The commission issues permits for energy generation, sets prices paid to RE producers and regulates the market between the Independent Power Producers (IPPs) and the state-owned companies operating in the electricity and gas markets.

**National Commission for the Efficient Use of Energy (CONUEE).** The commission is the government's regulatory body that monitors many of its energy efficiency policies, in general, and the implementation of the National Programme on the Sustainable Use of Energy, in particular.

**National Energy Control Centre (CENACE).** Created during the 2014 energy policy reform as an independent system operator for the electricity grid, the CENACE will be supervised by SENER and consists of the parts of the CFE that were so far in charge of the maintenance of the electricity grid. It is charged with ensuring that all companies have a non-discriminatory access to the grid (**Global Wind Energy Council, 2014**).

### 3.3.5. Monitoring and evaluation

In order to monitor the progress towards expanding RE in Mexico, the government semi-annually publishes a report by SENER that contains key data in this respect (**SENER, 2013b**). Additionally, a governmental web platform publishes the results of the monitoring of the indicators of the Special Programme on Renewable Energy and PRONASE<sup>(6)</sup>.

The National Energy Strategy is reviewed and revised annually by the CNE and SENER. The National Strategy on Climate Change foresees a review of its mitigation activities by the CICC at least every ten years, and every six years regarding its adaptations efforts. These reviews are complemented by evaluations of the Mexican National Institute of Ecology and Climate Change and the Climate Change Council (**Government of Mexico, 2013a, p. 54**).

(5) "The Council shall, when it deems appropriate, invite to its meetings the heads of the other agencies of the Federal Government, representatives of the states, municipalities, organisations of civil society and industry, private, academic institutions and the general public, which may interfere with voice but no vote"

(6) See <http://www.transparenciapresupuestaria.gob.mx/>

## 3.4. GOALS AND ACTION PROGRAMMES

The following three strategy documents, namely the ENTEASE, the National Strategy on Climate Change, and the National Energy Strategy, outline the broader policy framework, and focus on integrating and coordinating related policy goals. More specific measures for the implementation of the goals are outlined in the special programmes.

### 3.4.1. National Strategy for Energy Transition and the Sustainable Use of Energy

The 2008 Law for the Sustainable Use of Energy defined the goal to reduce the share of fossil electricity generation to 65% by 2024. The law's 2011 reform complemented it with long-term goals of 60% in 2035 and 50% in 2050.

### 3.4.2. National Strategy on Climate Change

The 2012 National Strategy on Climate Change (revised in 2014) sets the goal to expand the share of clean energy<sup>(7)</sup> in the Mexican electricity mix to 35% by 2024. Additionally, it outlines GHG reduction targets of 30% by 2020 and 50% by 2050 (compared to the base year 2000). The strategy further defines the types of instruments to be used in its implementation, but does not outline specific actions or policy instruments. It underscores the importance of expanding RE and fostering EE for reducing the country's dependence on fossil fuels, but remains general beyond this point.

### 3.4.3. National Energy Strategy (NES)

The NES outlines a total of 22 strategic goals and sets milestones to evaluate them in the years 2018, 2024 and 2027. Key among them is the goal to increase the share of non-fossil fuels in electricity production to at least 35% by 2024 (**SENER, 2013a, p. 4**). The strategy does not provide technology-specific goals. A large part of the strategy focuses on approaches to diversifying the energy mix, and to reforming the national petrochemical industry and infrastructure planning. In order to track progress, it establishes strategic indicators that are directly related to its various objectives (see an overview in section 8.4 of the annex). These objectives are of an intentionally general nature in order to give the implementing agencies enough room to implement the necessary actions as they see fit (**SENER, 2013a, p. 62**; for an example, see section 8.5 of the annex). The strategy itself does not outline any action programme, but refers to the more specific programmes and laws already in place and instead focuses on coordinating efforts between them.

### 3.4.4. Medium-term implementation programmes

The special programme on renewable energy and the national programme on the sustainable use of energy provide the link between the long term strategic goals outlined in ENTEASE, the National Strategy on Climate Change and the National Energy Strategy. They outline specific policy measures and instruments that fall under the responsibility of various ministries and departments and that contribute to the implementation of these strategies and to the attainment of their objectives.

(7) The term 'clean energy' in the strategy includes nuclear energy along with renewables.

### 3.4.4.1. Special Programme for the Development of Renewable Energy

The Special Programme outlines 5 objectives and 24 strategic actions designed to achieve them. The implementation is measured by the indicators in the table below.

#	Name of the objective	Indicator for the change between the base line year 2013 and 2018
1	Increase installed capacity from non-fossil energy sources <sup>(8)</sup> in total installed electricity capacity	Increase the share in total installed capacity from 28.4% to 34.6%
	Increase the share of RE in total installed electricity capacity	Increase the share in total installed capacity from 25.32% to 32.8%
	Increase the share of RE in total electricity generation (in GWh per year)	Increase the share in total electricity generation from 14.78% to 24.9%
2	Increase public and private investment in generation and in the construction and expansion of infrastructure	Reduce the number of days required for processing from 620 to 465 and to process all applications in compliance with the National Digital Strategy
3	Increase the share of biofuels in the national energy mix	Increase the generation from 974 MWh/year to 2,142 MWh/year
4	Promote technological development, talent and value chains in RE	Increase the Climatescope index score from 2.625 to 3.2 (out of 5)
		Increase permanent employment in RE (without large hydro): from 2155 to 4398 Increase temporary employment from RE (without large hydro): from 3085 to 6800
5	Democratising access to RE through rural electrification, thermal utilisation and social participation	Increase the share of people in rural communities who have access to renewable electricity from 6% to at least 8%
		Increase the electricity produced from efficient cogeneration processes from 0 (2013) to 1480 MW (2018)

**Table 2: Objectives and indicators of the Special Programme for Renewable Energy**

The programme also forecasts the development of power generation from clean energy - to 22.81% in 2018; 24.61% in 2024; and 26.49% in 2027 - thus staying below the country's goals (**Government of Mexico, 2013b, p. 21**). The implementation document for the Special Programme has itself identified this gap. The introduction of clean energy certificates as an incentive instrument for higher investments in RE is intended as an answer to this challenge and expected to accelerate the expansion of RE power.

(8) This includes nuclear energy, cogeneration, hydroelectricity and possibly in the future, coal power plants using carbon capture and storage.

### 3.4.4.2. National Programme for the Sustainable Use of Energy (PRONASE)

The PRONASE outlines a broad range of EE policy measures that can be grouped under six main objectives. Similar to the Special Programme, each objective has strategies and lines of action that coordinate measures to reach these objectives. While the strategies and lines of action do not have clear and measurable targets, the implementation of the main objectives is tracked by indicators over the duration of the programme (between the base line year 2012 and 2018) (**Government of Mexico, 2014b**). Each indicator assigns an agency responsible for its implementation and monitoring.

#	Name of the objective	Indicator for the change between the base line year 2013 and 2018
1	Design and develop programmes and activities to promote the optimal use of energy processes	Maintain the nation-wide energy intensity per unit of GDP
2	Strengthen the regulation of energy efficiency for appliances and energy consuming systems manufactured and/or marketed in the country	Increase the share of final energy consumption that is covered by energy efficiency policies from 46% to 51%
3	Strengthen the governance system for energy efficiency	Increase the number of state commissions that promote the sustainable use of energy from 6 to 24
4	Encourage the development of technical and technological capacities linked to the sustainable use of energy	Increase the number of people trained in the sustainable use of energy by 10%
5	Contribute to the development and dissemination of an energy saving culture in the country	Increase the number of people receiving information about the benefits of the sustainable use of energy by 3%
6	Promote research and technological development in energy efficiency	Increase funding for research and development in energy efficiency by 5%

**Table 3: Objectives and indicators of the National Programme for the Sustainable Use of Energy**

## 4. SPECIFIC POLICY MEASURES IN MEXICO

### 4.1. HUMAN QUALIFICATIONS AND TECHNOLOGICAL KNOW-HOW

- **University programmes.** A total of 55 courses<sup>(9)</sup> are offered by educational institutions, most of them universities, for training in renewable energies and energy efficiency (**IRENA, 2015b**).
- **Standards for RE and EE training.** SENER has been developing, in collaboration with business stakeholders as well as with GIZ, standards for the certification of professional training programmes in RE and EE<sup>(10)</sup>.
- **R&D financing through different CONACYT sources.** Mexico is considered to still be lagging behind in scientific research on renewable energies, particularly regarding solar and wind energy (**Alemán-Nava et al., 2014**). However, a number of Mexican research institutions are involved in R&D on renewables, leading among them is the Universidad Nacional Autónoma de México. The National Council for Science and Technology (CONACYT) is promoting research and development by providing funding in collaboration with government ministries<sup>(11)</sup>. On behalf of SENER, it is managing the Sustentabilidad Energética funding scheme, which focuses on R&D on RE and EE and the diversification of energy sources in Mexico.

### 4.2. ACCESS TO CAPITAL

#### 4.2.1. Renewable Energy

Especially since the global financial crisis, Mexico's commercial banks have hardly been able to finance RE investments on their own. These difficulties notwithstanding, Mexican banks have developed various types of financing instruments that are able to support the deployment of RE/EE in the country:

- **International sources of carbon finance.** A broad range of international financing institutions ranging from the IADB, the IFC or the World Bank finance different types of RE/EE investments by private developers. Loans and project finance from international development institutions to Mexico for wind and solar power projects amounted to US\$740 million between 2009 and 2014 (see also section 2.5). Certified Emission Reductions (CERs) under the UNFCCC's Clean Development Mechanism are a further source of capital for investments. In 2013, Mexico set up a trading platform for CERs (MEXICO2) that allows the trading of such certificates. Bilateral agreements with the UK and Japan also allow the international trade in certificates (**Garcia, 2013; Twidale, 2014**).

(9) The definition of courses in IRENA's RE Learning Partnership (IRELP) database comprises university courses and programmes, webinars, training guides and manuals on both renewable energy and energy efficiency. Examples for such training programmes can be found here: <http://www.igs.org.mx/en>; <http://www.ier.unam.mx/nosotros/index.html> or <http://www.cicy.mx/posgrado-en-energia-renovable/inicio>

(10) Certification for specialists in renewable energies and energy efficiency is being made mandatory. A committee for professional competence in renewable energy resources and energy efficiency was set up in 2012 in cooperation with the Mexican Ministry of Energy. This committee is tasked with developing professional training standards that will form the basis for certifying trained specialists. Nine competence standards have been developed so far. There are also agreements in place with several different programmes that make certification for specialists in renewable energies and energy efficiency mandatory. A project supporting these efforts is part of GIZ Mexico's Sustainable energy programme: <https://www.giz.de/en/worldwide/13919.html>

(11) An overview of the CONACYT programme can be found here: <http://www.conacyt.mx/index.php/fondos-sectoriales-constituidos2>

- **Levy on fossil fuel sales by PEMEX.** The Mexican publically owned petroleum company PEMEX (Petróleos Mexicanos) is required to pay a levy of 0.65% on its annual oil and gas sales, the proceeds of which are to go towards research and development in RE and EE. Of the annual income generated, 80% is earmarked for the Hydrocarbon Fund, which finances EE in the fossil energy sector, and the remaining 20% is destined for the federal government's Sustainable Energy Fund (Fondo de Sustentabilidad Energética) (OECD, 2013, p. 85).

## 4.2.2 Energy Efficiency

### 4.2.2.1. Financing Green Buildings

- The Green Mortgage Programme is a national programme designed to enable low-income households to make EE investments into their homes, including retrofitting (World Habitat Awards, 2013). The programme is implemented through INFONAVIT, a lending institution set up by the labour unions, the private sector and the federal government to provide loans to those sectors of society that are not serviced by commercial banks. It is financed by workers' payroll contributions. Between 2009 and 2012, the programme reached 900,000 households, benefited over 3 million people and provided more than US\$1.5 billion in capital (IEA, 2013, p. 21).
- The ECOCasa Programme is a programme set up by one of Mexico's development banks (Sociedad Hipotecaria Federal) and the Ministry of Finance and Public Credit. It is co-financed by a range of international development banks, such as KfW and the Inter-American Development Bank and its Clean Technology Fund that provide more than US\$200 million in capital. The programme provides concessional loans and financial incentives to compensate for the additional initial investment costs for up to 27,000 energy-efficient homes (Sociedad Hipotecaria Federal, 2013).

### 4.2.2.2. Financing energy-efficient lighting and appliances

The capital for various policy instruments that foster investments in energy-efficient lighting, energy-efficient appliances, home insulations and retrofitting stem from national as well as international sources. The specific policy instruments financed through the programme are presented in section 4.4.2.

- Already in 2002, the FIDE and the CFE launched a Programme for the Financing of Electric Energy Saving. In order to complement the programme, the federal government and the state-owned development bank Nacional Financiera set up the Mexico Efficient Lighting and Appliances Project, with financial support from international partners. The project is financed by the Clean Technology Fund (US\$50 million), the IBRD (US\$250 million) and the GEF (US\$7 million). This funding is matched by Mexican resources (see figure below).



Figure 21: Financiers involved in the Mexico Efficient Lighting and Appliances Project

Source: (World Bank, 2013)



## 4.3. LEVEL PLAYING FIELD AND FORMATION OF FAIR PRICES

Two specific instruments that put a price on the external effects of fossil fuels have been adopted recently. While a carbon tax is already in place, an emissions trading scheme is still being debated within the government.

- **A carbon tax** of US\$3.50 per ton of CO<sub>2</sub> is currently applied to the use of fossil fuels. The initial proposal for the tax was significantly weakened by Congress before being adopted: Natural gas was exempted completely, and the initial price of US\$5 per ton of CO<sub>2</sub> was also reduced (**SEMARNAT, 2014a**). Companies will be able to offset their tax burden using CERs generated under the CDM.
- In 2014, SENER also announced the establishment of an **Emissions Trading Scheme**. However, most details of the scheme are still unclear and a matter of debate between SENER, SEMARNAT and the CRE (**SEMARNAT, 2014b**).

## 4.4 SUPPORT MEASURES TO FOSTER DEMAND

### 4.4.1 Renewable energy

#### 4.4.1.1. RE self-supply modality and tax deductions for RE investments

- **Influence of the self-supply mode of electricity generation.** Only a small fraction of the current RE capacity has been installed by the CFE or is operating under the IPP modality within the federal electricity market. The overwhelming majority – especially of wind power projects – are formed under the **self-supply modality** (or auto-abastecimiento). The regulation itself is not a financial incentive instrument, but has a similar effect, as it makes investments in RE attractive. Under the scheme, an RE developer works with an off-taker under a fixed-rate power purchasing contract valid for 20 years. Under this arrangement, licenses for access and use of the transmission and distribution grid are granted by the CRE. The modality is thus attractive for investors as it provides security against rising prices – especially in combination with the ability to deduct investments from taxes. 60% of installed wind power capacity fall under this modality (**Ernst and Young, 2014, p. 29**).
- **Accelerated depreciation for RE investments.** The most important financial support instrument for RE investments is a provision under the Federal Income Tax Law that allows developers to deduct up to 100% of their investment costs from their income tax **in the first year** the investment is made (**INECC, 2007; UNEP, 2011, p. 551**). Investments in wind power installed under the IPP modality – thus, wind power fed into the electricity market – are similarly eligible for tax deduction.

#### 4.4.1.2. Waiver on import tariffs on industrial goods that are beneficial to the environment

**Import tariff waivers for environmentally beneficial imports.** Imports of any equipment for RE installations or EE projects are exempt from import tariffs, which otherwise would amount to 15% to 20% of its price. This is a general trade policy for all goods considered to be ‘beneficial to the environment’ (see **INECC, 2007**).

#### 4.4.1.3. Direct procurement via large-scale RE development projects (PERGE)

- **Direct procurement of Renewable Energy** itself is not a financial incentive instrument, but a project-specific approach to directly procuring RE. The federal government directly procures wind power via the IPP modality and is inviting bids from wind power developers. SENER issued a first

call for project bids in late 2012 to procure a total of 101 MW of wind power capacity in two phases (until 2016). Under the scheme, financed by the World Bank, the CFE will buy wind power at a fixed price under a 25-year contract. The first phase of the project has been concluded (the plant came into operation in 2012) and the second phase is still underway<sup>(12)</sup>.

#### 4.4.1.4. Clean Energy Certificates as financial incentives for RE investments

**Tradable Clean Energy Certificates (CEC).** Tradable Clean Energy Certificates will be awarded to non-fossil power plants built (or upgraded) after August 2014. The amount of CECs a power plant receives will be calculated on the basis of a methodology developed by the Energy Regulatory Commission (CRE). SENER is to determine in 2015/2016 who will be required to hold what amount of CECs by the time the instrument formally starts in 2018. Among those required to hold CECs are likely to be power producers and major electricity consumers that self-supply their electricity. In parallel to the allocation of the certificates, a market will be created in which the certificates can be traded under the supervision of the CENACE and the CRE. So far, SENER has only issued guidelines on the policy. The details of its implementation will be specified in the coming years (**Hindus, Save, & McNeece, 2014**). An overview with the main characteristics of the Clean Energy Certificates can also be found in the annex (section 8.7).

### 4.4.2. Energy efficiency

#### 4.4.2.1. FIDE label for EE products

- **Labels for energy-efficient appliances and materials.** The FIDE label for energy efficiency has now been in force for more than twenty years and identifies energy-efficient appliances (Sello FIDE A) – electric motors, lamps, refrigerators, TV sets, air conditioners, etc. – as well as a second type of products that help save energy by using them (thermal insulation) (Sello FIDE B). Every product carrying the label is annually reviewed and evaluated against constantly updated standards. In addition to providing the label to identify energy-efficient products, the FIDE website also contains a directory for all products certified under both labels (**see FIDE, 2013**).
- In 2012, FIDE launched the Programme Enterprise Eco-Credit, which received technical assistance by GIZ to become a Nationally Appropriate Mitigation Action (NAMA) project for Small & Medium-sized Enterprises (SME). The NAMA project strives to replace inefficient appliances such as commercial refrigerators, lighting, and air conditioning, with FIDE-labelled efficient equipment. As of October 2015, nearly 25 thousand units have been replaced, resulting in energy savings of around 60.2 GWh and almost 30,000 tons of avoided CO<sub>2</sub> emissions.



**Figure 22: FIDE labels for energy efficiency (types A and B)**

Source: (FIDE, 2013)

(12) For specific information, see <http://www.worldbank.org/projects/P077717/large-scale-renewable-energy-development-project-phase-1-25m-phase-2-45m?lang=en>

#### 4.4.2.2. Financial incentives to low- and medium-income households: lighting and appliances

- Mexico Efficient Lighting and Appliances Programme (Programa Nacional para la Sustitución de Equipos Electrodomésticos).** The programme is financed by the Mexican government, the NAFIN and international donors. It provides free CFLs to replace inefficient lighting, in addition to vouchers and loans for replacing inefficient appliances, in order to reach those parts of society that otherwise would not have the means to invest in EE. Demand for energy-efficient appliances is increased through consumer rebates and subsidised loans. The loans are repaid via monthly instalments that are directly deducted from the electricity bills (IEA, 2014a, p. 107). The programme is part of PRONASE 2014-2018. Close to 1.7 million refrigerators and 200.000 air conditioners were replaced under the programme between 2010 and 2015 (IEA, 2015). It should be noted that evaluations have cast doubt on the programme's effectiveness – at least with regard to air conditioning appliances – due to rebound effects (compare Can, Leventis, Phadke, & Gopal, 2014, p. 63). Still, it is estimated that the measures under the programme will result in energy savings of 9.5 TWh in 2015 (compared to BAU) (IEA, 2015)<sup>(13)</sup>.

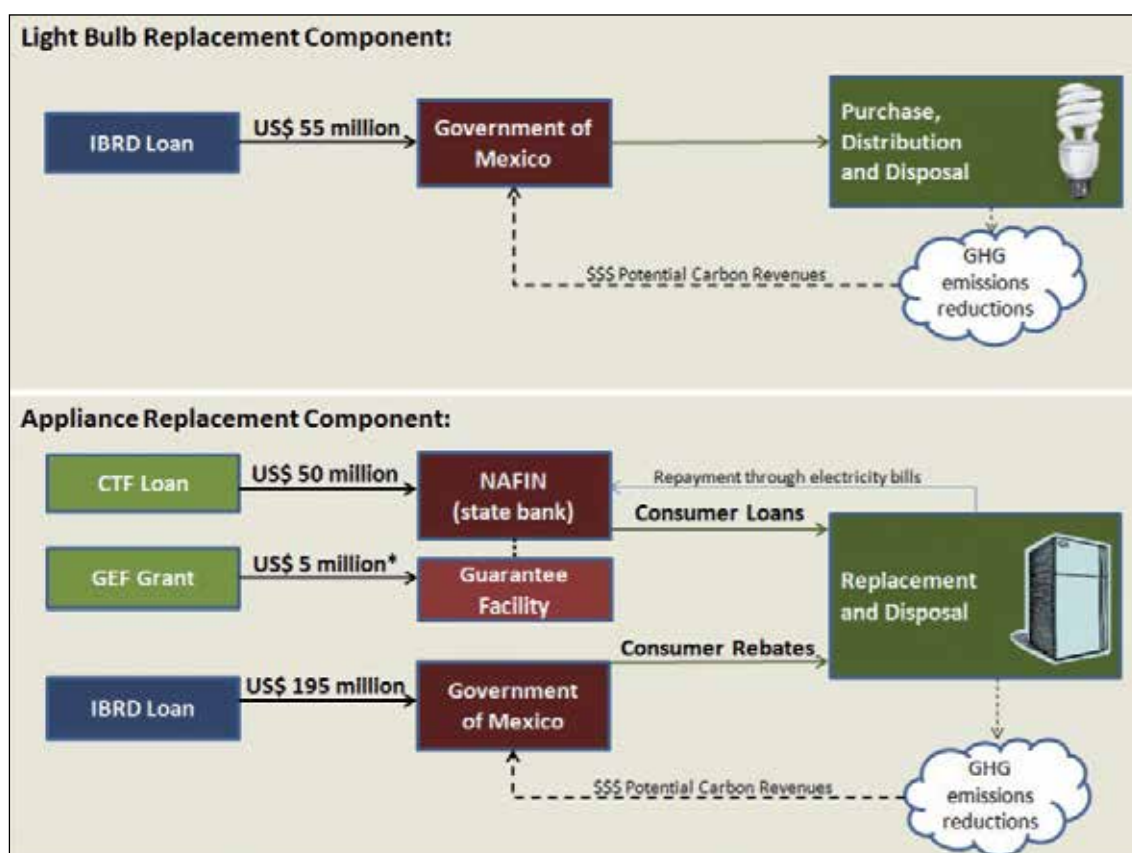


Figure 23: Incentives to consumers to purchase EE lighting and appliances

Source: (World Bank, 2013)

- Large-scale distribution of efficient light bulbs.** Under the Luz Verde project, one million energy efficient CFLs were distributed to Mexican low- and middle-income households (4 per household). The Mexican government and international partners from the industry and banking sector initiated the project. It was the first demand-side mass-scale project to receive carbon credits under the UNFCCC's CDM as a programme of activities (IEA, 2014a; Simonetti, 2013).
- Regulatory phase-out of incandescent light bulbs.** In addition to these incentives, regulatory measures were used to phase out incandescent light bulbs completely. 2013 was the last year in which these could be legally sold in Mexico.

(13) For more information on the specific outcomes of the programme, see (IEA, 2015).

#### 4.4.2.3. Leadership by the public sector on energy efficiency in buildings

- **Energy Savings Programme for Federal Public Administration Buildings (Programa de Ahorro de Energía en la Administración Pública).** The programme aims to create a lead market for energy efficient construction and retrofiting. The programme builds on early efforts in the 1990s (100 Buildings Pilot Programme) that developed initial evaluation methodologies and provided technical guidance. The programme itself was established in 1999 and resulted in EE investments in over 2,800 office buildings as well as annual savings of 309 GWh throughout the past decade (compared to BAU). These investments are mandatory for federal agencies, are implemented by the EE officers of each agency, and are supported by the methodologies developed by the CONUEE (which is also managing the programme). The latest 2012 reform presented a range of new EE guidelines with specifications for the management of buildings as well as for the procurement of technical equipment (lighting, air conditioning, insulation, etc.). The CONUEE has also launched the National Programme for Energy Management Systems (PRONASGEN), which serves as a framework for learning exchange networks on energy management systems based on ISO 50001. The next steps in the programme will be a benchmarking system (based on the international Energy Star criteria) and energy performance contracting to make this market more attractive for companies specialised in energy efficiency improvements (**SENER & CONUEE, 2013**).

# 5. OUTLOOK ON MEXICO'S DEVELOPMENT IN RE AND EE

## 5.1. MARKET DEVELOPMENT

### 5.1.1. Anticipated market development for RE

Given the expected on-going growth of the Mexican economy and the concurrent growth of electricity demand, complemented by the increasing competitiveness of renewable energy and energy efficiency technologies as well as the introduction of a carbon tax and emissions trading scheme, the Mexican market for sustainable energy products will in all likelihood continue to grow. Industry observers have praised the recent reforms of the Mexican electricity market and the announcement of a system of tradable Clean Energy Certificates as a further financial incentive to invest in RE (**Ernst and Young, 2015**). A key bottleneck for the accelerated expansion of wind and solar power, however, will be the limited capacity of the electricity grid to transmit and distribute that power.

While the government itself has not yet issued technology-specific RE capacity development goals, the Mexican wind energy association is advocating the goal of 12,000 MW by 2022 (**Global Wind Energy Council, 2014, p. 64**). Other sources estimate “at least 7,000 MW of installed wind capacity by 2025” (**Bierzwinsky, 2011**). Foreign analysts suggest that “Mexico is poised to become one of the world’s fastest growing wind energy producers” (**US Energy Information Administration, 2014**). Given the absence of a strong local content policy, it remains to be seen how much actual domestic employment in RE would result from this.

### 5.1.2. Anticipated market development for energy efficiency

Energy efficiency constitutes another large market, with a particular focus on the building sector. It is estimated that up to 43% of the current energy consumption of Mexican buildings could be reduced by 2030 (**Clean Energy Information Portal, 2014**).

### 5.1.3. Anticipated employment effects

The exact employment effects of sustainable energy technologies in Mexico are still a matter of investigation and debate. A recent study of the ILO, INECC and SEMARNAT identified more than 1.8 million directly and 971,000 indirectly environment-related jobs in Mexico in 2011 (**ILO, 2013**). The study estimated that shifting final demand to green activities in several sectors of the economy has a slightly negative impact on GDP, but results in a net increase in employment with more than 730,000 new jobs, equivalent to 2% of the workforce. Among these, the study estimates that 22,000 jobs could be created through RE, 459,000 in the clean industry sector and 349,000 in sustainable construction (**ILO, 2013**).

## 6. CONCLUSION: KEY FEATURES OF THE MEXICAN APPROACH, EXPLANATORY LIMITATIONS OF THE STUDY AND FUTURE NEEDS FOR RESEARCH

### 6.1. KEY FEATURES OF THE MEXICAN STRATEGIES AND POLICIES ON RE AND EE

#### 6.1.1. Strategic approach to RE and EE

- The Mexican approach is clearly policy-driven yet conceptually relatively open: The government's strategy documents mainly focus on outlining overall goals and targets and on coordinating policies and activities across a number of fields. In this sense, they provide for a broad, long-term direction of deployment with a comprehensive set of indicators. They so far do not, however, contain technology-specific goals for capacity additions in the power sector.
- More specific strategies and lines of action are outlined in the medium-term programmes on renewable energy and the sustainable use of energy. Their implementation is accompanied by public participation from business, civil society and academia. One observation from observers is that the EE programme is much more vague in its goals and measures than the RE programme. The future Law on Energy Transition, however, is expected to improve the transparency and specificity of the government's policies and measures with regard to EE.
- The progress in implementing the strategies and programmes on RE and EE is regularly evaluated using a broad set of indicators that go beyond quantitative goals and also consider 'qualitative' objectives such as creating a culture of energy saving or democratising the access to RE.
- Both energy and climate policy each clearly have a lead ministry assigned to it, and there are institutions for integrating the concerns of 'interested parties' outside of government in the strategic processes. While institutions also exist to foster coordination between ministries, actual cooperation is still rare in practice.

#### 6.1.2. Policy instruments for RE and EE

- It is noteworthy that there is no generic RE support instrument, such as a feed-in tariff or renewable portfolio standards. The attractiveness of the self-supply mode for investing in RE lies in the existing disadvantages of the electricity market regulation. Self-supply provides security against price hikes. It enables the purchasing party to become independent of the electricity market – and to benefit from generous tax incentives. If the RE plant is built by developers who sell the generated capacity to a third party, they also benefit from the security of a long-term contract covering their investment costs.
- International financing institutions play an important role in providing capital and incentives for investments in both RE and EE.
- The Mexican policy approach toward EE has been widely credited as being both cutting edge in Latin America and a major driver behind EE investments (**IEA, 2015**). Many of the policy instruments used to stimulate EE in households and buildings specifically acknowledge the limited ability of low- and medium-income households to finance such investments.

- The 2013/14 energy sector reforms are expected to have a major impact in terms of fostering additional investments in RE generation capacities. The enacted carbon tax and the planned emissions trading scheme are both likely to further increase the attractiveness and competitiveness of RE compared to fossil sources.

## 6.2. EXPLANATORY LIMITATIONS OF THE STUDY

There are a number of limitations to be pointed out, many of which Mexico shares with other countries and which impede an exact and reliable assessment of present and future RE and EE employment impacts.

- ***Evolving nature and unclear impacts of the energy sector reform process.*** For a number of policy instruments, it is more or less clear when and how they will be enacted (e.g. the carbon tax, the Clean Energy Certificates or the emissions trading scheme). The introduction of these instruments runs parallel to the liberalisation of the energy market, which similarly will have a significant impact on the development perspectives of the Mexican energy system. How exactly these changes will affect investments in RE and EE, and what the subsequent impacts on domestic employment will be, can only be answered in the course of the coming years.
- ***Quality and availability of data.*** Similar to other countries, the available data on employment in or through RE and EE is very scarce and poor. The lack of data is particularly true for the solar PV sector, as it has started to 'kick off' only recently.
- ***Level of detail and precision of data.*** Again, similar to other countries, the data on investments in RE that is available through the FS-UNEP Collaborating Centre for Climate and Bloomberg Sustainable Energy Finance can illustrate a trend, but is aggregated for the entire country. It does not provide disaggregated data for the federal states or for individual sectors or specific information on the origin and destination of the investments.

## 6.3. OPEN QUESTIONS FOR FUTURE RESEARCH

Some of the questions for future research are linked to the implementation of the energy sector reforms, while others aim at improving knowledge on how the Mexican instruments have worked exactly and what other countries can draw from this.

- Many of the policy changes announced in the follow-up to the energy sector reforms of 2013/2014 have not been enacted yet and it is unclear how they will affect the development of the RE and EE sectors in Mexico. The analysis of this reform process (e.g. the debate on the specific design of the carbon tax and its revision to accommodate vested interests of the fossil fuel industries) can produce important insights for similar undertakings in other countries.
- Studying the development of significant RE capacities outside the existing markets, specifically in an environment with heavily regulated power tariffs, can provide new insights into how to incentivise investments in RE beyond the well-known demand-side instruments (such as feed-in tariffs or renewable portfolio standards).

- Another aspect worth studying in greater detail is how EE policy instruments have been designed to be more accessible for low-income households. Future research on this aspect should look at how effective the measures in this field (such as the Green Mortgage or the Efficient Lighting and Appliances Programmes) have been in engaging low-income sectors of society to invest in EE, and how such programmes can be replicated in other countries and further accelerated by international sources of carbon finance.
- Lastly, the proximity to the US means that there are a number of ways in which the energy, electricity and technology markets of these two countries influence each other. Shedding more light on how these interactions unfold and on how they affect the competitiveness of RE in Mexico can help to better understand the impact of internationalising markets and supply chains on domestic development and employment in the host countries.



## 7. LITERATURE

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## 8. ANNEX

### 8.1. WIND POWER SITES INSTALLED AND UNDER CONSTRUCTION IN MEXICO (2013)

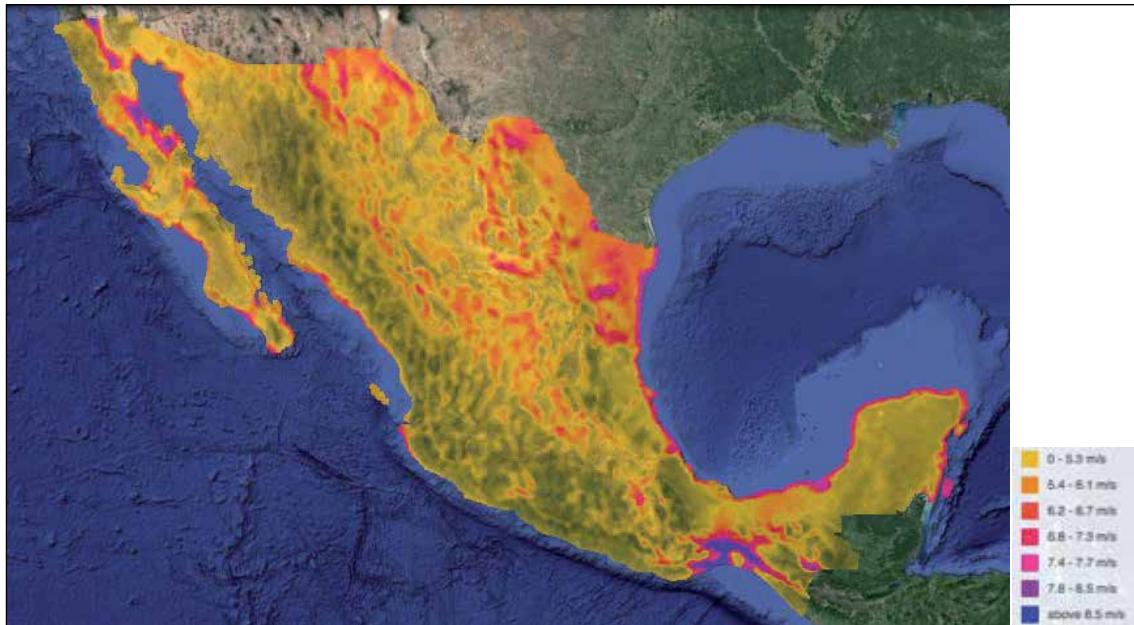
WIND FARMS IN OPERATION AND UNDER CONSTRUCTION IN MEXICO						
Project	Location	Project State	Developer/Investor	Manufacturer	Operation Date	Capacity (MW)
<b>OPERATION</b>						
La Venta	Oaxaca	Operation	CFE	Vestas, 225 KW	1994	1.57
La Venta II	Oaxaca	Operation	CFE	Gamesa, 850 KW	2006	83.30
La ventosa II	Oaxaca	Operation	Iberdrola	Gamesa	2008	49.30
La Ventosa	Oaxaca	Operation	Iberdrola	Gamesa	2008	30.60
Eurus, 1st Phase	Oaxaca	Operation	Cemex/Acciona	Acciona, 1.5 MW	2009	37.50
Eurus 2nd Phase	Oaxaca	Operation	Cemex/Acciona	Acciona, 1.5 MW	2010	212.50
Bii Nee Stipa I	Oaxaca	Operation	Cisa-Gamesa	Gamesa, 850 KW	2010	26.35
La Mata - La Ventosa	Oaxaca	Operation	Electrica del Valle de México (EDF-EN)	Clipper, 2.5 MW	2010	67.50
Fuerza Eólica del Istmo	Oaxaca	Operation	Peñoles	Clipper, 2.5 MW	2011	50.00
Oaxaca II, III y IV	Oaxaca	Operation	CFE/Acciona	Acciona, 1.5 MW	2011	306.00
La Venta III	Oaxaca	Operation	CFE/Iberdrola	Gamesa, 850 KW	2012	102.85
Oaxaca I	Oaxaca	Operation	CFE/EYRA (ACS)	Vestas, 2 MW	2012	102.00
Fuerza Eólica del Istmo	Oaxaca	Operation	Peñoles	Clipper, 2.5 MW	2012	30.00
Bii Nee Stipa II (Stipa Nayad)	Oaxaca	Operation	ENEL Green Power	Gamesa, 2MW	2012	74.00
Bii Nee Stipa III (Zopiloteapan)	Oaxaca	Operation	ENEL Green Power	Gamesa, 2MW	2012	70.00
Piedra Larga	Oaxaca	Operation	Renovail/Demex	Gamesa	2012	90.00
Bii Stinú	Oaxaca	Operation	EDF Energies Nouvelles	Gamesa, 2MW	2012	164.00
La Ventosa III	Oaxaca	Operation	Iberdrola	Gamesa	2013	20.00
Eoliatec del Pacifico	Oaxaca	Operation	EDF Energies Nouvelles	Gamesa	2013	160.00
Bii Nee Stipa II Fase III El Retiro	Oaxaca	Operation	Cisa-Gamesa	Gamesa, 2MW	2013	74.00
Guerrero Negro	Baja California	Operation	CFE	Gamesa	1999	0.6
La Rumorosa	Baja California	Operation	Turbopower	Gamesa	2009	10.0
Arriaga	Chiapas	Operation	Grupo Salinas	Vestas	2012	28.8
Los Altos	Jalisco	Operation	Grupo Dragón	Vestas	2013	50.4
El Porvenir	Tamaulipas	Operation	GEMEX	Vestas	2013	54.0
Sta. Catarina	Nuevo León	Operation	Comexhidro/Asergen	GE	2013	22.0
<b>CONSTRUCTION</b>						
Bii Hloxo	Oaxaca	Construction	GNF	Gamesa, 2MW	2014	234.00
Bii Nee Stipa II Fase IV Dos Arbolitos	Oaxaca	Construction	Cisa-Gamesa	Gamesa, 2 MW	2014	70.00
Piedra Larga II	Oaxaca	Construction	DEMEX	Gamesa	2014	138.00
Sureste I Fase II	Oaxaca	Construction	CFE/ENEL	Undefined	2014	102
Granja SEDENA	Oaxaca	Construction	SEDENA	Vestas	2014	15.00
Energía Sierra Juárez	Baja California	Construction	IENOVA (SEMPRA)	Vestas	2014-2015	155.1

Source: AMDEC

Figure 24: Wind farms in operation and under construction

Source: (Global Wind Energy Council, 2014)

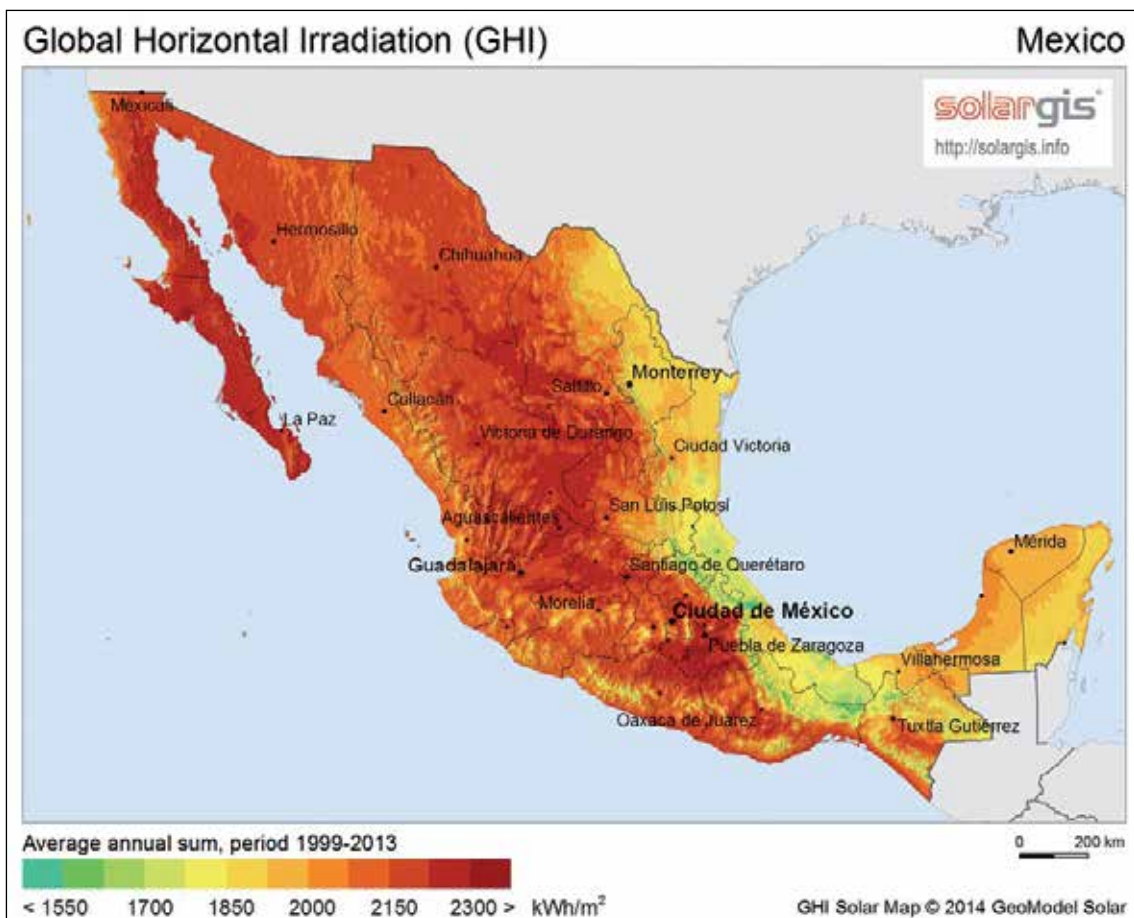
## 8.2. WIND ENERGY MAP OF MEXICO



**Figure 25: Wind energy map**

Source: (IRENA, 2015a)

## 8.3. SOLAR IRRADIATION MAP OF MEXICO



**Figure 26: Solar irradiation map**

Source: (Solargis, 2014)

## 8.4. NATIONAL ENERGY STRATEGY: STRATEGIC INDICATORS

Objetivo estratégico		Elementos de integración		
		Sustentabilidad	Eficiencia	Seguridad
		Indicador	Indicador	Indicador
		Emisiones de GEI del sector energético	Intensidad energética	Índice de independencia energética
Impulso al crecimiento del PIB	Participación del sector Energético en el PIB	Participación de fuentes no fósiles en la generación de electricidad	Porcentaje de transporte de petrolíferos por ruedas	Diversidad de fuentes en la matriz energética nacional
		Emisiones de CO2	Rendimiento de gasolinas y destilados intermedios	Días de autonomía en terminales de almacenamiento críticas: gasolinas
		Crecimiento en reservas probadas de hidrocarburos / crecimiento PIB	Tasa de restitución de reservas 1P	Líneas de transmisión en situación de saturación
		Relación Reservas Probadas / Producción	Aprovechamiento de gas natural	Capacidad de transporte de gas natural
Inclusión social	Consumo per cápita	Brecha entre regiones del consumo per-cápita de combustibles en sector residencial	Relación precio-costo de energía eléctrica	Crecimiento en abasto de energía mediante generación distribuida
		Proporción de hogares sin acceso a la electricidad	Equipamiento energético de los hogares	Medidas con comunidades para facilitar el desarrollo de líneas eléctricas y ductos
		Cobertura del servicio de energía eléctrica	Precio medio de energía eléctrica al consumidor	Participación del sector social en proyectos energéticos

Figure 27: Strategic indicators of the National Energy Strategy

Source: (SENER, 2013a, p. 61)

## 8.5. NATIONAL ENERGY STRATEGY: STRATEGIC GOAL RELATED TO THE SHARE OF NON-FOSSIL FUELS IN PRIMARY ENERGY

### Participación de fuentes de energía primaria no fósil

*Descripción:* Porcentaje de las fuentes de energía primaria no fósil que se producen y aprovechan en el país. Se considera que en la medida de que exista una mayor diversificación y una menor dependencia hacia los hidrocarburos, se contará con un mayor grado de seguridad en el abastecimiento de energía.

*Fórmula:* Total de la energía primaria producida a través de fuentes distintas a hidrocarburos entre el total de la energía primaria producida

*Unidad de medida:* Porcentaje

*Medidas de política relacionadas:* Transición energética

Figure 28: Exemplary strategic goal on the share of non-fossil fuel in primary energy

## 8.6. CLIMATE POLICY MEASURES AT THE THREE LEVELS OF GOVERNMENT



**Figure 29: Climate policy measures at the three levels of government**

Source: (Government of Mexico, 2013a, p. 16)

## 8.7. CLEAN ENERGY CERTIFICATE SCHEME

<b>Target setting</b>	The CEC scheme aims to support the achievement of the national clean energy generation goal of 35% by 2024.
<b>Obligated parties</b>	<ul style="list-style-type: none"> <li>• Suppliers</li> <li>• Qualified users participating in the power market</li> <li>• End-users who obtain electricity from an isolated supply</li> <li>• Holders of Interconnection Agreement Legacies which include a load centre</li> </ul>
<b>Eligible technologies</b>	All the clean energy sources as defined by the Electricity Industry Law. Clean generators shall be entitled to receive a CEC for each unit of power they generate without the use of fossil fuels. For efficient cogeneration, they will receive a given number of CECs according to the methodology defined by the CRE for clean energy accountability for this type of technology. A CEC has permanent validity until it is cancelled to comply with a quota obligation.
<b>Enforcement</b>	Some economic penalty is considered to be in place to enforce compliance. Nevertheless, the penalties scheme for non-compliance is already devised by the CRE, although the exact value of the penalty has not been announced.
<b>Start of operation</b>	2018

**Table 4: Main characteristics of the Clean Energy Certificate Scheme**

Source: (IRENA, 2015c, p. 33)