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Economic Cooperation

# PEER REVIEW ON ENERGY EFFICIENCY IN MEXICO

Final Report

APEC Energy Working Group (EWG)

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PRODUCED BY:

Asia Pacific Energy Research Centre (APERC)
Institute of Energy Economics, Japan
Inui Building, Kachidoki 11F, 1-13-1 Kachidoki
Chuo-ku, Tokyo 104-0054 Japan
Tel: (813) 5144-8551
Fax: (813) 5144-8555
E-mail: master@aperc.ieej.or.jp (administration)
Website: http://aperc.ieej.or.jp/

FOR:

Asia-Pacific Economic Cooperation Secretariat
35 Heng MuiKeng Terrace, Singapore 119616
Tel: (65) 68 919 600
Fax: (65) 68 919 690
E-mail: info@apec.org
Website: http://www.apec.org


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# PREFACE

According to the guidelines for the APEC Peer Review on Energy Efficiency (PREE), the objectives of the PREE as endorsed by APEC Leaders at their 2007 meeting are to:

- Share information on energy efficiency performance as well as on policies and measures for improving energy efficiency.

- Provide opportunities for learning from the experiences of other economies and for broadening the network among energy efficiency policy experts.

- Explore how energy efficiency goals on an overall and /or sectoral basis and action plans could be effectively formulated in each economy under review, taking into account the range of possible strategies that could be used, according to the circumstance of each economy.

- Monitor progress attaining energy efficiency goals on an overall and/or sectoral basis and implementing action plans, if such goal and action plans have been already formulated at the time of the review.

- Provide recommendations for voluntary implementation on how implementation of action plans could be improved with a view to achieving energy efficiency goals.

Three activities are undertaken as part of the PREE:

A. **Peer Review** of volunteer member economies.
B. The **Compendium of Energy Efficiency Policies** of APEC member economies based on either the APEC voluntary PREE or energy efficiency aspects of the IEA Energy Policy Review.
C. The **Energy Efficiency Policy Workshop** for capacity building of member economies.

Mexico volunteered to undertake a Peer Review on Energy Efficiency (PREE) and this was the eleventh PREE exercise for an APEC Economy. This report presents the results of a peer review of energy efficiency policies conducted in Mexico City. The primary accountability for each peer review is shared by the economy being reviewed and the PREE Review Team.

The peer review in Mexico was conducted by a PREE Review Team of eleven experts (see Appendix A) who visited Mexico City from 6-10 March 2017.

During the visit, the PREE Review Team held comprehensive discussions on energy efficiency with representatives and experts from government ministries and agencies (see Appendix B). The Review Team wishes to thank all the presenters and those who participated in the discussions, including officials from CONUEE (National Commission for the Efficient Use of Energy), FIDE (Electric Energy Savings Trust Fund), CENACE (National Energy Control Centre) and especially the representatives of Mexico's Ministry of Energy (SENER), who organized the event.

# EXECUTIVE SUMMARY

This peer-review assesses the current status of energy efficiency policy in Mexico. It is worth taking into consideration that Mexico's energy sector is under transformation following the landmark 2013 Energy Reform that changed legislation on almost every topic related to the energy sector, from oil exploration to electricity rates. Energy efficiency was addressed in the new legal framework, in which a new strategy, programs, and targets were all established.

This assessment was completed by the PREE Review Team, a group of 11 experts from the APEC region that analysed the economy's achievements and challenges with respect to energy efficiency policy. The results contained in this report cover eight key policy sectors, each of which were covered by an expert specialising in that area of energy efficiency policy. The report is divided into two main sections: the first, prepared by the Mexican government, is a detailed description of the energy efficiency sector in Mexico, while the second contains the achievements, challenges and suggestions put forward by the PREE Review Team.

The Review Team's analysis is divided into eight fields: institutional framework, targets and strategy, data collection and monitoring, buildings, industry, transport, electricity, and appliances. After analysing the achievements and challenges of energy efficiency in Mexico, the experts made specific recommendations targeted at strengthening energy efficiency policy according to their own area of expertise. As a result, this PREE review contains 46 policy recommendations to the Mexican government that have the potential to bolster energy efficiency in the economy in order to reach both domestic efficiency goals, as well as international commitments.

In the first section of this report, SENER (Ministry of Energy of Mexico) describes the existing structure of the energy sector, including the legal framework and relevant institutions related to energy efficiency policy. This section of the report also includes the government's domestic achievements and progress towards increasing international cooperation on energy efficiency. The foundational legal instrument is the Energy Transition Law (LTE), which establishes the goals and targets for energy intensity and carbon emissions over the next 30 years. Lastly, this section covers the Ministry of Energy's forecast on energy consumption under two scenarios: a "business as usual" scenario with no major changes in policy and a "transition" scenario in which the governments' programs and policies are effectively implemented, resulting in a reduction of more than 40% of final energy consumption compared to the "business as usual" scenario.

The second section of the report contains the results of the PREE Review Team's analysis of the eight policy fields with each section drafted by the relevant expert. This analysis combines the results of the experts' previous research, information shared by SENER with the PREE Review Team and the team's work during their visit to Mexico. The site visit in Mexico City resulted in substantive and profound discussions about energy efficiency with officials from SENER, CONUEE (National Commission for the Efficient Use of Energy), FIDE (Electric Energy Savings Trust Fund) and CENACE (National Energy Control Centre).

The PREE Review Team commends, in general, Mexico's well-structured institutional framework for energy efficiency policy, highlighting SENER's leadership and CONUEE's wide array of programs and cooperation projects despite having limited resources and workforce. However, better communication and coordination

between these institutions and other ministries and local governments remain a challenge, through which greater benefits could be achieved. The PREE Review Team has recommended an increase in CONUEE's budget and staff in order to both carry out additional projects and extend those currently in operation.

The team recognises SENER's efforts on setting not only a coherent strategy for energy efficiency, but also concrete medium and long-term goals and targets. The PREE Review Team appreciates the challenges in effectively decoupling economic growth from increasing energy demand while achieving energy efficiency targets. In this regard, continuing to monitor policy and energy data, as well as increasing public awareness will be key for Mexico in achieving its goals and targets.

In terms of data collection and monitoring, the PREE Review Team lauds the efforts in making most of the related data available online. The team also supports the government's active role in both international and domestic settings, including the important role of the LTE in promoting cooperation and data sharing among concerned institutions. Nevertheless, further data completeness and disaggregation remains a challenge for data quality. In this regard, both CONUEE and SENER seem to have made limited progress on data disaggregation due to budget and labour constraints. Additionally, while international cooperation is strong, the team encourages CONUEE to enhance cooperation with APEC.

The PREE Review Team acknowledged that the building sector's main components are regulated under energy efficiency standards (NOMs), as well as the presence of the Energy Services Company (ESCO) scheme in Mexico. Although Mexico's energy demand for buildings is relatively low because of mild weather, the team has identified that Mexico is not making the most of its solar energy potential for residential use. For instance, there is huge potential for photovoltaic use in water heating. The team also suggests that establishing federal voluntary building codes and increasing cooperation between CONUEE and local governments for building code enforcement would be highly beneficial. Finally, the government should lead the way by improving energy efficiency in its own buildings.

In the industry sector, the PREE Review Team commended CONUEE's role in successfully promoting the adoption of best practices such as the ISO 50001 Energy Management Standard and the Learning Energy Efficiency Networks (LEEN). However, the team found challenging the lack of a public plan to build capacity to support and grow a profitable energy management industry. Without a plan, the ambitious 41% energy savings target for the industrial sector might not be achievable. The PREE Review Team recommends the government take measures with low financial cost, but potentially high impact, such as further promoting the Learning Networks approach, speaking to the industry in their own language (energy productivity and lower costs, rather than energy efficiency), offering benchmarking and recognition for exemplar companies, and adopting a building energy performance-rating scheme.

The PREE Review Team acknowledges there have been commendable achievements in the transport sector, such as progress on removal of fuel subsidies, standards for vehicle fuel efficiency, innovation in sustainable public transport in Mexico City and growth in electric vehicle use. The transport sector is the major final energy consumer in Mexico, accounting for 46% of energy demand and is one of the sectors with great potential for energy savings. However, the team discovered several obstacles that could hinder the ability to achieve savings targets, including growing demand for both public and private transport, fragmentation in public transport modes particularly in big cities and impediments to the uptake of electric vehicles. The PREE Review Team

recommends prioritising funding for public transport and non-motorised transport modes, greater coordination on transport planning among the different levels of government and setting policies that accelerate the uptake of electric vehicles such as fiscal incentives and domestic targets.

The PREE Review Team had meaningful discussions about the new structure of the electricity sector and the importance of increasing efficiency in it. The team commended the inclusion of long-term clean energy power generation goals, the transition from a centralised power utility to a market-based approach and the realisation of long-term auctions for energy, capacity and clean energy certificates. The experts, however, suggested that some issues, such as efficiency programs implementation, sub-optimal coordination between related agencies, risks in infrastructure development and a new presidential administration that could bring new strategies and policies on energy efficiency, could turn into potential obstacles. The PREE Review Team recommended establishing Public Benefits funds as a way to assure sufficient resources for energy efficiency programs, in addition to developing standards for water products and equipment and creating a framework that strengthens demand response including tariff reforms that more accurately reflect real costs.

Finally, the appliance and equipment sector was positively assessed by the PEEE Review Team. The team praised both CONUEE's Minimum Energy Performance Standards (MEPS), mandatory energy labels program, as well as the robust regulatory framework and testing laboratory infrastructure for efficient appliances and equipment. Despite these accomplishments, the team considered that international benchmarking of MEPS was necessary, in addition to increasing public awareness of the savings achieved through efficient products that comply with the MEPS and labelling programs. Apart from benchmarking MEPS with other economies, the team suggested increasing CONUEE's resources to enable a more proactive and comprehensive role, and creating messaging campaigns to raise awareness on the public.

In summary, this Peer Review report concludes that energy efficiency is currently a key part of energy policy in Mexico and progress in this regard is already evident in several sectors. However, it was also clear that the current approach to energy efficiency faces considerable challenges, and therefore requires greater attention from the government's relevant institutions, more funds and labour dedicated to this effort, and increased awareness from the public. Moreover, achieving ambitious goals on energy efficiency policy requires proactive mid- and long-term planning, notwithstanding changes in the federal administration and political cycles. A successful energy efficiency strategy will render economic benefits by reducing costs, enhancing energy security via reducing fuel imports and creating a more sustainable development with less pollutant emissions, among other advantages for Mexico. The PREE Review Team sincerely hopes this report will help recognise Mexico's progress on energy efficiency abroad and reinforce the importance of reaching further achievements domestically in coming years.

# RECOMMENDATIONS

### *Institutional Context*

**Recommendation 1:** SENER and CONUEE should continue keeping communication and coordination among them, not only for the successful implementation by CONUEE of SENER-designed energy efficiency policies, but also for getting feedback from CONUEE's experience to SENER's policy designing.

**Recommendation 2:** Strengthen communication between CONUEE and subnational institutions for energy efficiency programs and actions; every institution should have a designed official serving as a link and responsible for energy efficiency policy.

**Recommendation 3:** Enhance the capabilities of subnational governments in order to adequately oversee, assess and enforce energy efficiency codes, programs and policies.

**Recommendation 4:** SENER and CONUEE are recommended to continue international cooperation in energy efficiency policy not only as a beneficiary but also as a benefactor in the near future.

### *Energy Efficiency Goals, Targets, and Strategy*

**Recommendation 5:** The government should continue to have energy efficiency as a priority in its energy policy and make sure that the committed targets are achieved.

**Recommendation 6:** An institutional cooperation mechanism should be established to increase collaboration on energy efficiency actions across government.

**Recommendation 7:** Improve energy efficiency monitoring to better assess results of related programs and measures.

**Recommendation 8:** Ensure the most life-cycle cost efficiency programs and targets are undertaken and established to mitigate any potential economic impact.

**Recommendation 9:** Make sure that energy efficiency targets do not affect negatively economic growth.

**Recommendation 10:** Promote capacity building, research and development, and financial support for energy efficiency projects.

### *Energy Data Collection and Monitoring*

**Recommendation 11:** Enhance cooperation with relevant actors in conducting household energy consumption surveys.

**Recommendation 12:** Strengthen cooperation with APEC.

**Recommendation 13:** CONUEE should join the cooperative relationship that APERC-ESTO and SENER already have for data and statistics.

**Recommendation 14:** SENER and CONUEE should continue taking measures to improve data collection and monitoring, in terms of energy efficiency indicators by sectors and end-use.

**Recommendation 15:** SENER should reinforce its ties with other government institutions to have better data quality by sharing information and communicating more effectively with them.

**Recommendation 16:** Despite the legal base exists, SENER should continue exploring mechanisms to improve the integration and updating of information, in coordination with CONUEE and CFE to better contribute to the PRODESEN's (the government's electricity program) forecasting.

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***Policy Measure – Government and Buildings Sectors***

**Recommendation 17:** Consider a stronger energy demand growth in the buildings sector due to a rise on people's living standards.

**Recommendation 18:** The government should continue its efforts in setting up federal voluntary building codes.

**Recommendation 19:** The government should continue undertaking measures to improve energy efficiency in its own buildings.

**Recommendation 20:** SENER should continue including residential and commercial buildings in pilot and demonstrative projects to raise awareness.

**Recommendation 21:** The government should continue promoting photovoltaic and solar air conditioning in the residential sector.

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***Policy Measure –Industrial Sector***

**Recommendation 22** The government should continue expanding the Learning Network approach for large energy users.

**Recommendation 23:** SENER should aim for engaging 50% of the industrial sector by using voluntary agreements.

**Recommendation 24:** The government should consider talking to the industrial sector in terms of energy productivity rather than energy efficiency (speak in their language).

**Recommendation 25:** The government should continue offering more benchmarking tools and recognition awards for exemplar companies.

**Recommendation 26:** The government should continue building strong links with universities and training colleges.

**Recommendation 27:** SENER should offer an online self-assessment tool for small and medium enterprises.

**Recommendation 28:** The government should adopt a low-cost building energy performance-rating scheme.

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***Policy Measure – Transport Sector***

**Recommendation 29:** Push for greater coordination around transport planning and energy efficiency between all levels of government.

**Recommendation 30:** The government should prioritize funding to public transport and non-motorized modes over additional road infrastructure. .

**Recommendation 31:** The government should update and extend the vehicle fuel economy standards.

**Recommendation 32:** Consider mandatory fuel economy labelling of vehicles at point of sale or in advertising.

**Recommendation 33:** Set policies that accelerate the uptake of electric vehicles such as fiscal incentives, promoting charging stations construction, government leadership on EV usage, among others.

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***Policy Measure – Electricity Sector***

**Recommendation 34:** Establish energy efficiency Public Benefits funds program.

**Recommendation 35:** Institutionalize Integrated Energy Planning.

**Recommendation 36:** Develop equipment standards and voluntary programs for water products.

**Recommendation 37:** Enhance the National Program for Energy Management to require training.

**Recommendation 38:** Develop a framework and incentives to strengthen demand response, including adopting tariff reform to better reflect true costs and incentivize demand reduction and response programs.

**Recommendation 39:** Promote and encourage the development of micro-grids.

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***Policy Measure – Appliances and Equipment***

**Recommendation 40:** Benchmark energy efficiency standards with other APEC economies.

**Recommendation 41:** Increase resources in CONUEE for Minimum Energy Performance Standard (MEPS) implementation to enable a more proactive establishment and revision of standards, particularly in fast-moving technologies such as LED lighting.

**Recommendation 42:** Based on the survey results, CONUEE should consider including products such as TV sets

in the MEPS program and the label program. Likewise, in the industrial sector, usage of equipment such as compressors, fans, and blowers, should be included in the survey and the MEPS.

**Recommendation 43:** Consider replacing incandescent lamps directly with LED technologies, bypassing compact fluorescent lamps (CFLs).

**Recommendation 44:** Evaluate the subsidy projects and payback-on-electricity-bill schemes carefully for their effectiveness in reducing overall energy consumption. Consumer behaviour may affect the final result of energy savings.

**Recommendation 45:** Increase public awareness of the voluntary label program.

**Recommendation 46:** Regularly review *Sello FIDE* impacts on the market transformation of different products, and upgrade the energy efficiency requirements accordingly

# PART I:

# BACKGROUND INFORMATION

The background information contained in this report has been contributed by the Mexican Government. This information is intended to provide some context to the recommendations of the PREE Review Team.

## 1. INTRODUCTION

In the last decades, Mexico has positioned itself as one of the most solid economies in the world, despite the strong global slowdown that exists in the global economic plane. Since 2005, the Mexico's population growth rate has been of 1.3%, going from 107.2 to 121 million people. This moderate increase represents a substantial impact on oil, petroleum products, and electricity demand. On the other hand, the consumer price index, in the last 10 years, has maintained an annual average of 4.1%, due to the current monetary policy in Mexico that guarantees general stability in the price level (see table 1-1).

Gross Domestic Product (GDP) grew by 2.7% over the period 2005 to 2015, despite the slowdown during 2009. The government seeks to revive the economy with the support of reforms to achieve a medium-term growth of GDP by approximately 5.0%. The energy sector is strategic for the development of the Mexican economy, given its importance in the operation of all the productive activities and the impetus given to them. Example of these activities include the transport of people and goods, production of manufactures, operation of establishments, trade, services, factories and homes; in short, the development of the energy sector in Mexico is firmly related to economic growth.

**Table 1-1- Main macroeconomic variables of Mexico**

| Macro-economic Variable | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | Tmca |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Population (thousands) | 107.2 | 108.4 | 109.8 | 111.3 | 112.9 | 114.3 | 115.7 | 117.1 | 118.4 | 119.7 | 121.0 | 1.3% |
| GDP (2008 million pesos) | 11160 | 11718 | 12087 | 12256 | 11680 | 12277 | 12744 | 13287 | 13468 | 13770 | 14110 | 2.7% |
| Exchange rate (pesos per US Dollar) | 10.9 | 10.9 | 10.9 | 11.1 | 13.5 | 12.6 | 12.4 | 13.2 | 12.8 | 13.3 | 15.8 | 3.5% |
| Consumer prices (annual variation percentage | 4.0 | 3.6 | 4.0 | 5.1 | 5.3 | 4.2 | 3.4 | 4.1 | 3.8 | 4.0 | 2.7 | - |

*Source: SENER with information from INEGI (Prospectiva del Sector Eléctrico 2016-2030).*

*Tmca: Average annual growth rate.*

An economy can only grow sustainably when it is productive. Therefore, productivity and its democratization are the most important challenge that Mexico currently faces. The Democratization of Productivity Program identifies low productivity growth as the cause of low economic growth and establishes strategies and lines of action to raise productivity in different sectors of the economy.

The *Law to Promote the Sustainable Increase in Productivity and Competitiveness of the National Economy* establishes the obligation of the Government of the Republic, both current and future administrations, to have a program that explicitly incorporates actions to shore up productivity and competitiveness.

To achieve this, the Government of the Republic undertook the necessary reforms to increase and democratize productivity. There is a special emphasis on the educational, labour, financial, energy, competition and telecommunications reforms.

The goal is to induce a greater formality on the economy, increase the levels of investment in human capital, innovation, and technological development, guarantee greater access to credit, and foster a business environment with adequate conditions for the growth of companies, sectors and regions. All this, in order to foster more and better products and services, under a scheme of greater efficiency in the use of the factors of production. In support to this, a policy of promotion was designed to advance a structural change towards activities of greater benefit and the orderly transformation of traditional sectors to support productivity in Mexico. In the last four years, the Government of the Republic directed its efforts to position Mexico, as an attractive investment benchmark for the energy sector; it was possible to make clear progress in the transformation of the value chain of the sector through the Energy Reform.

The Reform establishes the bases for the construction of an efficient energy sector that allows taking energy to the whole territory continuously and at competitive prices. Likewise, the basis was defined for the new State Productive Companies, which have the obligation to start its operation with a modern and independent corporate government.

### 1.1 Mexico's energy sector in the international environment

Mexico coordinates an agenda of international cooperation in energy matters whose main objectives are:

- Strengthen the consolidation of the energy sector and the positioning of Mexico before the international energy community.
- Use the exchange of experiences and knowledge to implement best international practices in Mexico.

Currently, Mexico has signed 70 international energy cooperation agreements with 23 countries, 3 energy organizations, the International Energy Agency, 3 international initiatives, and 3 energy institutes, among others. Energy cooperation issues include:

- Renewable energy and clean technologies.
- Nuclear energy.
- Rational and efficient use of energy.
- Carbon capture and storage.
- Oil and natural gas.
- Reform and transformation of the electricity sector.

Mexico currently participates actively in the following international initiatives in the field of clean energy and energy efficiency:

- Ministerial of Clean Energies (CEM).
- Alliance of Electrical Systems of the 21st Century (21CPP).

- North American Energy Ministers Working Group on Energy and Climate Change.
- Mexico Denmark Program on Energy and Climate Change.
- Mexico Germany Program in Sustainable Energy and Solar at Large Scale.
- Energy Alliance (AE) Mexico Germany Program.
- The United States Program for the Development of Emissions Reductions (MLED).
- International Energy Efficiency Cooperation Alliance (IPEEC).
- Sustainable Energy for All (SE4ALL).
- Mission Innovation (MI).
- International Renewable Energy Agency (IRENA).
- Carbon Sequestration Leadership Forum (CSLF).
- North American Trilateral Energy Task Force for carbon capture and storage projects.
- Ocean Energy Systems (OES).

As part of these international cooperation activities, Mexico has promoted the following themes:

- Training of talent and human resources in energy.
- Transformation of electrical systems.
- Intelligent electrical networks.
- Solar energy, wind, bioenergy, carbon capture and storage, ocean energy and geothermal.

### 1.2 Accession process to the International Energy Agency

During the Ministerial Meeting of the International Energy Agency (IEA), held in Paris, France, on November 16, 2015, the Ministry of Energy of Mexico made the official request to join this international body. The integration of Mexico into the IEA will allow developing joint responses and global cooperation schemes to guarantee energy security, promote economic development as well as environmental sustainability.

### 1.3 Sixth and seventh Clean Energy Ministerial (CEM6 and CEM7)

During the sixth Clean Energy Ministerial, held in Merida, Mexico on May 2015, Canada, USA, Mexico, and other world leaders announced important actions to accelerate the global transition to clean energy. Among others, these were the commitments reach in this meeting:

- The "Global Lighting Challenge", which aims to place 10 billion efficient, high quality and low-cost lighting products.
- The "Challenge of Electric Systems", which is aimed at facilitating the use of smart grids and renewable energy sources such as solar or wind.
- Strengthening the "Clean Energy Solutions Center" in which real-time, cost-effective expert support is provided to up to 80 countries around the world on clean energy policy issues.
- Recently, during the seventh Clean Energy Ministerial, held in San Francisco, USA on June, 2016; the agreements reached during the CEM6 were followed up, in addition to new announcements of the ministers of the three countries, among which stand out:
    - Announcement of the "Energy Management Campaign" which aims to achieve fifty-one thousand certifications under the ISO 50001 energy management system by the year 2020.

- Launching of the PRODETES (Sustainable Energy Technologies Development Project) Prize, which provides an incentive bag for up to 3.5 million US dollars to clean technologies in its pre-commercial or commercial stages.

As part of the "Innovation Mission" initiative, Mexico announced that it would quadruple its investment in research and development for clean energy to a total of US $ 310 million by 2018.

## 2. INSTITUTIONAL FRAMEWORK

### 2.1 Ministry of Energy (SENER)

SENER is responsible for conducting the Mexico's energy policy, within the current constitutional framework, to guarantee the competitive, sufficient, high-quality, economically accessible and environmentally sustainable supply of energy that requires the development of Mexico, endowing the population of full access to energy inputs, at competitive prices. SENER must do this through public and private companies of world quality, operating within an appropriate legal and regulatory framework.

### 2.2 National Commission for the Efficient Use of Energy (CONUEE)

A decentralized administrative body of SENER that has technical and operational autonomy. Its purpose is to promote energy efficiency and to play its role as a technical body in the field of sustainable energy use. In other words, CONUEE is the federal agency responsible for energy efficiency programs implementation in Mexico.

### 2.3 Energy Regulatory Commission (CRE)

A coordinated regulatory body in energy matters autonomously, transparently and efficiently directs the interests of users and regulated subjects to the development of a competitive and sustainable energy market for the benefit of society. It regulates in a transparent, impartial and efficient manner the activities of the energy industry that are within its competence, in order to generate certainty that encourages productive investment, fosters healthy competition, provides adequate coverage and reliability, quality and safety in the supply, delivering services at competitive prices, for the benefit of society. In other words, CRE is the energy sector's main regulatory institution.

### 2.4 National Energy Control Centre (CENACE)

CENACE is the power grid Independent System Operator; it performs its functions under the principles of efficiency, transparency and objectivity, meeting the criteria of quality, reliability, continuity, safety and sustainability in its operation and control.

CENACE is a decentralized public body whose objectives are to exercise the operational control of the National Electrical System, the operation of the Wholesale Electricity Market, and to guarantee impartiality in access to the National Transmission Network and to the General Distribution Networks.

It carries out the operation of the Wholesale Electricity Market in conditions that promote competition, efficiency and impartiality, through the allocation and optimal dispatch of generation plants to satisfy the energy demand of the National Electricity System.

It is responsible of the formulation of programs for the expansion and modernization of the National Transmission Network and the General Distribution Networks, which, if authorized by SENER, will be included in the National Electricity System Development Program (PRODESEN).

### 2.5 National Institute of Electricity and Clean Energy (INEEL)

A decentralized public body of SENER, with legal personality, property and autonomy of management, in accordance with the applicable provisions of the Federal Law of Parastatal Entities. INEEL used to be the Institute of Electricity Research (IIE) but in December 2015, according with the Energy Transition Law; it was assigned new tasks and responsibilities as well as a new name transforming it into the National Institute of Electricity and Clean Energy (INEEL).

### 2.6 Federal Electricity Commission (CFE)

It is the state-owned electric utility, defined by the 2013 reform as a State Productive Company, which objectives are to provide the public electric energy service with criteria of sufficiency, competitiveness and sustainability to generate, transmit, distribute and commercialize electric energy; and contribute through this to the transition to a low-carbon energy matrix.

### 2.7 Electric Energy Savings Trust Fund (FIDE)

It is a private, non-profit trust, constituted at the initiative of CFE, in support of the Electric Energy Savings Program. It is an organization that contributes to Mexico's energy security, mitigation of environmental impact and social equity; provides financing, certification and technical assistance; promotes and develops integral programs and projects of saving, conservation and efficient use of energy, distributed generation, cogeneration and use of renewable sources for the energy transition. In addition, it develops applied research and technological innovation, and disseminates the culture of saving and the efficient use of energy.

### 2.8 Ministry of the Environment and Natural Resources (SEMARNAT)

SEMARNAT is responsible for designing and implementing, within its competence, the promotion and regulatory instruments to prevent, control and remediate pollution from the generation and transmission of electrical energy, including greenhouse gases and compounds. SEMARNAT is also responsible of the elaboration of Mexican Official Standards (NOMs) that establish limits of progressive emissions according to the type of technology of electricity generation, considering best practices. SEMARNAT is also responsible for determining negative externalities originated by the fossil energies.

### 2.9 Ministry of Economy (SE)

In coordination with SENER, the Ministry of Economy is responsible for designing and implementing a roadmap to promote the development of clean energy value chains, under conditions of economic sustainability and in accordance with the approved budgetary conditions, which will indicate the specific instruments for the promotion of the development of value chains of clean energies. The Ministry of Economy also offers direct support to small and medium-sized enterprises using existing mechanisms; prepares a study to determine the needs and potential of the electric power industry in clean energy; and promotes investment in technological development and innovation in clean energy.

## 3. ELECTRICITY SECTOR OVERVIEW AND FORECAST 2016-2030

### 3.1 Regulatory and Policy Framework for the Electricity Sector

In Mexico, the necessary mechanisms are being developed to carry out a transition for a greater use of clean energies. To achieve this purpose a series of mandates were established both in the Law of the Electricity Industry (LIE), as in the Energy Transition Law (LTE), which provide the legal basis to increase the participation and regulation of clean energies in the electricity generation process.

In order to carry out the energy transition process and to fulfil the objective of increasing gradually the share of clean energy in the electricity generation matrix, the LTE is supported by strategies, programs, measures and public policies that allow to increase the share of clean energies and to meet the established goals. The strategy serves as an instrument for continuous improvement that includes the evaluation of its partial results, the identification of barriers and opportunities for improvement. The strategy also considers the adoption of corrective measures if some compliance indicators are not achieved.

An important part of accomplishing an effective energy transition is promoting projects that create added value to the energy industry. Other important aspects are to strengthen and promote the institutes of research and education, providing the necessary tools to strengthen the sector with the development of new technologies and the human capital required to carry out this transition.

The indicative planning for the next fifteen years was presented in May 2016 with the publication of the National Electricity System Development Program (PRODESEN) in May 2016. The basis of this program is on the Law of the Electricity Industry, in which the collaboration of the Ministry of Energy is vital, since the planning of the electric sector is a strategic area[1].

### 3.2 Structure of the Electricity Sector

The electricity sector in Mexico is made up of a group of actors, both public and private, that intervene in the processes of generation, transmission, distribution, commercialization and operational control of electrical energy.

The restructuring of the sector is an answer to citizen's needs, which require cheaper, efficient and high-quality electricity. For the industrial and commercial sector, it is vital to reduce energy prices to reduce their costs, allowing a growth in their production or services provided, thus increasing the productivity of the Mexican economy. This transformation seeks the equality of conditions for public and private companies, creating more competitiveness, allowing them to offer electricity at lower prices and promoting the use of clean energy.

The process of transformation requires a greater integration of all the institutions involved in the electricity sector, which contribute to its smooth functioning and, with the support of the various legal systems, develop a new model of modern, efficient and competitive Mexican Electricity Market. The Ministry of Energy (SENER), the Energy Regulatory Commission (CRE) and the National Energy Control Centre (CENACE) are key public bodies

[1] SENER (2016) Prospectiva del Sector Eléctrico 2016-2030: http://www.gob.mx/cms/uploads/attachment/file/177626/Prospectiva_del_Sector_El_ctrico_2016-2030.pdf

in the electricity sector, which have the powers to carry out a planning of the sector according to the requirements of the population.

Because SENER leads the energy sector, it supervises and leads the realization of programs, projects, studies, prospects, economic and social guidelines, official standards, methodologies, conventions and treaties, administrative procedures and sanctions.

The Federal Electricity Commission (CFE), the state owned power company, is also under transformation. From being a vertically integrated company, at the end of 2016 it had created 13 subsidiaries and affiliates: six generation subsidiary companies, CFE Transmisión, CFE Distribución, CFE Suministro Básico, CFE Generador de Intermediación, CFE Calificados, CFEnergía and CFE International. Additionally, CFE is now facing competition from other companies in the generation and wholesale supply sectors where private companies are now allowed to participate.

The main strategies that will achieve the objectives of the electric sector reform include the renewal of the power generation infrastructure with the use of more efficient technologies and lower levels of pollution, the expansion of transmission infrastructure and the modernization of distribution networks.

This will create greater opportunities for the participation of companies in the sector and the adoption of new technologies, promoting the diversity of power generation sources and the reduction of costs in all segments of the productive chain. As a result, the households, businesses, and industries will be substantially supported by reducing their electricity rates.

Historically, the electricity sector has been an important factor in boosting Mexico's economy. With the Energy Reform, the Mexican government has established the objective of providing a better quality, lower cost and more environmentally friendly electricity service. Thanks to the increasing development and availability of natural gas, the costs of electricity generation have been reduced by substituting expensive and highly polluting fuels such as fuel oil and diesel.

### 3.3 New Markets

The Official Electricity Market Guidelines (*Bases del Mercado Eléctrico*) established the principles that guide the design and operation of the Wholesale Electrical Market (MEM). This document also define the rules and procedures that its participants will carry out in order to commercialize energy, related services, Clean Energy Certificates (CELs), transmission financial rights, among others, in the different modalities. Market participants will represent power plants or load centres, depending on their contract with CENACE.

The Clean Energy Certificates (CELs) are securities issued by the CRE that accredit the production of a determined amount of electricity generated from clean sources that meets the requirements associated with the consumption of the load centres. With this instrument, the domestic targets will become individual obligations.

The CELs are an instrument to promote new investments in electricity generation coming from clean sources, as different technologies will compete with each other to meet the goals. Generators and distributors can sell and buy CELs in proportion to their electricity consumption. If they do not accomplish the minimum percentage (5%)

of energy generation from clean sources, the producer or distributor must pay the fine imposed by the authority, which will be equal to the highest CELs price.

In this way, power generators using renewable sources can make profits by selling two goods:

1 The electricity generated and sold to the grid or off-the-grid consumers.
2 CELs materialized in commercial bonds.

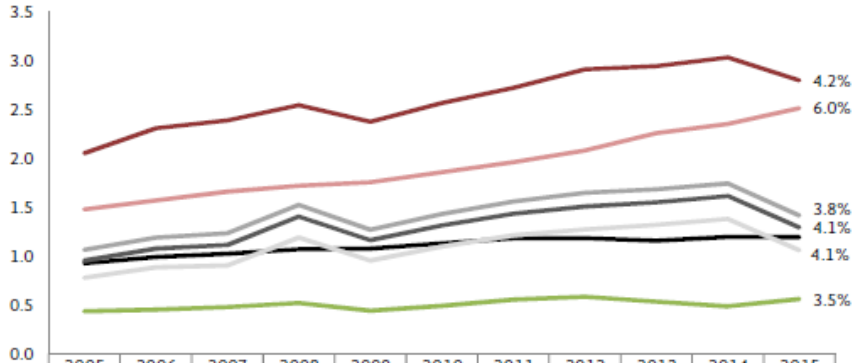
### 3.4 Power users

One of the commitments made in this six-year presidential period is to increase the percentage of the population with access to the electric power service. At the end of 2015, CFE reported 39.7 million users, an increase of 3.0% over 2014 (equivalent to 1.16 million annual customers). In recent years, the residential service has maintained the highest level of electricity supply, representing 88.6% of CFE's total customers, 9.8% at commercial section, and 1.6% in the industrial, services and agricultural sectors.

### 3.5 Electricity price and rates

In 2015, the availability of natural gas and its low prices resulted in a reduction in electricity rates. This situation drove to a progressive substitution of fuel oil and diesel by cheaper sources of energy, as is the case of natural gas. In 2015, the average price of electricity decreased approximately 11.9% compared to 2014, to 1.4 pesos per kilowatt-hour. The commercial and industrial sectors showed reductions of 7.7% and 19.8% (see Figure 1.1).

**Figure 1.1 - Average price of electric energy per sector. (Mexican pesos/kWh)**




| | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Comercial | 2.1 | 2.3 | 2.4 | 2.5 | 2.4 | 2.6 | 2.7 | 2.9 | 2.9 | 3.0 | 2.8 |
| Servicios | 1.5 | 1.6 | 1.7 | 1.7 | 1.8 | 1.9 | 2.0 | 2.1 | 2.3 | 2.4 | 2.5 |
| Empresa mediana | 1.1 | 1.2 | 1.2 | 1.5 | 1.3 | 1.4 | 1.6 | 1.6 | 1.7 | 1.7 | 1.4 |
| Residencial | 0.9 | 1.0 | 1.0 | 1.1 | 1.1 | 1.1 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| Gran industria | 0.8 | 0.9 | 0.9 | 1.2 | 1.0 | 1.1 | 1.2 | 1.3 | 1.3 | 1.4 | 1.1 |
| Agrícola | 0.4 | 0.5 | 0.5 | 0.5 | 0.4 | 0.5 | 0.6 | 0.6 | 0.5 | 0.5 | 0.6 |
| Industrial | 1.0 | 1.1 | 1.1 | 1.4 | 1.2 | 1.3 | 1.4 | 1.5 | 1.6 | 1.6 | 1.3 |

*Source: SIE, SENER. Prospectiva del Sector Eléctrico 2016-2030.*

The Ministry of Finance and Public Credit (SHCP), with the participation of the Ministries of Energy (SENER) and Economy (SE), and the Federal Electricity Commission (CFE), shall fix the rates, in order to meet the financial and expansion needs of the public service, and the rational consumption of energy.

The average prices of electric energy for the different sectors reflect differentiated rates for the commercial, services, and industrial sectors. Because of the incentives to agricultural activity, this sector has the lowest and most stable rate for the last 15 years. The rates for the supply and sale of electric energy are classified according to their use and voltage level.

The electricity rates depend on several factors, including the costs associated with generation, transmission and distribution of electricity. These rates also include the operating, maintenance, and depreciation costs of generation plants. Electricity rates are part of the rate of generator's profits, which in turn may be reinvested in the electricity system's infrastructure.

General rates have consumption and demand charges with regional differences, time and seasons. Domestic, public and agricultural services are adjusted by fixed factors, with no time differences.

**3.6 Subsidies on electricity rates**

Subsidies for electricity rates are defined as the difference between the price of the electricity paid by consumers and the average cost of supply. The subsidies on CFE's rates are financed through accounting records. The Federal Government reimburses CFE for part of the subsidies transferred to its consumers.

The commercial rates of industrial and domestic consumption are not subsidized, but in many cases, they pay more than their service cost. The surplus contributions of these users are used to offset some of the subsidies granted to other type of users. Therefore, the funds provided by the Federal Government cover only a share of the total subsidy. In Mexico, the subsidy is implicit in domestic rates, with the exception of consumers who are subject to the "high consumption household" rate and do not receive any type of subsidy.

Other household rates are subsidized depending on the temperature and season in which they are applied. Subsidies have three ranges, in which regions with higher temperatures, receive higher subsidies.

At the end of 2012, the estimated amount of subsidies granted to household users amounted to 89,821 million pesos. Industrial and commercial rates do not have subsidies and tend to cover costs.

**3.7 Mexico's consumption of electricity**

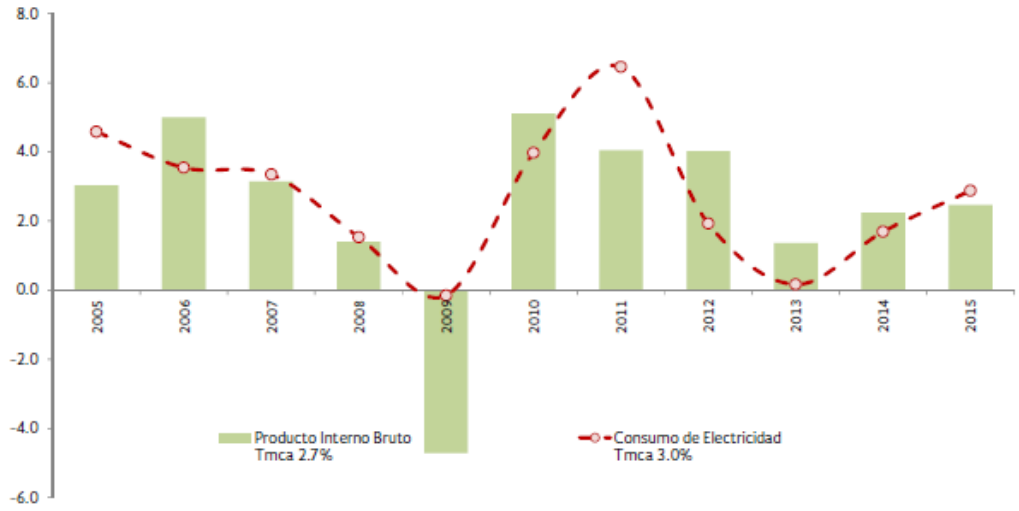
There is a strong correlation between the Mexican economy and the consumption of electricity, as the economic performance is directly related to the productive activities developed, such as industrial and commercial activities.

In recent years, economic growth has presented a modest recovery, with growth rates of 1.1% and 2.5% in 2013 and 2014, respectively. This growth was largely due to the boost in manufacturing exports, derived from the automotive industry.

The Energy Reform will give a boost to Mexico's economic growth, since it expects an increase in oil and gas production, as well as providing cheaper energy inputs to Mexican industries, thereby increasing the demand for electricity.

Between 2004 and 2014, domestic electricity consumption increased at an average rate of 2.9% per year, reaching 244,673.1 Gigawatt hours (GWh) in 2014. On the other hand, GDP presented an average annual growth rate of 2.5 %, in the same period, as shown in Figure 1.2, below.

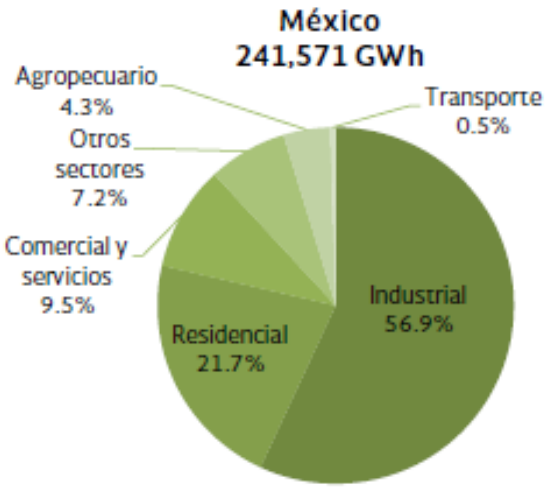
**Figure 1.2 - Evolution of GDP and consumption of electric energy in Mexico, 2005-2015 (percent annual variation)**




*Source: SENER, with information of INEGI and CFE. SENER. Prospectiva del Sector Eléctrico 2016-2030.*

In order to estimate the demand for electrical energy, it is necessary to consider several factors, such as the sales in the various zones of Mexico, electrical losses, historical behaviour of the factors of load, and a diversity of scenarios of sectorial consumption of electricity, among others. Between 2016 and 2030, the planning scenario expects annual growth on gross consumption of 3.4%, amounting for 476.0 TWh (See Figure 1.3).

**Figure 1.3 - Mexico's composition of electricity consumption per sector, 2013 (GWh, percentage)**



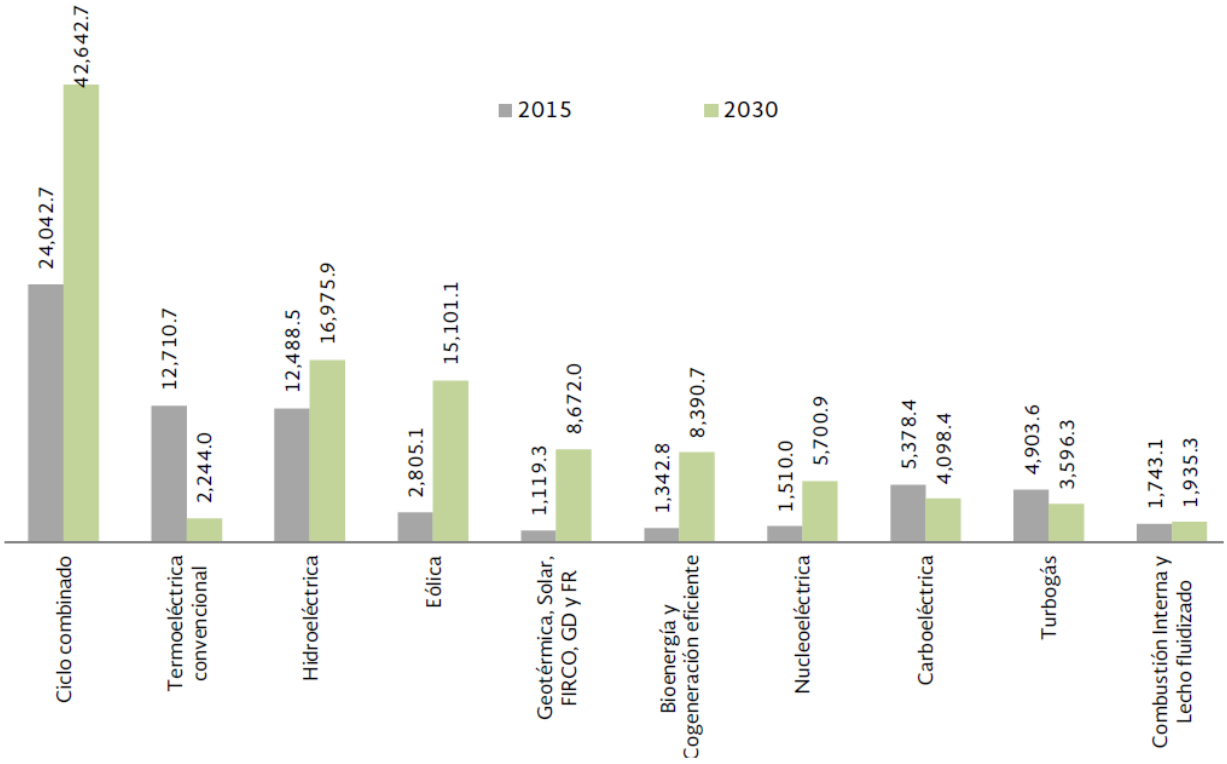

*Source: Electricity information 2015, International Energy Agency.*

The behaviour of the low prices of electric energy, and the loss reduction programs implementation, allowed the

commercial, middle-size industry and domestic sectors to have important increases in the volume of energy consumed.

With the increasing consumption of electricity, it is necessary to expand the infrastructure to respond to such needs. Increasing capacity for electricity generation requires considering several factors that influence investment decisions, such as the availability of fuel in the area where the plants will be installed, the costs of the various technologies to choose, the polluting effects, among others (Figure 1.4).

**Figure 1.4 - Installed capacity evolution per technology, 2015-2030 (MW)**




*Source: SENER. Information from PRODESEN.* *SENER. Prospectiva del Sector Eléctrico 2016-2030.*

Although Mexico maintains an important generation capacity based on fossil fuels, it has sought mechanisms to promote the diversification of its energy matrix. In this sense, it seeks to boost the development of sources such as geothermal and wind energy, increasing its share of Mexico's total net electricity capacity.

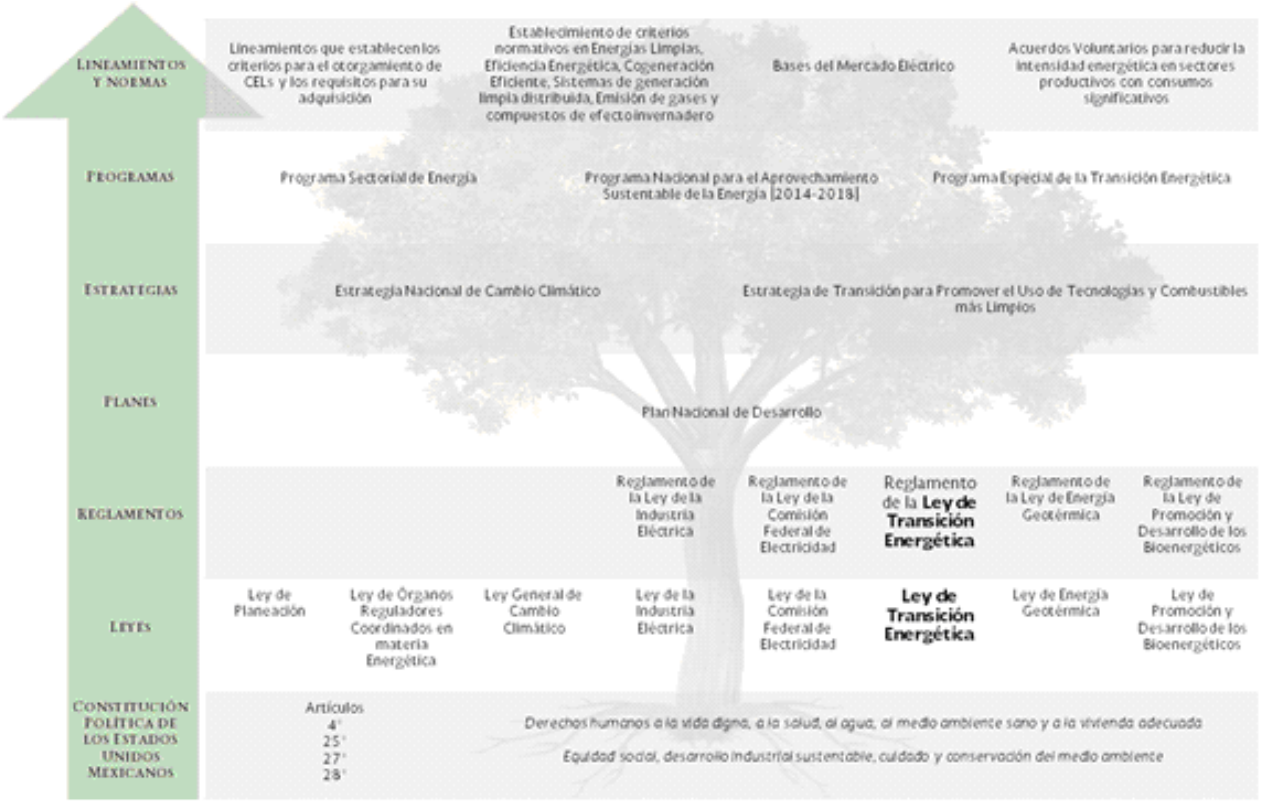
Within the new electricity generation modalities, CFE's generation share will be reduced from 55.2% in 2015 to 39.0% in 2030. This reduction is largely due to the restructuring of the Energy Reform.

Finally, at the North American level, new generation capacity must replace plants with high levels of pollutants or inefficiency; hence, there is a constant exchange with the United States and Canada of technological information that contributes to the improvement of power generation in the region.

## 4. LEGAL FRAMEWORK

The publication of the Energy Transition Law (LTE) on December 24, 2015 in the Official Journal of the Federation (DOF) derives from a legal framework that started from rights established in the Political Constitution of the United Mexican States. This Energy Transition period is outlined and framed by a broad set of laws, regulations, plans, programs, guidelines and standards that have been developed over the last few years (see Figure 1.5).

**Figure 1.5 - Legal framework of the Energy Transition**




### 4.1 Energy Transition Law (LTE)

On December 24, 2015, the Mexican Congress enacted the LTE, defining the legal basis to promote a transformation towards a sustainable energy and economic model in the long term. The LTE in its Article 3 defines the Strategy, the Special Program for Energy Transition (PETE) and the National Program for the Sustainable Use of Energy (PRONASE), which became obligatory policies on clean energy and energy efficiency.

The Energy Transition Law (LTE) aims to regulate the sustainable use of energy, as well as the obligations in clean energy and reduction of emissions of pollutants of the Electrical Industry, maintaining the competitiveness of productive sectors.

The LTE goals are, among others:

- To anticipate the gradual increase of the participation of clean energies in the electric industry with the objective of meeting the established goals in the field of clean energy generation and emissions reduction.

- Facilitate compliance with the clean energy and energy efficiency goals referred to in this law in an economically viable manner.
- Incorporate externalities in the evaluation of the costs associated with the operation and expansion of the electrical industry, including those on health and the environment.
- Determine the obligations regarding the sustainable use of energy and energy efficiency.
- Establish mechanisms to promote clean energy and reduce pollutant emissions.
- Reduce, under conditions of economic viability, the generation of pollutant emissions in the generation of electric energy.
- Support the objectives of the General Law on Climate Change, related to the greenhouse gas emissions reduction targets and the generation of electricity from clean energy sources.
- Promote the sustainable use of energy in final consumption and energy transformation processes.
- Promote the efficient use of energy and renewable resources and waste.
- Approve the obligations established in the field of clean energy and reduction of emissions of pollutants of the electricity industry to products consumed in Mexico's territory, regardless of their origin.

To this end, the LTE mandates the elaboration of a Transition Strategy to Promote the Use of Cleaner Technologies and Fuels.

The strategy comprises five stages:

1. Compilation of information.
2. Public consultation.
3. Integration.
4. Review by the Energy Transition Advisory Board.
5. Approval and publication by the Ministry of Energy (SENER).

The collection of information was a process that involved the different areas of Mexico's energy sector, its actions and programs and the analysis of the future technical, scientific, technological, economic, financial, fiscal, environmental and social conditions of the infrastructure for exploitation, production, transformation, transmission, distribution and end-use of energy.

The strategy was developed under consultation mechanisms established after the installation of the Consultative Council for Energy Transition (CCTE) on April 7, 2016, according to the mandate of the LTE, creating four working groups:

- Energy production.
- Energy consumption.
- Energy efficiency.
- Energy storage.

The leaders of each group called on representatives of both public and private sectors in the energy field to participate in forums and workshops during May and June 2016. These forums were organized in order to make a diagnosis on energy transition, analyse the current domestic situation and international trends in energy efficiency and clean energy, as well as identifying policies and actions for the strategy. SENER established

different channels of permanent communication for the reception of contributions and interaction with representatives. As a result, the groups obtained through surveys, papers, shared documents and proposals, 451 opinions in total.

The strategy is the guiding instrument of Mexico's energy policy in the medium and long term in clean energy, sustainable energy use, improved energy productivity and economically viable reduction of pollutant emissions. To this end, this instrument must establish goals of clean energy and energy efficiency, as well as its respective roadmap for the implementation of these goals.

### 4.2 Components of the Transition Strategy to Promote the Use of Cleaner Technologies and Fuels

The strategy contains:

- A long-term planning component for a period of 30 years.
- A medium-term planning component for a period of 15 years.

#### *4.2.1 Long-term planning component for a period of 30 years*

In this component, the scenarios proposed to meet the clean energy goals and the energy efficiency goal are defined, which contains a set of analysis and studies on technical, scientific, technological, economic, financial, fiscal, environmental and social impacts of the infrastructure for exploitation, production, transformation, transmission, distribution and end-use of energy.

#### *4.2.2 Medium-term planning component for a period of 15 years*

This component identifies the goals of clean energy and energy efficiency in 15 years, as well as their degree of compliance and establishes a diagnosis of:

- The state of art of the electrical industry, in general, and electricity generation through clean energy in particular.
- The final energy consumption level.
- Obstacles to the development of clean energy.
- The environmental pollution caused by the electricity industry, according to the information provided by the Ministry of Environment and Natural Resources (SEMARNAT).
- Dependence on fossil energy sources for electricity generation and progress in energy efficiency.
- Technological evolution in electricity generation and cost reduction, as well as other technology elements that can add value to the National Electricity System.

## 5. FINANCING MECHANISMS

Several mechanisms support the energy transition through the direct financing of projects related to clean energy and energy efficiency. Mechanisms for funding research and technological development include granting of preferential rates for investments in the productive sector, financing through development banks with traditional schemes, or institutions that finance infrastructure projects aimed at particular sectors.

A common element in several of these mechanisms is that they often serve as recipients of international funders, and they have strict criteria for project selection, as well as very robust monitoring and evaluation tools. Another common element is a high degree of certainty in the achievement of the stated objectives.

### 5.1 Energy Transition and Sustainable Use of Energy Fund (FOTEASE)

The FOTEASE was created in accordance with article 27 of the Law for the Use of Renewable Energy and Financing of Energy Transition (LAERFTE), with the purpose of promoting energy transition, energy savings, clean technologies development and the use of renewable energies. This is achieved through the granting of credit guarantees or other financial support for projects that meet the objectives of the National Strategy for Energy Transition and Sustainable Use of Energy (ENTEASE).

Since 2009, around 9.4 billion pesos have been authorized through 41 projects, distributed as follows: 74% related to energy efficiency and 36% to renewable energy. In 2015, 420.3 million pesos were assigned to the trust from the Federal Expenditure Budget (PEF). As a result, the total resources managed by FOTEASE in favour of its beneficiaries during 2015, was of 1.048 billion pesos.

Some of the most relevant programs supported by FOTEASE are:

- Energy Savings Appliance Replacement Program,
- National Energy Efficiency Project for Municipal Public Lighting,
- Sustainable Light Program,
- Incandescent bulbs replacement for energy-saving lamps;
- Business Energy Efficiency Savings Program;
- Renewable energy technologies in distributed electricity generation;
- ILUMEXICO Rural Illumination Program,
- The initiative for the development of the wind sector in Mexico,
- The initiative for the development of renewable energies in Mexico.

### 5.2 Electric Energy Savings Trust Fund (FIDE)

Between 1990 and 2014, FIDE conducted 1.8 million energy diagnoses, 4,000 financed projects and 2.6 million pesos in credits (of which 72% corresponded to the Home Appliances Replacement Program and the rest to the Energy Saving Financing Program). Finally, FIDE has financed 60 million compact fluorescent lamps (CFLs), among other actions.

### 5.3 Shared Risk Trust (FIRCO)

FIRCO is a parastatal entity, created by Presidential Decree and leaded by the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA), to promote agribusiness, rural development by micro-basins and to perform functions as technical agent in programs of the agricultural and fishery sector.

The SAGARPA-World Bank-FIRCO program has used 60.5 million dollars for the development of a plan for the installation of renewable technologies in rural areas.

### 5.4 Trust Funds for Agriculture (FIRA)

FIRA is comprised by four public trusts, and its purpose is to facilitate access to credit, as well as the granting of credit guarantees to projects related to agriculture, livestock, poultry, agribusiness, fishing and other related activities related to rural areas.

FIRA's Energy Efficiency Program aims to help agro-industries invest in energy efficient technologies.

### 5.5 National Infrastructure Fund (FONADIN)

The National Infrastructure Fund (FONADIN) is the coordinating vehicle of the Government of Mexico for the development of infrastructure in energy, communications, transport, water, environment and tourism. In terms of clean energy, the fund has supported projects such as the Piedra Larga Wind Farm (Oaxaca) and the development of integrated urban transport systems in several cities throughout Mexico.

### 5.6 National Bank of Foreign Trade (BANCOMEXT)

This bank has a financing program for renewable energy and energy efficiency projects for the granting of long-term resources. Among others, BANCOMEXT and the KfW (German Reconstruction Credit Institute) have signed an agreement to contract credit lines to support the financing of solar energy projects.

### 5.7 Nacional Financiera S.N.C. (NAFIN)

It facilitates financing for the development of renewable energy projects and energy efficiency with international organizations' resources.

### 5.8 National Works and Public Services Bank (BANOBRAS)

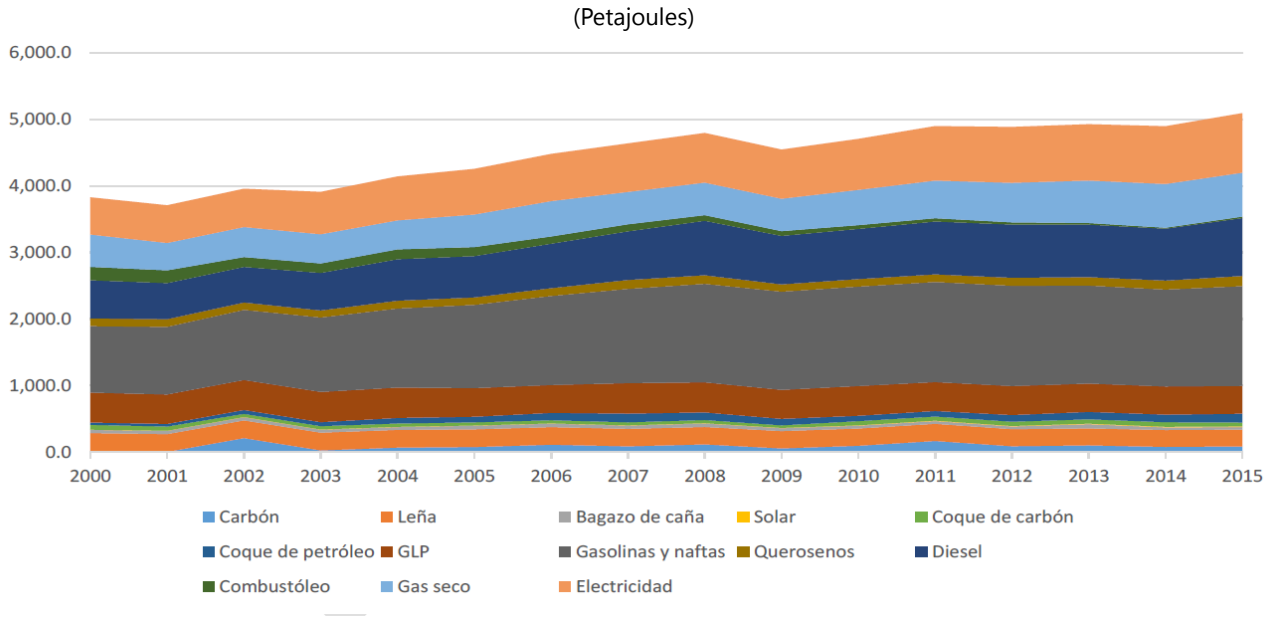
Its purpose is to finance or refinance public or private investment projects in infrastructure and public services, at the federal, state and municipal levels. It also encourages private investment in the development of infrastructure in Mexico through various financing schemes for projects carried out under the public-private partnerships.

## 6. EFFICIENCY POTENTIALS AT THE SECTORAL LEVEL

### 6.1 Energy consumption by end use sector and trends

In 2015, Mexico's energy consumption was 8,442 Petajoules. Electricity consumption had the highest growth in final energy consumption with 60% from 2000 to 2015, followed by diesel with 51%, gasoline with 50% and natural gas (dry gas) with 36%. Likewise, fuel oil consumption fell by almost 90%, while LP gas did by 7% (see Figure 1.6).

**Figure 1.6- Total Energy consumption per fuel**




*Source: Energy Information System, SENER.*

Thus, in 2015 oil and petroleum products accounted for 58% of total energy consumption, distributed in the following way: 30% gasoline, 17% diesel, and 8% LP gas. Electricity summed 17% of total energy consumption, while renewables (hydro, wind and solar) had 6%.

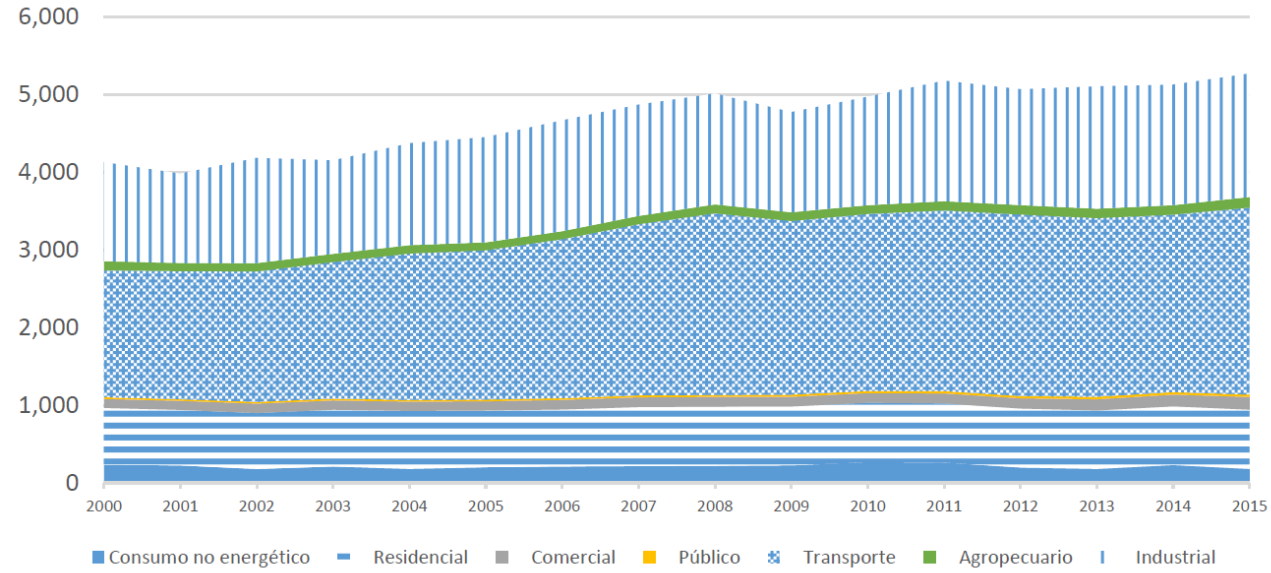
### 6.2 Consumption by sector

Energy consumption grew by 30% between 2010 and 2015; the transport sector had the highest growth (47%), followed by industrial (25%) and finally, the residential sector, which only grew by 3%. (See Figure 1.7).

In 2015, as a fraction of the final energy consumption, the transport sector accounted for 46%, followed by the industrial sector 30% and then by the residential sector 14%.

**Figure 1.7 – Final energy consumption per sector**

(Petajoules)



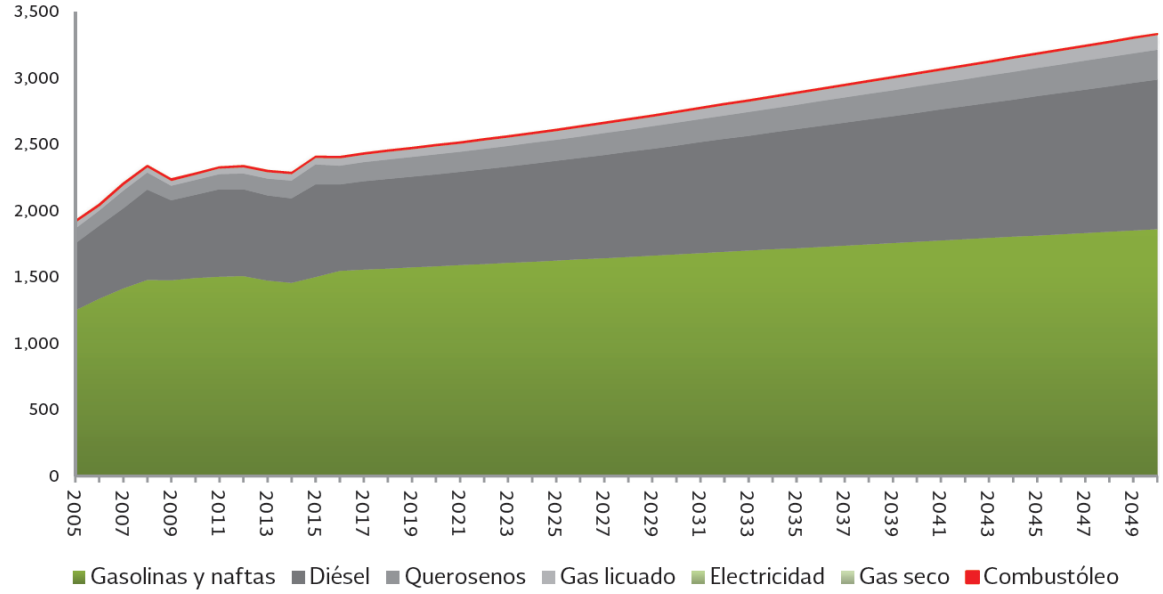

*Source: Energy Information System, SENER.*

### *6.2.1 Transport sector*

The transport sector consumes 46% of Mexico's total final energy consumption, wherein 92% is dedicated to motor transport. Likewise, gasoline accounts for 71% of energy consumed in motor transport, mainly by private passenger vehicles. Passenger buses and freight trucks consume mostly diesel, accounting for 26% of energy consumed in motor transport. This implies that private passenger vehicles account approximately for 30% of total energy consumption (see Figure 1.8).

**Figure 1.8- Fuel consumption for transport sector**

(Petajoules)




*Source: Energy Information System, SENER.*

The demand for mobility will increase in the future, as population is expected to grow to 150 million people by 2050 and greater economic development will be achieved. To advance the energy transition, the transport sector must incorporate new technologies and reduce fossil fuels consumption.

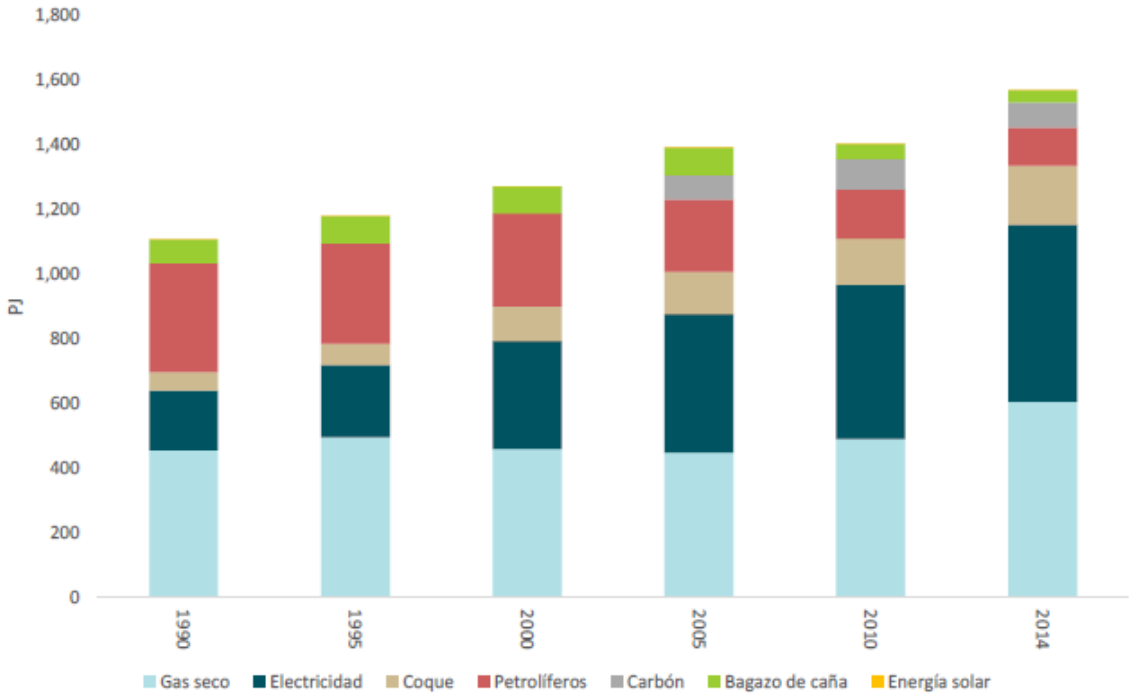
### *6.2.2 Industrial sector*

The industrial sector experienced a remarkable change in its energy matrix between 1990 and 2015. This change was mainly due to greater consumption of electricity and coke in the most intensive industries. For example, the most energy-intensive industry has been the basic iron and steel industry, which accounted for 13.6% of industrial consumption in 2015.

Likewise, the mining industry experienced a structural change by reducing its dry gas consumption by about 3.8% annually, replacing it with electricity at a rate of 6.9% per year (see Figure 1.9).

**Figure 1.9. Energy consumption for the industrial sector**

(Petajoules)




*Source: Energy Information System, SENER.*

The cement industry has been a major energy consumer with 10% of the industrial consumption in 2015. Between 1990 and 2014, it reduced its fuel oil consumption by an average of 16.1% annually, while its electricity consumption increased by 5.4% and coke by 39.5%. In addition, this industry uses other alternative sources to cover its energy requirements, such as tires, solid waste, and liquid waste.

In 2014, natural gas was the most consumed fuel by the industry, representing 38.5% of the sector's demand;

electricity was the second energy source with 35%, followed by coke with 11.6%. On the other side, sugarcane bagasse consumption recorded a negative growth of 2.8% per year.

### *6.2.3 Residential, commercial and public sector*

In 2015, the residential and commercial sectors consumed 19% of final energy in Mexico. The majority of this consumption was in the residential sector, with about 82% of this share. Households in Mexico consume 74% of its energy in thermal uses (LPG, natural gas and fuelwood), while 26% is electricity, which demand increases by 0.6% each year.

Solar energy (photovoltaic) showed the highest growth rates in this sector due mainly to the direct use of this technology in urban areas. However, its share in the sector's matrix is still marginal, since in 2014 it barely represented 0.6% of the total demand.

### *6.2.4 Farming*

In 2014, this sector accounted for 3.3% of final energy consumption and increased at an approximate rate of 2.3% per year between 1990 and 2014, with diesel and electricity being the most widely used energy sources.

## 7. SCENARIOS: FORECAST, MEDIUM AND LONG-TERM GOALS

### 7.1 Legal and programmatic references

The scenarios and goals set forth in this strategy are fundamentally based on the Energy Transition Law and the Electricity Industry Law. These legal instruments include provisions of the General Law on Climate Change, instruments such as the National Climate Change Strategy, the National Electricity System Development Program (PRODESEN), and the Intended Nationally Determined Contributions (INDC) of Mexico to the United Nations Framework Convention on Climate Change.

Mexico assumed in the General Law on Climate Change the indicative objective or aspirational goal of reducing its emissions by 30% compared to the baseline of 2020 and in 50% by 2050, in relation to those emitted in the year 2000. Furthermore, power generation with clean energy sources must reach at least 35% by 2024.

Mexico sent in March 2015 its Intended Nationally Determined Contribution (INDC) to reduce its emissions of greenhouse gases (GHG) and black carbon. The Non-Conditional Target is set to reduce GHG emissions in 22% by 2030 compared to the baseline, and in 50% by 2050, both targets baseline year is 2000. Electricity generation will contribute to a 31% reduction in $CO_2$ emissions by 2030.

### 7.2 Sectorial Scenarios

The baseline outlines a "business as usual" and "transition" scenario includes actions to establish or evaluate the fulfilment of goals related to clean energy and energy efficiency.

The scenarios are based on variables that reflect the growth of the economy, the expected evolution of population and oil prices:

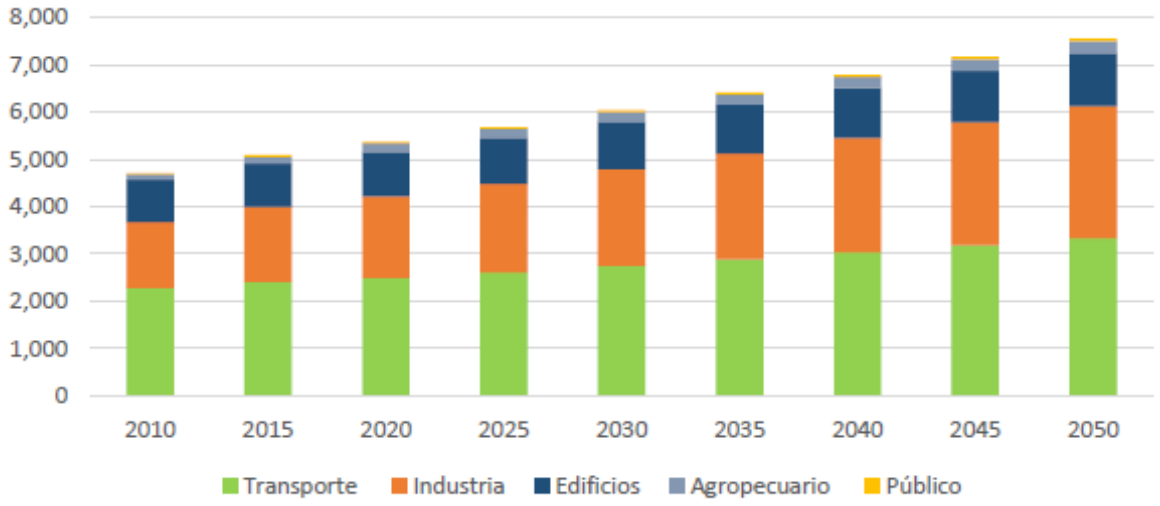
- Population of 137.5 million inhabitants in 2030 and 150.8 million in 2050.
- Average annual growth rate of economic activity of 3.3% for the period 2016-2050.
- The GDP growth breakdown by the main productive sectors was estimated in the following way for the prospective period:
    - Agricultural sector: 2.9%.
    - Mining Sector: 3.0%.
    - Manufacturing Sector: 4.1%.
    - Construction Sector: 3.3%.
    - Services Sector: 3.1%.

### 7.3 Business as usual (BAU) scenario

This scenario estimates an average annual growth of 1.3%, from 5,129 Petajoules (PJ), in 2016 to 7,546 PJ in 2050 (Figure 1.10).

**Figure 1.10. Total final consumption per sector (BAU scenario) 2016-2050**

(Petajoules)




*Source: SENER*

### 7.4 Transition scenario

The "transition" scenario reflects the use of different energy saving potentials in final consumption sectors. This scenario proposes to strengthen actions based on existing energy efficiency measures to stabilize the growth of energy consumption in the short and medium term. In the long term, it requires structural changes that involve the transformation of industrial production schemes, new infrastructure to give universal access to public and private electric transport in cities, and improving the energy performance of residential and commercial buildings. These long-term elements are expected to affect significantly energy consumption.

In Mexico, industry, buildings and transportation are the main energy consumers, the latter being the most demanded. It is possible to reduce demand in these sectors without affecting their productivity and competitiveness by significantly increasing energy efficiency, introducing new technologies and substantially changing consumptions patterns.

The essential components of the reduction in energy demand are:

- Significant improvements in energy efficiency.
- Increase of recycling processes in key industries.
- Replacing inefficient or old equipment in the industrial and commercial sectors.
- Massive increase of public transport infrastructure in urban centres and reduction of private car use.
- Electrification of public and private transport sector, as much as possible.

The industrial sector could reduce its energy demand through a strong investment in recycling, equipment replacement, process integration and cogeneration.

The residential sector has a great potential for saving energy in lighting and space cooling. Additionally, water heating could be supplied with solar water heaters. On the other hand, the greatest energy savings in commercial

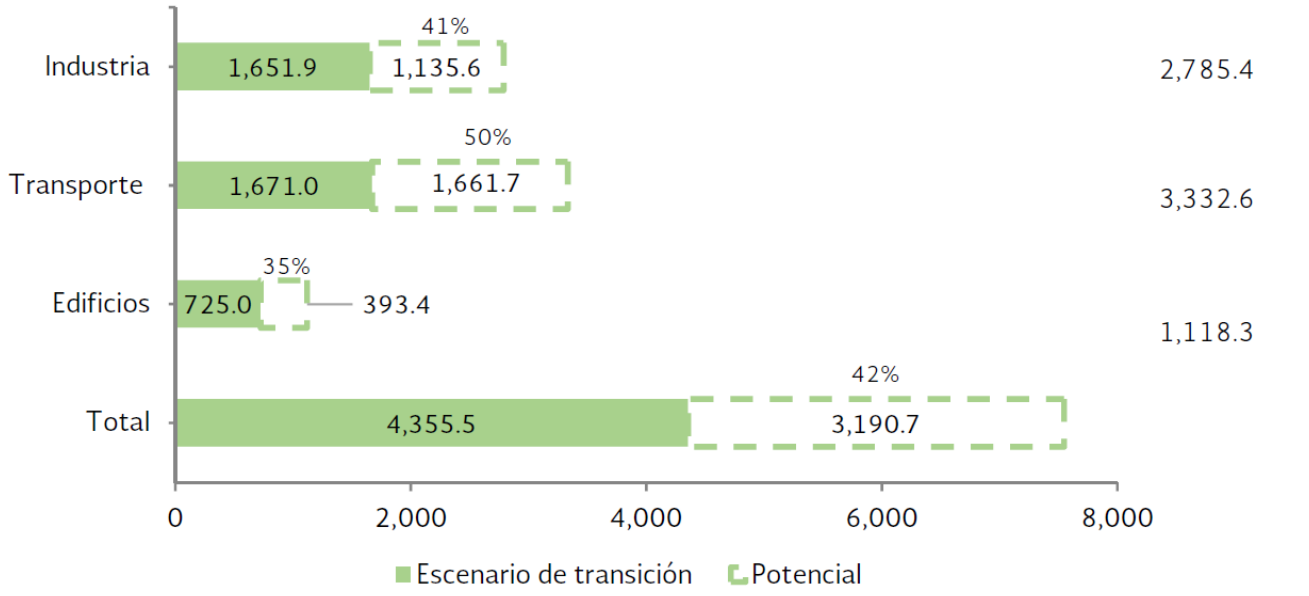
buildings can occur in lighting and air conditioning systems.

To reach the transition scenario, it is necessary to reduce the use of private cars and promote the massive use of public transport. In addition, it will be necessary for most of the vehicle fleet to be electrified and to increase the performance of the remaining fleet to fossil fuels.

The energy supply with renewable sources in the transition scenario is of great importance, since one of the essential elements is to increase the use of electrical appliances and devices for the different end-uses of buildings, industry and, particularly, transport (see Figure 1.11).

In sum, in order to achieve this scenario, a paradigm shift in the transport sector, greater energy efficiency measures in the industry and the promotion of financing schemes for clean energy projects are required.

**Figure 1.11. Potential for reducing final energy consumption in the industry, transportation and buildings sectors, 2050. (Petajoules)**




*Source: SENER and CONUEE.*

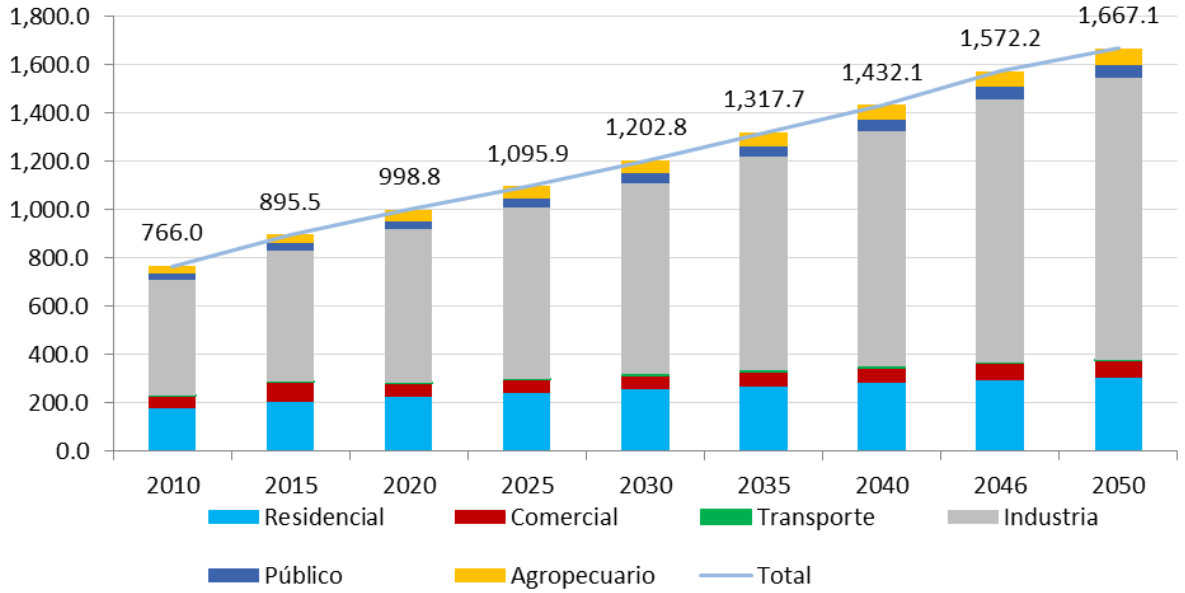
### 7.5 Electricity consumption with efficiency measures

Energy efficiency measures have an impact on electricity demand in Mexico. The largest reductions occur in the industrial (45.8%), residential (53.4%) and commercial (78.7%) sectors compared to the base scenario (see Figure 1.12).

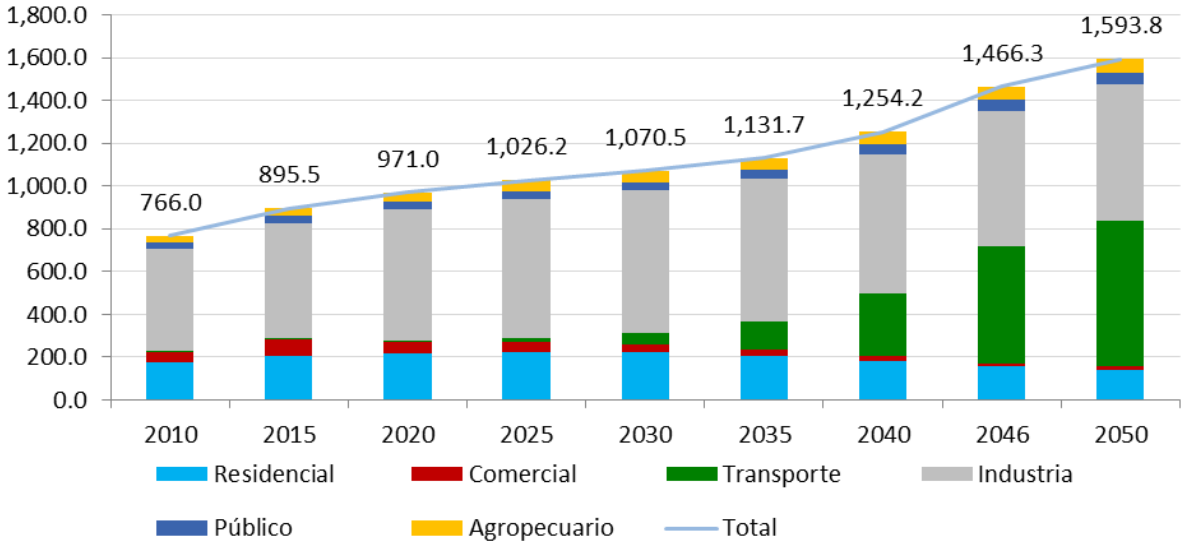
**Figure 1.12. Electricity demand scenarios, 2010-2050.**

(Petajoules)

**Base Scenario**




**Energy Transition Scenario**

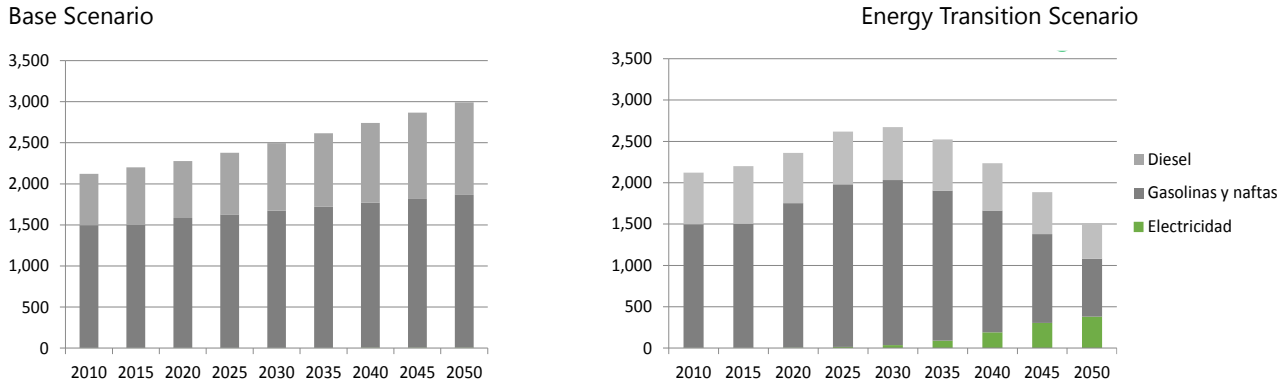



*Source: SENER and CONUEE.*

The major difference between the scenarios is when transport electrification occurs, increasing transport's electricity demand by 133 times in comparison with the base scenario. The substitution of electricity over gasoline and diesel in the transport sector will be equivalent to more than 50%, or approximately 1,500 PJ (see Figure 1.13).

**Figure 1.13. Comparison of energy consumption of the transport sector, 2010-2050.**

(Petajoules)



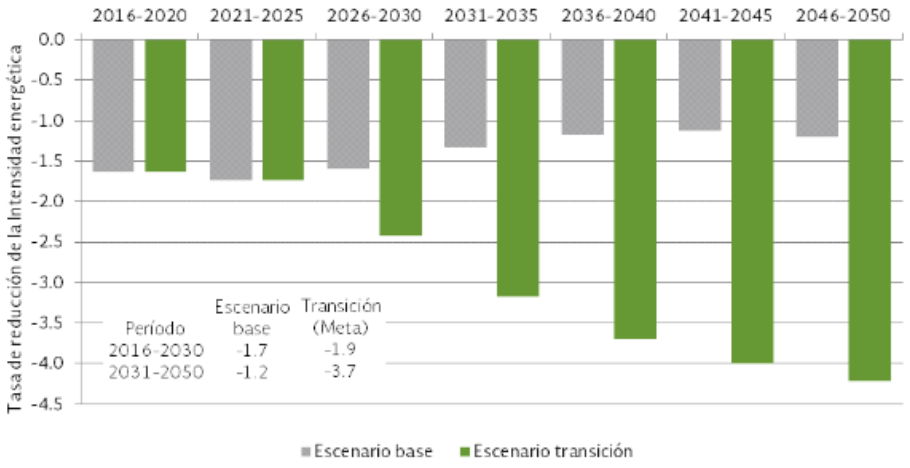

*Source: SENER and CONUEE.*

### 7.6 Energy efficiency targets

At a macro-level, the energy intensity index is a well-used metric to approximate energy efficiency, since it allows us to monitor the amount of energy required to produce a unit of economic value. In this way, the strategy's energy efficiency goal is defined in terms of a reduction rate of final consumption intensity.

The energy efficiency goal reflects the speed at which energy consumption is decoupled from the growth of the economy, improving its energy productivity. This means that when comparing the energy efficiency improvements of the transition scenario with respect to the baseline scenario, the first one will show a lower growth of energy consumption compared to the second, for the same expected economic growth. Thus, in the transition scenario, the use of energy is optimized in comparison with the base scenario (Figure 1.14):

**Figure 1.14. Energy intensity goals, 2016-2050.** (Percentage)




| ***Energy Efficiency Goals*** | |
|---|---|
| ***2016-2030*** | ***2031- 2050*** |
| Average annual rate of 1.9% of reduction in final energy consumption intensity. | Average annual rate of 3.7% of reduction in final energy consumption intensity. |

## 8. ENERGY EFFICIENCY INDICATORS AND DATA

Since the National Program for the Sustainable Use of Energy (PRONASE) 2014-2018 defines the objectives, strategies and lines of action that will be carried out by the Federal Government, its fulfilment will be decisive for the articulated and responsible work of the different orders of government and the various sectors of society.

The PRONASE establishes the following indicators to verify and assess the progress in achieving the objectives and targets[2]:

A. Energy final consumption regulation index by Mexican Official Standards (NOMs),
B. Energy intensity of final consumption,
C. Number of states with institutional capacity to develop actions and projects of energy efficiency,
D. Number of municipalities supported with technical assistance in the field of energy efficiency in public services,
E. Number of professionals trained in techniques of sustainable use of energy through postgraduate courses,
F. Number of training workshops on the sustainable use of energy,
G. Benefits of sustainable energy use and,
H. Funds dedicated to research and technological development projects in energy efficiency.

Another important initiative to highlight is the North American Cooperation Framework in Energy Information, which is in place since 2015. SENER, the Energy Regulatory Commission (CRE), the National Hydrocarbons Commission (CNH), the National Power Control Centre (CENACE), the National Control Centre for Natural Gas (CENAGAS), PEMEX, CFE and the National Institute of Statistics and Geography (INEGI) jointly collaborate in this regional initiative along with the United States Energy Information Administration and the Census Bureau, as well as with Canada's Department of Natural Resources, Statistics Office and the National Energy Board. The three governments share information on international energy trade, infrastructure maps and a trilateral energy outlook, among other relevant issues.

[2] SENER (2014) National Program for the Sustainable Use of Energy (PRONASE) 2014-2018.

# PART II:

# PREE REVIEW TEAM REPORT

This part of the report presents the PREE Review Team's conclusions and recommendation about energy efficiency policies and programs in Mexico.

## 1. OVERALL/INSTITUTIONAL CONTEXT

Energy efficiency policy should be prioritised and not only be a key component of energy policy but also of Mexico's global set of policies. Energy efficiency improvement has multifaceted and profound impacts on a society and economy. There is no cleaner or less costly form of energy than avoiding its wasteful consumption. Some of the main benefits derived from efficient energy consumption are:

- Strengthening economic competitiveness through energy cost reduction.
- Improving energy security by reducing energy imports.
- Directly contributing to climate change problems by decreasing greenhouse gases emissions.

Progress on energy efficiency measures requires the engagement of different levels of government, the industrial sector, and the public. An effective understanding and strong support by society as a whole is indispensable for successful energy efficiency policies. Consequently, governments should focus on raising public awareness through educational programs and information sharing is a crucial component of energy efficiency policy.

Though energy efficiency improvement will pay off in long run, high initial costs often become a barrier to it. Therefore, special financing mechanisms for energy efficiency investment may be required depending upon characteristics of each sector of the economy.

### 1.1 Achievements

#### 1.1.1 The Energy Transition Law (LTE) and the Transition Strategy to Promote the Use of Cleaner Technologies and Fuels provides a sound legal framework that clearly delimits responsibilities among the key institutional actors on energy efficiency policy.

The Ministry of Energy (SENER) is the leading actor in Mexico's energy policy; as such, SENER is in charge of designing energy efficiency policy and programs. In addition, the National Commission for the Efficient Use of Energy (CONUEE) is established as the federal agency responsible for implementing these policies and programs designed by SENER. It is worth mentioning that CONUEE is strictly a decentralised body from SENER with autonomous resources and decision-making processes. This allows CONUEE to execute and direct its policies and programs with a rather technical approach to efficiency and energy savings. This clear-cut legal framework, defined by the LTE and the Transition Strategy, favours a direct flow of information in the policies decision-making process as well as during its implementation.

#### 1.1.2 The new legal framework demands and encourages the participation of state and local governments as well as other Ministries and Federal Agencies to reach the economy's energy efficiency goals and targets.

While SENER and CONUEE are the key energy efficiency policy actors in the economy, the new legal framework acknowledges the importance of horizontal and vertical cooperation within the federal government to achieve the domestic energy efficiency goals and targets. Institutions such as the Ministry of Environment and Natural Resources (SEMARNAT) and the Ministry of Communications and Transport (SCT) now play a key role on energy

efficiency policies, in contrast to the relatively marginal role they used to play in this sector. Furthermore, the cooperation and strengthening of capabilities of state and local governments is crucial in sectors such as buildings, mobility and urban planning. The LTE and the Transition Strategy recognise the importance of involving subnational institutions in energy efficiency policy.

### 1.1.3 SENER and CONUEE have been benefiting from international cooperation in energy efficiency policy and programs, including those through APEC.

The Mexican government has successfully pursued an international agenda on energy efficiency by participating in related forums and initiatives. For instance, SENER played an active role by chairing from 2014 to 2016 the Political Committee of the International Alliance on Energy Efficiency Cooperation (IPEEC). Mexico is also part of the Sustainable Energy for All Initiative (SE4all) and is currently candidate country for International Energy Agency (IEA) membership.

Likewise, energy efficiency programs and actions done in Mexico have brought the attention of international organisations and companies to participate in partnership with the Mexican government. CONUEE has concluded successful cooperation partnerships with different organizations such as the Danish Energy Agency (DAE), the German Corporation for International Cooperation (GIZ) and the World Bank, among others. Additionally, Mexico has participated in APEC initiatives such as the Energy Efficiency Policy and the APEC Electric Vehicles Roadmap workshops.

## 1.2 Challenges

- The ambitious energy efficiency goals and targets in Mexico will require a profound and close collaboration among federal institutions that had not been working together in this way before. CONUEE and the public-owned power utility, CFE, will have to work harder, for instance, with SCT on policies related to electric vehicles. Collaboration with SEMARNAT (Ministry of Environment and Natural Resources) will be also very important in energy sectors such as the industry and transport, in which emissions will be continuously assessed.

- This increased cooperation will require not only stronger and closer collaboration among institutions from the federal government but also with subnational institutions. Communication and coordination in policy implementation within state governments, between state and local governments, among different local governments, and from federal institutions with state and local governments will be key to the achievement of domestic targets.

- These interactions will be full of challenges and will vary widely across the economy depending on the strength of local institutions, particularly in local governments, where many municipalities face challenging realities with scarce budgets and human resources. One example of this is the enforcement of building codes for energy efficiency. Even in places were building codes include energy efficiency provisions, frequently, local governments do not have enough staff nor economic resources to verify whether building codes are observed. As a result, those who are not in compliance with the codes might not receive any punitive action from the local government despite being in breach with the regulations.

### 1.3 Recommendations

**Recommendation 1:** *SENER and CONUEE should continue keeping close communication and coordination among them, not only for the successful implementation by CONUEE of SENER-designed energy efficiency policies, but also for getting feedback from CONUEE's experience to SENER's policy designing.*

While the current coordination and close communication between SENER and CONUEE is commendable, Mexico's ambitious goals require these efforts to continue and even get closer in regards to budgeting and assessment. Moreover, smooth communication between these two pillar energy efficiency institutions at the federal level will favour coordination with other Ministries and Federal Agencies. As already mentioned, relevant federal institutions in the transport, industrial, residential and commercial sectors will be key on leading the way towards Mexico's goals and targets.

**Recommendation 2:** *Strengthen communication between CONUEE and subnational institutions for energy efficiency programs and actions; every institution should have a designated official serving as a link and responsible for energy efficiency policy.*

The current domestic efficiency goals require horizontal collaboration among federal institutions but also a vertical approach with state and local governments. While the bulk of the programs and policies is present already in the Transition Strategy and the LTE, several energy efficiency actions are, either partially or totally, responsibility of state and local governments. Moreover, certain policies such as the ones related with mobility and public transportation might require the joint action of two or more state governments and several local authorities. Every state and local government should appoint an official responsible for energy efficiency, who, at the same time, serves as the link with other institutions.

These challenging scenarios provide an opportunity for SENER and CONUEE to lead the action with subnational authorities. If effective communication among actors were not achieved, Mexico's already ambitious goals and targets would be even harder to accomplish.

**Recommendation 3:** *Enhance the capabilities of subnational governments in order to adequately oversee, assess and enforce energy efficiency codes, programs and policies.*

Subnational institutions, specially state and local governments, play an increasing relevant role in energy efficiency policy. Efficiency goals and savings in some sectors could only be achieved with the active participation and collaboration of state and local governments. However, some state and local governments have limited capabilities to stablish and enforce regulations targeted to energy savings. One example of this is the buildings sector where building codes sometimes do not even include energy efficiency provisions or simply the local government is not capable of enforcing the building code terms.

**Recommendation 4:** *SENER and CONUEE are recommended to continue international cooperation in energy efficiency policy not only as a beneficiary but also as a benefactor in the near future.*

The Mexican government is encouraged to continue its active participation on the international energy efficiency forums and activities. Likewise, Mexico should maintain its partnerships and cooperation schemes with other

economies, in which Mexico has mainly participated as beneficiary, for instance the energy efficiency programs with Germany and Denmark. However, Mexico has potential to cooperate as benefactor in the future, particularly regionally. One initial step in the right direction is CONUEE's Learning Networks cooperation project with Nicaragua and El Salvador.

## 2. ENERGY EFFICIENCY GOALS, TARGETS AND STRATEGY

### 2.1 Achievements

During the past years, The Government of Mexico has made progress with its energy efficiency development and promotion. The government has recognized that energy efficiency is one of the most important measures to develop economic and social sustainability, increase energy security and reduce environmental impact. Mexico has initiated and implemented many energy efficiency practices domestically.

More importantly, the Congress enacted the Energy Transition Law (LTE) in December 2015, aiming to regulate and promote the sustainable use of energy and clean energy, while maintaining the competitiveness in energy sectors. The LTE specified the government's strategy in harmony with the Special Program for Energy Transition and the National Program for the Sustainable Use of Energy. Goals of clean energy generation and energy efficiency were set accordingly, as well as a roadmap.

#### 2.1.1 The Energy Transition Law with medium and long-term targets

With the enactment of the Energy Transition Law in 2015, Mexico has effectively stablished energy efficiency initiatives, especially the setting up of energy intensity aspirational goals, strategies and targets. The law provides a more solid framework for clean energy, energy efficiency, and greenhouse gas emissions reduction. Furthermore, the law is the instrument that sets the direction to the medium and long-term energy intensity reduction targets. Towards this end, relevant institutions, such as SENER, CONUEE, CRE, CENACE, among others, should implement energy efficiency projects and programs according to their respective roles and responsibilities.

The medium and long-term strategies were designed for a period of 15 and 30 years, respectively. The energy efficiency goals have been set up at the average annual rate of 1.9% of reduction in final energy consumption intensity from 2016 to 2030 and at 3.7% from 2031 to 2050. It is important noting that these figures are decoupled from Mexico's expected economic growth.

#### 2.1.2 Energy Efficiency Roadmap (PRONASE)

The energy efficiency roadmap, officially the National Program for Sustainable Energy Use (PRONASE 2014-2018), was successfully approved at the domestic level in 2014. The PRONASE has six main objectives:

I. To design and develop programs and actions that enable the optimal use of energy in processes and activities in Mexico's energy supply chain.
II. To strengthen regulation of energy efficiency in appliances and energy consuming equipment, manufactured and commercialized in Mexico.
III. To strengthen the systems and government agencies responsible for energy efficiency at the federal, state, and municipal levels, integrating public, private, academic and social institutions.
IV. To promote the development of technical capacities related to sustainable energy use.
V. To contribute to the capacity building and dissemination of an energy savings culture in society.
VI. To promote research and development on energy efficiency technologies.

The National Commission for the Efficiency Use of Energy (CONUEE) has also set up an annual work plan, which includes energy efficiency standards. The work plan encourages co-operation among the federal, state and local governments to contribute to greenhouse gas (GHG) emissions mitigation, as set in the Special Program on Climate Change.

### 2.1.3 Energy Efficiency activities and programs

SENER, CONUEE, CRE, CENACE, INEEL, and CFE are essential institutions that work in harmony towards the success of Mexico's aspirational goals in achieving energy efficiency and GHG emissions targets within the timeframe set under the LTE.

In terms of the implementation, several energy efficiency measures, projects, and programs have been launched with the financial support from the public and private sectors. These measures include both, compulsory and voluntary measures; examples of these programs are The Energy Savings Appliance Replacement Program, the National Energy Efficiency Project for Municipal Public Lighting, the Business Energy Savings Program, among others.

## 2.2 Challenges

- During the past years, Mexico has experienced a rapid economic and population growth, consequently demanding more infrastructure and services. This has meant a huge increase on energy consumption, as well as on pollutant emissions. These augmented emissions are often the result of the development of big projects lead by the government such as transportation systems or electricity generation plants.

- In alignment with international efforts on climate change mitigation, Mexico has committed to make a great attempt towards its greenhouse gas emissions reduction. In this transitional period, Mexico faces challenges such as rapid growth on mobility demand in big cities and the need for infrastructure development in small cities, sometimes left neglected by the authorities. Both challenges require further attention from the government.

- These challenges seem to influence negatively the government's effort in achieving its energy efficiency targets. It is important to note that as the energy efficiency targets are decoupled from the economic growth, benefits derived from the targets might not be distributed proportionally. Even though many economies have brought this decoupling concept for successful energy efficiency goals setting, implementation still remains a challenge.

## 2.3 Recommendations

**Recommendation 5:** *The government should continue to have energy efficiency at the core of its energy policy and make sure that the committed targets are achieved.*

The Mexican government should continue its commitment to ensure that energy efficiency policy be implemented successfully in order to meet its targets. In addition, the government should support the economic sectors involved. Meanwhile, international cooperation commitments should be met and the government should follow-up closely its collaboration with international organizations on energy efficiency and greenhouse gas emissions.

**Recommendation 6:** *An institutional cooperation mechanism should be established to increase collaboration on energy efficiency actions across government.*

As there are various government agencies responsible for energy efficiency policy and implementation with own targets and constraints, it is therefore important to coordinate and implement their work actively and effectively, avoiding tasks or programs duplication.

Energy efficiency intersect in many areas with environmental impact, such as greenhouse gas emission and climate change. The government should ensure that Mexico meets its targets, in line with its international commitments.

**Recommendation 7:** *Improve energy efficiency monitoring to better assess results of related programs and measures.*

The PRONASE should include individual sectors and be able to track the achievements and progress, especially the energy savings resulting from energy efficiency projects. SENER should monitor and assess effectively all the measures and progress on the energy efficiency programs. A government unit that collects and inform the results of the energy saving or other related data could be established as a tool to help monitoring the energy efficiency implementation policies results.

**Recommendation 8:** *Ensure the most life-cycle cost efficiency programs and targets are undertaken and established to mitigate any potential economic impact.*

SENER, as the leading institution on energy policy in Mexico, should ensure that energy efficiency policies be implemented both in the demand and supply side. SENER should ensure that human and financial resources be allocated accordingly in order to successfully achieve the goals and targets.

The energy efficiency improvement and development policy should receive a strong support from both government and private sectors in order to achieve successfully the energy efficiency targets.

**Recommendation 9:** *Make sure that energy efficiency targets do not affect negatively economic growth.*

The government should work ambitiously to ensure that the support and measures to reduce energy intensity levels do not affect negatively economic growth.

**Recommendation 10:** *Promote capacity building, research and development, and financial support for energy efficiency projects.*

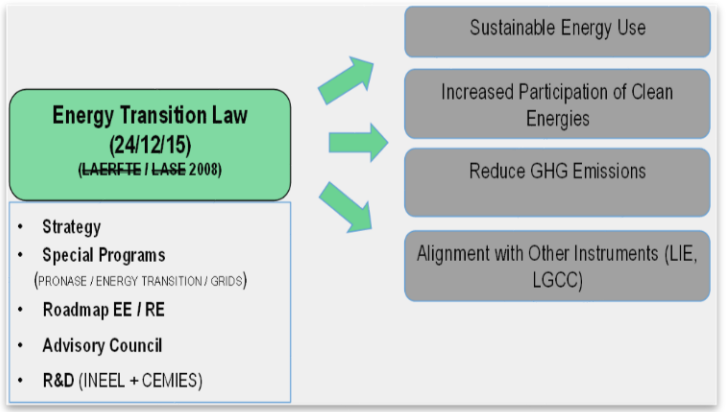
Capacity building and financing are essential to the success of energy efficiency development. The government should take these issues in more consideration. Research and development in energy efficiency technologies, as well as standards for buildings, equipment, machineries, and appliances should be promoted continuously. In addition, research and development should be the positioned with clear policy and action plans. The studies should be relevant and developed into demonstrations and successful case studies for market access and expansion. Financial support and measures such as dissemination and awareness campaigns promoting energy efficiency should be more encouraged.

## 3. ENERGY DATA COLLECTION AND MONITORING

In an environment where energy statistics serve as the foundation for developing sound policies, effective data collection and monitoring system are crucial. Data collected provides indicative information on global energy development, market trends, etc. After obtaining the data, the next challenge is how to compile and maintain them. During the conduct of this peer review on energy efficiency in Mexico, these were some of the challenges found, especially as data sources come from different organizations.

Mexico's energy sector has undergone transition through the enactment of the Energy Reform in 2013 to revive the energy sector and bolster the overall economy. While the Energy Reform was focused mainly in transforming the economy's oil, gas and electricity sectors, it actually touches all aspects of Mexico's energy industry and even beyond. In addition, in December 2015, to complete the reform process, the Energy Transition Law (*Ley de Transición Energética*) was issued.

**Figure 2.1- Energy Transition Law goals.**




*Source: CONUEE's Sergio Segura presentation during PREE in Mexico*

The Energy Transition Law aims to regulate the sustainable use of energy and articulate the electric industry's obligations regarding Mexico's need to transition to using clean energies and cutting polluting emissions, while at the same time maintaining Mexico's productivity and competitiveness on the world stage. The Law became Mexico's cornerstone towards achieving clean energy and energy efficiency goals.

### 3.1 Achievements

#### 3.1.1 Cooperation among stakeholders to share and submit data to the concerned units in SENER.

As a decentralized administrative body of SENER, CONUEE has the technical and operational autonomy to promote energy efficiency and to play a role as technical body in the field of sustainable energy use. As such, the LTE instructed CONUEE to be continuously monitoring efficiency improvements in Mexico's energy sector and required them to submit the results of implementing energy conservation measures within six months of enforcing the LTE.

In this regard, CONUEE requests the cooperation of its energy stakeholders to submit relevant information on

energy especially from large energy users, e.g. energy consumption, plant specifications for industry, vehicle data in the transport sector and floor area data in the building sectors, among others. Though difficult, the Mexican government, through SENER and CONUEE was able to facilitate submission of some of the needed information from concerned stakeholders.

**Article 18 Energy Transition Law**

・Provide technical advice on the sustainable use of energy to the agencies and entities of the Federal Public Administration, as well as to the governments of the states and municipalities that request it and to conclude agreements for this purpose.

・Issue binding opinions for agencies and entities of the Federal Public Administration and for states and municipalities in programs, projects and activities of sustainable use of energy using federal public funds.

### 3.1.2 Strong collaboration with international institutions to improve data.

Along with the efforts of CONUEE to obtain data, several international organizations have also forged collaboration with them to enhance capability in collecting and improving data. The Economic Commission for Latin America and the Caribbean (ECLAC) supported a project called BIEE (*Base de Indicadores de Eficiencia Energética*). The project was sponsored by the German Corporation for International Cooperation (GIZ) in collaboration with UN-Sustainable Energy for All, the International Partnership for Energy Efficiency Cooperation (IPEEC), the French Environment and Energy Management Agency (ADEME), and the company ENERDATA to enhance capability of CONUEE in collecting and analysing energy efficiency indicators in Mexico.

Likewise, the International Energy Agency (IEA) provides technical assistance to CONUEE in filling out reporting templates on energy efficiency, which IEA requires Mexico to submit. Other cooperation includes the conduct of consumption surveys that will help CONUEE in benchmarking energy end-use data. Through this projects and international cooperation, CONUEE was able to collect and generate time series analysis of efficiency indicators across all energy-consuming sectors.

### 3.1.3 Strong efforts to make all data available online.

The Law recognises the importance of data transparency, hence in its instructions, LTE highlighted that data and results of energy conservation measures conducted by the government be known and available to the public.

In this regard, CONUEE is developing the system SITE where they will be able to analyse different programming options, allowing access to present information from databases and the possibility of interconnection with other systems. The system will provide reliable and up-to-date information on energy efficiency to domestic and international institutions.

***Article 100 Energy Transition Law*** For the integration and updating of the System, the agencies and entities of the Federal Public Administration, as well as Users of High Consumption Pattern, shall provide the System with the following information on the energy utilization obtained immediately in the preceding year:

- I. Measures implemented for Energy Efficiency, and
- II. Economic and energy results of the energy conservation measures derived from the previous fraction.

### 3.1.4 Awareness on the importance of data to realize the Energy Efficiency goals set by the Energy Reform.

The Law strengthened the scope and functions of relevant institutions in the energy sector in Mexico. CONUEE, which was delegated to implement measures on the efficient use of energy, continues to seek ways to realise how to achieve the energy efficiency goals set by the Energy Reform. Collaboration with various important international and local institutions were strengthened to enhance capacity of CONUEE in data collection and analysis. SENER and CONUEE collaborate with INEGI, Mexico's statistical office, in the conduct of the household expenditures survey (ENIGH). At least, some of the related information on household energy consumption is incorporated in the ENIGH survey questionnaire.

CONUEE also strengthened its relationship with the private sector by implementing the energy management system. In return, energy users in both large and medium industries submit production and energy consumption data to CONUEE. Cooperation with IEA is also ongoing with technical assistance on energy statistics and modelling.

## 3.2 Challenges

Despite strong efforts to improve data collection and even though there is willingness as well as cooperation from industry sector to submit data, the Mexican government encounters various challenges in collecting data, among others:

- Completeness and disaggregation of demand data is still a major challenge. This is a common challenge to energy demand data. Although data is available, often, there is no disaggregation on end-use level. This is particularly difficult when there is no basis of the data, like an energy consumption survey.

- Availability of energy demand and supply data is still an issue. This challenge goes along with the issue of confidentiality or lack of legal basis or even absence of incentives for stakeholders; hence, some industries or companies are not inclined to give information.

- Lacking cooperation from other government institutions to validate data. Collection of energy data is also linked to other government institutions. Sometimes the collected data requires further validation, but most often, this would be an additional burden for concerned institutions.

- While there is a strong support from the international entities, the government believes that further capability enhancement is still needed. For example, as CONUEE is relatively new in conducting energy surveys, they seek training in this area, from the designing up to the actual conduct of it. Capability in energy statistics and modelling were other areas they also seek enhancement.

- While cooperation with other international institutions was evident, cooperation with APEC seems to be an oversight. During the review, the experts were surprised to learn that some units in SENER have little knowledge of APEC and APERC and its cooperative activities.

- Lack of staff and budget in both SENER and CONUEE seem to limit various activities including data collection as well as data quality. For instance, there is not concrete data on floor area.

### 3.3 Recommendations

**Recommendation 11:** *Enhance cooperation with relevant actors in conducting household energy consumption surveys.*

While current efforts of the Mexican government in improving data collection are noteworthy, the government needs to enhance cooperation with other institutions, particularly INEGI, in conducting household energy consumption surveys as their result will be very good basis to improve data, e.g. disaggregation to end-use levels.

**Recommendation 12:** *Strengthen cooperation with APEC.*

Cooperation with international entities proves to be effective in all aspects of capability enhancement in data collection and analysis. However, it would also be befitting for the government to revitalise its cooperation with APEC. By being a member economy, cooperation with APEC is the closest avenue where Mexico can find possible ways of achieving its goals. In this regard, it is highly recommended to send representatives to the Expert Group on Energy Data and Analysis (EGEDA) and the Expert Group on Energy Efficiency and Conservation (EGEEC) as these energy expert groups in APEC have a similar mandates in energy data and energy efficiency improvement in the region, respectively.

**Recommendation 13:** *CONUEE should join the cooperative relationship that APERC-ESTO and SENER already have for data and statistics.*

SENER, through its General Directorate for Energy Planning and Information, has already stablished strong cooperation with APERC Energy Statistics and Training Office (ESTO). The GD for Planning submits data regularly to ESTO; likewise, ESTO conducts energy statistics and modelling training to them. CONUEE may also want to consider establishing this kind of cooperation with APERC.

**Recommendation 14:** *SENER and CONUEE should continue taking measures to improve data collection and monitoring, in terms of energy efficiency indicators by sectors and end use.*

Activities to obtain and improve data should not stop with the achievement of targets set by the Energy Reform. SENER should take advantage of the available technical and financial resources to carry out activities that will improve data collection and monitoring.

**Recommendation 15:** *SENER should reinforce its ties with other government institutions to have better data quality by sharing information and communicating more effectively with them.*

To address challenges in validating some data, SENER should strengthen ties with other government institutions like SEMARNAT (Ministry of Environment and Natural Resources) or SCT (Ministry of Communications and Transport), whose input may be helpful. The issuance of a high-level directive can be helpful to enhance coordination among institutions.

For example in the Philippines, while several government agencies have their own statistics, there is one body, the Philippines Statistics Authority (PSA), which compiles time-series statistical information of the Philippines' economic and social environment, such as energy (supply and demand), industry (floor area and house construction), environment and natural resources, etc. The Department of Energy (DOE) along with other government institutions submit relevant statistics for inclusion in the Philippine Statistical Yearbook (PSY). Though still needs further improvement in terms of completeness, the collaboration between relevant organizations is clear.

**Recommendation 16:** *Despite the legal base exists, SENER should explore mechanisms to improve the integration and updating of information, in coordination with CONUEE and CFE to better contribute to the PRODESEN's (the government's electricity program) forecasting.*

The Mexican government develops PRODESEN (Development Program for the National Electric System 2016-2030) through the office of the Deputy Minister of Electricity at SENER. However, not all data from CFE, CONUEE and SENER's General Directorate for Planning was used. The Deputy Minister of Electricity may take advantage on engaging more actively CONUEE, CFE, and other relevant institutions.

## 4. POLICY MEASURES-GOVERNMENT AND BUILDINGS

### 4.1 Achievements

#### 4.1.1 Energy efficiency standards in Mexico include buildings' main components.

The main components of residential and non-residential buildings such as envelope, glass glazed system, and lighting are included in the energy efficiency standards. However, solar water heating systems were rescheduled in the Standardization Program on Energy Efficiency 2017. The mandatory energy efficiency standards (NOMs or Mexican Official Standards) that integrate cutting edge technology to ensure a more efficient energy use, have a mature development process and already cover thermal insulation for buildings, buildings envelope, lighting systems of non-residential buildings and thermal and optical characteristics of glass and glazed systems. Together with water pumps and some appliances, NOMs cover most of the energy consumption components related with buildings.

#### 4.1.2 The ESCO scheme is already used for energy efficiency projects in Mexico.

For more than 20 years, the Energy Services Company or ESCO scheme has been used for energy efficiency projects in Mexico. There are about 25 companies grouped in an industrial chamber called AMESCO (ESCOs Mexican Association) and they have carried out projects in industries, hotels, and local government's buildings. In 2014, a working group comprising CONUEE, AMESCO, the Mexican Social Security Institute (IMSS), Mexico's Tributary Administration Service (SAT), and the German Corporation for International Development (GIZ) developed an energy performance contract for agencies of the federal government and chose a service contract under the form of shared savings. The working group selected two "ideal" facilities to test the performance contract: the Gynaecology and Obstetrics Hospital No.4 and the Ministry of Communications and Transportation headquarters.

Economies throughout the APEC region and the rest of the world understand that a key barrier to energy efficiency and conservation is financing. An ESCO can help fill this financing gap by utilizing an energy service performance contract (ESPC) and providing the financing for bankable energy retrofit projects. After performing an investment grade audit and installing the required measures, the ESCO will be paid back through the energy savings.

#### 4.1.3 Completion of a study to collect data in federal government buildings.

The Inter-American Development Bank (IDB) conducted a study on federal government buildings entitled "Potential evaluation and proposal of financial-administrative strategy for the implementation of measures of energy efficiency in federal government buildings". With this, CONUEE has available data on energy efficiency of more than 1,000 federal government buildings. CONUEE found potential lighting saving in about 16% of the buildings with an investment of 30 million US dollars.

#### 4.1.4 Pilot projects of nearly zero energy green buildings already accomplished in Mexico.

Recently, some APEC developed economies set the goal to achieve Nearly (Net) Zero Energy Building (NZEB) and already launched some research programs and accomplished successful demonstration projects. Accomplished demonstration projects cover almost all climate zones and major building types. There are pilot projects of nearly zero energy green building already accomplished in Mexico and the energy savings could reach from 50% to 80% compared with the

ordinary buildings. The market of NZEB is currently small, but it is booming as the technology roadmap becomes clearer. The government should take the lead in demonstrating "Net Zero Energy Buildings" to the broad public and challenge the private sector to match, or even exceed, agency goals and targets in the future.

### 4.2 Challenges

- Federal building codes system, whether mandatory or voluntary, are not set up.

- Programs such as the Energy Efficiency and Sustainability Project (PRESEM) only cover local government's buildings; however, there should be programs for commercial and residential buildings as well.

- Several barriers still exist for ESCOs such as:

    - Inexperience in the development and implementation of performance contracts in the federal government.
    - Lack of a "standard contract" for hiring ESCOs, the previous energy assessment and the payback period is not standardized.
    - Solar energy is being under-utilized, particularly for water heating. Mexico could do more to fully take advantage of is great solar energy potential.

### 4.3 Recommendations

**Recommendation 17:** *Consider a stronger energy demand growth in the buildings sector due to a rise on people's living standards.*

When estimating future energy demand for the buildings sector, SENER should consider the fast rise of people's living standards, especially when more comfortable indoor air quality, such as heating and cooling, will be required. In general, the buildings sector is one of the largest energy consumer worldwide. Although buildings energy consumption in Mexico represent only around 20% of primary energy consumption, SENER should take into account that this trend may increase in the future and get closer to the APEC's region average, which is around 40%. SENER's current estimates seem to exclude growth on some end-uses that might increase energy demand.

**Recommendation 18:** *The government should continue its efforts in setting up federal voluntary building codes.*

The government should consider setting up federal building codes based on energy efficiency standards. Building energy codes are the key policy instrument used by governments to limit pressure on the energy sector and environment. Effective building codes consist on a set of mandatory requirements designed to reduce the energy intensity and consumption. Building codes have been instrumental in reducing the overall energy consumption of both residential and commercial buildings. The government made an important step in the right direction by issuing a roadmap for energy efficiency building codes in Mexico.

After the set-up of building energy codes, the government should ensure compliance of these codes. Additionally, SENER should revise and update them on a regular basis, making sure construction codes keep pace with technology advancement, while allowing feedback from interested stakeholders. As a result, energy consumption could be reduced gradually in new buildings over time.

**Recommendation 19:** *The government should continue undertaking measures to improve energy efficiency in its own buildings.*

The federal government could be a leader on energy efficiency by implementing more efficiency measures in governmental buildings and compounds. Commercial buildings, particularly large-scale ones, are usually energy intensive and thus have great potential for energy savings. The next step should be to deploy a mature monitoring and control system to more commercial buildings, and then the information of energy consumption at real time could be available.

**Recommendation 20:** *SENER should continue including residential and commercial buildings in pilot and demonstrative projects to raise awareness.*

Pilot projects should include more non-public buildings, since the energy using features could vary substantially. SENER should promote energy efficiency in residential buildings with demonstration projects. The Ministry should also encourage interested housing developers to construct demo energy-efficient houses. Demo energy-efficient residential buildings could create wider awareness for the public.

**Recommendation 21:** *The government should continue promoting photovoltaic and solar air conditioning in the residential sector.*

Photovoltaic, solar water heating and solar air conditioning, such as solar absorption chillers, should be considered as possible energy efficient technologies. Solar absorption chillers are one of the most effective and efficient ways to heat and cool buildings using only the power of the sun.

## 5. POLICY MEASURES-INDUSTRIAL SECTOR

### 5.1 Achievements

#### 5.1.1 The industrial sector has a clear pathway to improve efficiency and reduce carbon emissions.

The industrial sector is the second largest user of energy behind the transport sector (46%), consuming 30% of the total energy for Mexico, and is a priority area for the energy transition period in Mexico.

The industrial sector is to be congratulated on its proposed pathway to transition on the supply side towards natural gas and electricity, improving both efficiency and reducing carbon emissions. However, significant demand side opportunities remain. The government estimated a 41% energy reduction potential (1,136 PJ) by year 2050. It estimates that the energy efficiency measures will reduce electricity demand by 46 % in the industrial sector.

#### 5.1.2 CONUEE is successfully promoting the adoption of international best practices such as ISO 50001 and Learning Energy Efficiency Networks (LEEN).

CONUEE has started a commendable plan to encourage the industrial sector to adopt best practice energy management based on the ISO 50001 Energy Management Standard, using Learning Networks at the regional level to share information and skills learning. It has seven networks with 18 companies participating already. The program is developed on the German LEEN (Learning Energy Efficiency Network) experience and is a good model for large energy users who have the biggest opportunity to save energy through industrial process optimization of pumps, fans, compressed air, and heating systems.

Learning Energy Efficiency Networks (LEEN) is a concept developed in Switzerland back in the 1990s. Since then, the approach has been successfully transferred to Germany, France and Austria. With these networks, 10 to 15 regionally based companies from different sectors share their energy efficiency experiences in moderated meetings. After the companies have formed the network, the process starts with an energy review and the identification of profitable energy efficiency measures in each company. Afterwards, the participants decide upon a joint target, which is allocated to the partners according to their efficiency potential. The subsequent networking process enables a continuous exchange on energy efficient solutions fed by the experiences of the network partners as well as external experts. The performance of each company is continuously monitored and controlled on a yearly basis. The network operating period is typically from three to four years.[3]

#### 5.1.3 The government is building good relationships with large energy users with minimal funding support.

The LEEN approach allows the building of strong relationships with industry participants with small amounts of government funding for energy audits and the International Organization for Standardization (ISO) certification.

[3] Rohde, C., Mielicke, U., Nabitz, L., et al. (2015). Learning Energy Efficiency Networks - Evidence based experiences from Germany, ACEEE Summer Study on Energy Efficiency in Industry. http://aceee.org/files/proceedings/2015/data/papers/6-48.pdf, Retrieved on May 31, 2017.

**5.1.4 The government is proposing multiyear (three or more years) voluntary agreements with large energy users to help reduce energy use and emissions.**

## 5.2 Challenges

- Large energy users are often powerful corporates. The government requires mandatory energy use reporting, which can sometimes be difficult to obtain. It has powers to demand information but it is not practical to take a legal path for this. Hence, building stronger relationships with the large energy users is a better approach.

- It is usually difficult for companies to understand the value of ISO 50001 certification on energy management, especially if their products are commodities such as oil, cement, sugar, steel and there is not branding opportunity for them. The government needs to clarify the customer value proposition for ISO certification. For example, there are not tax advantages for companies with ISO certification in Mexico, as it is the case in Germany and the United Kingdom.

- The Government may need to evaluate whether ISO 50001 certification is a cost effective solution for smaller businesses or office building facilities.

- There is a need to clarify the necessary plan for building the capacity (number of experts) and capability (level of training and skills) to support and grow a profitable energy management industry. Without this, the ambitious 41% energy savings target for the industrial sector may be difficult to achieve.

## 5.3 Recommendations

**Recommendation 22:** *The government should continue expanding the Learning Network approach for large energy users.*

CONUEE should continue expanding and supporting the Learning Network engagement approach for the largest energy users. This will help build a better relationship with the government rather than a mandatory and compliance approach.

**Recommendation 23:** *SENER should aim for engaging 50% of the industrial sector by using voluntary agreements.*

The government should continue to roll out voluntary agreements with stretch energy and carbon savings targets. SENER should aim for engaging 50% of industrial clients on signing up in voluntary agreements based on industry sub-sector potentials savings data. The government will need to have good industry sub-sector energy use and potentials savings data to deliver a more targeted program.

**Recommendation 24:** *The government should consider talking to the industrial sector in terms of energy productivity rather than energy efficiency (speak in their language).*

The government should speak to the industrial sector in terms of energy productivity rather than energy efficiency or intensity, in other words, the government should speak to business owners in their language. Many economies such as the USA, Australia and New Zealand use energy as an enabler for economic productivity, which resonates best with

business who are interested in growth and profitability.

**Recommendation 25:** *The government should continue offering more benchmarking tools and recognition awards for exemplar companies.*

The government can build stronger links with industry sub-sectors by helping them with sector benchmarking tools, and promoting energy management awards and recognition for exemplar companies as well as program delivery partners.

The government should offer free benchmarking tools, and recognition awards for exemplar companies and program partners.

**Recommendation 26:** *The government should continue building strong links with universities and training colleges.*

SENER must create stronger links with universities and training colleges to form energy management professionals and promote research and development on this field.

**Recommendation 27:** *SENER should offer an online self-assessment tool for small and medium enterprises.*

SENER may consider offering an online self-assessment tool for small and medium enterprises (SMEs) to reduce program costs. The New Zealand government has recently created a web-based tool called the energy management journey (EMJ) that allows businesses to self-assess themselves, and offers ways to make improvements.

**Recommendation 28:** *The government should adopt a low-cost building energy performance-rating scheme.*

The government should consider adopting a Building Energy Performance Rating scheme such as NABERS or Energy star for office buildings rather than offering an expensive ISO 50001 energy management certification.

As an illustrative example, NABERS is a rating system that measures the environmental performance of Australian buildings, tenancies and homes. Put simply, NABERS measures the energy efficiency, water usage, waste management and indoor environment quality of a building or tenancy and its impact on the environment.

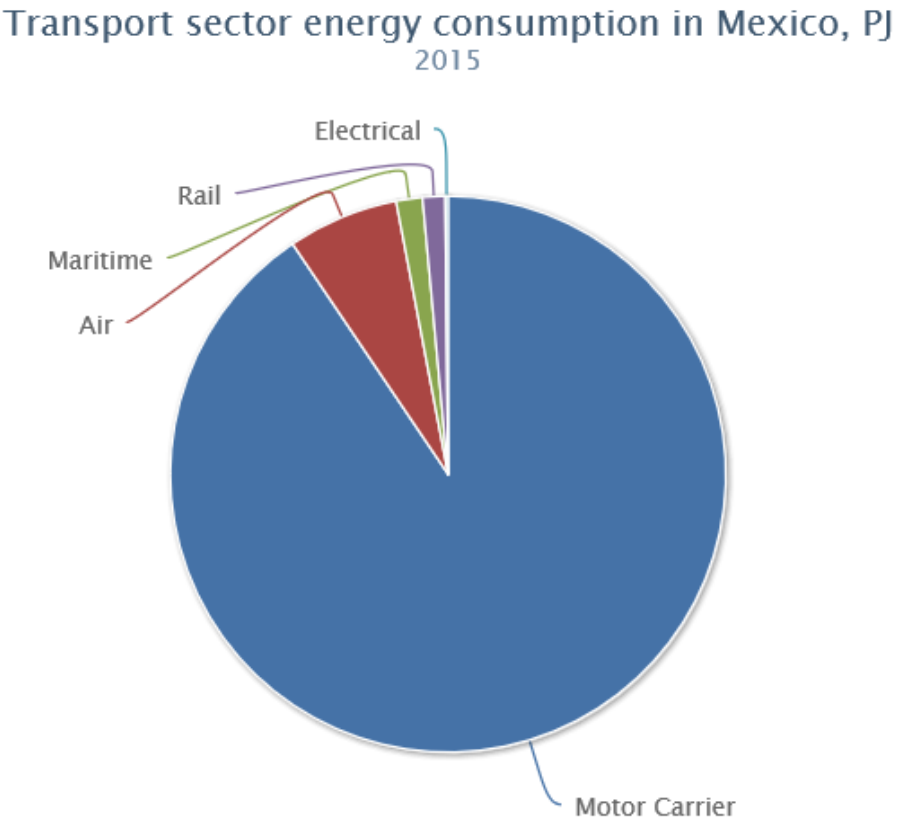
It does this by using measured and verified performance information, such as utility bills, and converting them into an easy to understand star rating scale from one to six stars. For example, a six star rating demonstrates market-leading performance, while a one star rating means the building or tenancy has considerable scope for improvement.

For over ten years, NABERS has helped property owners, managers and tenants across Australia to improve their sustainability performance, reaping financial benefits and building their reputation.

## 6. POLICY MEASURES- TRANSPORT SECTOR

Transport is the largest energy-consuming sector in Mexico, accounting for 46% of energy demand in 2015.[4] Of this demand, 92% is from land transport vehicles ("motor carrier"), as shown in Figure 2.2. Gasoline, used by passenger vehicles, comprises 71% of the land transport vehicle energy, with diesel fuel, used by buses and trucks, comprising 26%. There is no significant use of diesel fuel by light passenger vehicles.

**Figure 2.2 -**




*Source: SIE, SENER 2015*

### 6.1 Achievements

#### 6.1.1 Gradual removal of fossil fuel subsidies.

Mexico is gradually removing subsidies on the price of gasoline and diesel to consumers. As PEMEX was the sole producer and importer of oil products, total control over pricing policy was possible. Mexico's energy reform is allowing steady real price increases, which reduce fossil-fuel subsidies. Private sector participation is gradually being introduced to all parts of the transport fuel supply chain. This energy sector reform is continuing and is scheduled to be completed during 2018.

As a sign of its commitment to fossil fuel subsidy reform, Mexico endorsed an international *communiqué* by the group

[4] SENER (2017), National Balance of Energy. Link: https://www.gob.mx/sener/documentos/balance-nacional-de-energia. Retrieved on May 31, 2017, Retrieved on May 31, 2017.

of countries called "Friends of Fossil Fuel Subsidy Reform" to support G20 and APEC leaders' commitments to phase out inefficient fossil fuel subsidies. The Friends provided a statement of support for Mexico's reforms in March 2017.[5]

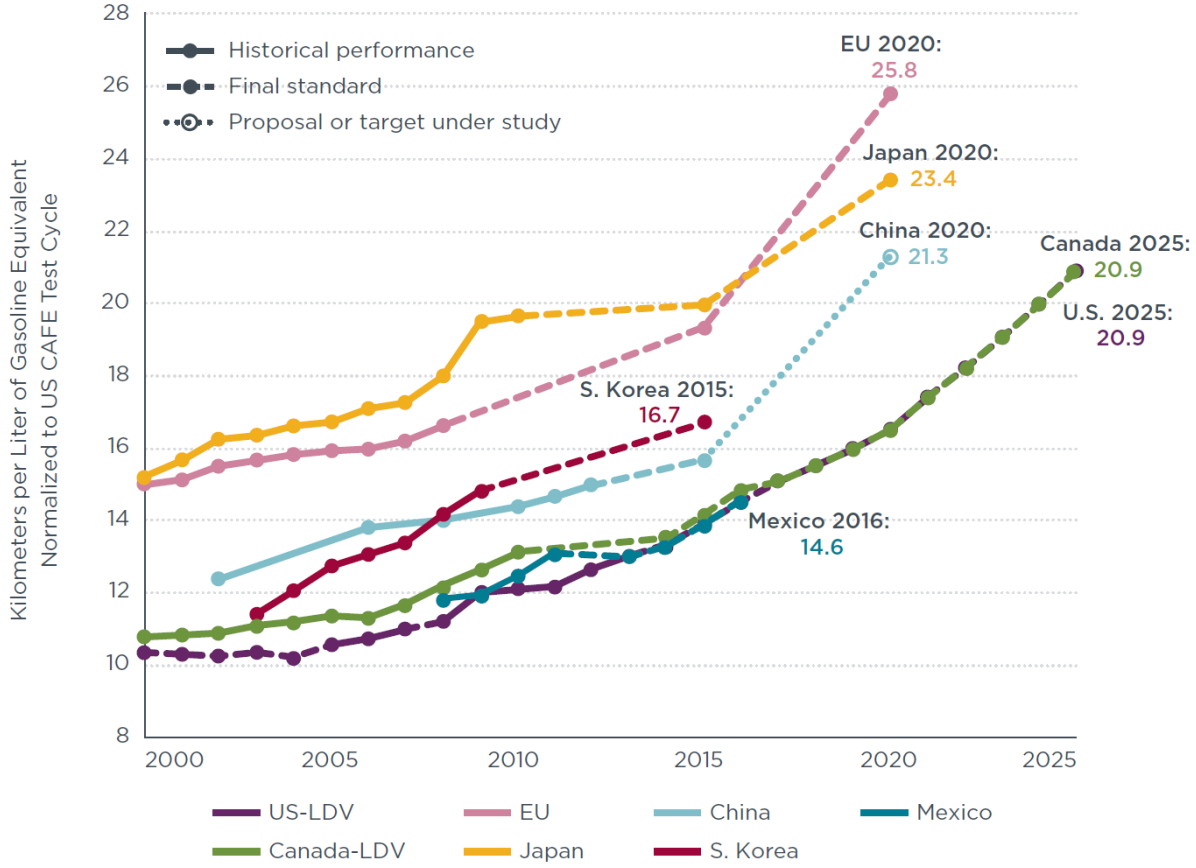
The achievement of the removal of fossil fuel subsidies will allow energy efficiency and new technologies to compete more fairly with established gasoline and diesel fuel use in transport.

### 6.1.2 Vehicle fuel efficiency

On June 21, 2013, the Mexican government published final standards regulating $CO_2$ emissions and the fuel economy equivalent for new passenger vehicles, including cars, pick-up trucks, and SUVs, entitled NOM-163-SEMARNAT-ENER-SCFI-2013[6]. The standards regulate $CO_2$ emissions in grams per kilometre, also expressed as fuel economy in km/L, over the period 2013 -2016.

Analysis by the International Council on Clean Transportation (ICCT), shown in Figure 2.3, shows that Mexico's vehicle fuel economy standard will put it on track to match standards in the US and Canada[7].

**Figure 2.3: International comparison of vehicle fuel economy standards**




*Source: International Council on Clean Transportation (2013)*

[5] Friends of Fossil Fuel Subsidy Reform (2017), Friends' statement of support to Mexico, http://fffsr.org/2017/03/friends-statement-of-support-to-mexico-declaracion-de-apoyo-a-mexico-por-parte-de-los-amigos-de-la-reforma-de-subsidios-a-los-combustibles-fosiles/, retrieved on May 31, 2017.

[6] Diario Oficial de la Federación (2013), Norma Oficial Mexicana NOM-163-SEMARNAT-ENER-SCFI-2013, Emisiones de bióxido de carbono (CO2) provenientes del escape y su equivalencia en términos de rendimiento de combustible, aplicable a vehículos automotores nuevos de peso bruto vehicular de hasta 3 857 kilogramos. http://dof.gob.mx/nota_detalle.php?codigo=5303391&fecha=21/06/2013, Retrieved on May 31, 2017.

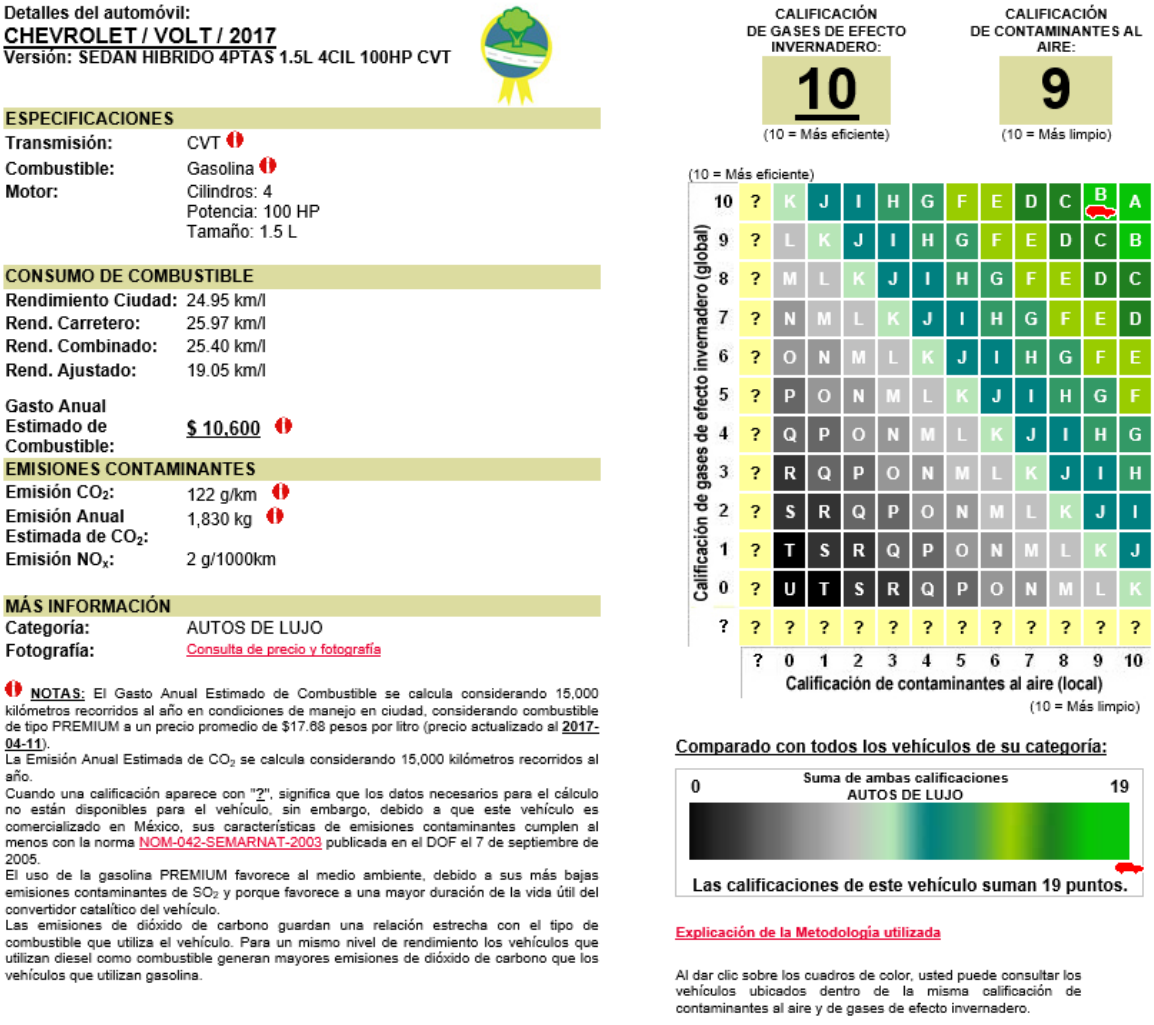
[7] International Council on Clean Transportation (2013), Mexico light-duty vehicle CO2 and fuel economy standards, Policy Update, http://www.theicct.org/sites/default/files/publications/ICCTupdate_Mexico_LDVstandards_july2013.pdf, retrieved on May 31, 2017.

Having such a standard in place is a significant achievement, and Mexico's standard is the only mandatory fuel economy standard in place in Latin America.

### 6.1.3 Consumer information on vehicle fuel efficiency

Consumer information on vehicle fuel efficiency is available through the Ecovehiculos website (www.ecovehiculos.gob.mx) jointly developed by CONUEE, the National Institute of Ecology and Climate Change (*Instituto Nacional de Ecología y Cambio Climático*, INECC) and the Federal Attorney's Office of Consumers (PROFECO). The website provides a rating score for new and used (from 2008) light vehicles in terms of both greenhouse gas emissions (efficiency) and air quality emissions (clean) , with 10 out of 10 being the best for both emission types. The website encourages consumers to select vehicles with a combined score of at least 17 out of 20 for both greenhouse gas and air quality (clean and efficient).
Figure 2.4 below shows the screenshot results for an example search on the Chevrolet Volt plug-in hybrid electric vehicle, which has a combined score of 19/20 and an overall rating of B as shown by the red car on the matrix graph.

**Figure 2.4- Results for the 2017 Chevrolet Volt on the EcoVehiculos website**




*Source: ecovehiculos.gob.mx (2017)*

It is important that energy efficiency objectives are not achieved at the cost of other environmental objectives. Mexico City, the capital and largest city, is situated at high altitude in a mountain basin with a climate that exacerbates pollution levels and air quality is a particular problem in the city. Mexico is commended on providing consumer information using an innovative approach that shows both vehicle fuel efficiency and air quality information.

### 6.1.4 Electric vehicles

The Mexican government has recognized the potential for electric vehicles to deliver significant energy efficiency benefits. The "Transition Strategy to Promote the Use of Cleaner Technologies and Fuels", published by SENER, states that one of the essential components of the reduction in energy demand is to "electrify as much as possible the different modes of transport, both public and private".

It is important to distinguish between plug-in electric vehicles and non-plug-in hybrid vehicles. Plug-in electric vehicles can use electricity from an external source: 100% "battery electric vehicles" such as the Nissan Leaf and Plug-In Hybrid Electric Vehicles (PHEVs) such as the Chevrolet Volt are plug-in electric vehicles. Hybrid vehicles such as the non-plug-in Toyota Prius and Ford Fusion hybrid are not plug-in electric vehicles, although they do provide good fuel efficiency benefits. In this document, the term "electric vehicles" refers to plug-in electric vehicles only.

Electric vehicles are around four times more energy efficient than their internal combustion engine counterparts. In addition to efficiency benefits, further emissions reductions are possible when switching to electricity, which is increasingly lower carbon.

Mexico plans for more than half of the 120 GW of new power generation capacity installed to 2040 to be renewable. This would halve the emissions intensity of power generation from more than 450 g CO2/kWh in 2014 to 220 g $CO_2$/kWh in 2040[8].

Table 1 provides a comparison of the $CO_2$ emissions from a typical electric vehicle, the Nissan Leaf, and compares these with a similar sized, modern gasoline vehicle popular in Mexico. It does this for both the 2014 electricity generation mix in Mexico and that planned for 2040 as given above, all other things being equal. This shows that the 2014 electricity generation mix would have resulted in a 50% reduction in $CO_2$ emissions when using an electric vehicle and this will further halve again by 2040.

**Table 2.1: Comparison of $CO_2$ emissions from electric and gasoline vehicles in Mexico**

| Vehicle model | Energy type | Vehicle energy consumption | $CO_2$ emissions rate, 2014 electricity generation mix | $CO_2$ emissions, 2040 electricity generation mix |
|---|---|---|---|---|
| **Nissan Versa[9]** | Gasoline | 18.27 km/litre | 170 g/km | 170 g/km |
| **Nissan Leaf[10]** | Electric | 18.6 kWh/100km | 84 /km | 41 g/km |

*Source: Ecovehiculos and US Department of Energy.*

[8] International Energy Agency (2016), World Energy Outlook Special Report: Mexico Energy Outlook, OECD/IEA, Paris, http://www.iea.org/publications/freepublications/publication/MexicoEnergyOutlook.pdf, retrieved on May 31, 2017.
[9] Data from www.ecovehiculos.gob.mx
[10] Converted from 30kWh/100 miles figure from US Department of Energy https://www.fueleconomy.gov/feg/bymodel/2016_Nissan_Leaf.shtml

### 6.1.5 Innovation in sustainable public transport in Mexico City

Various bodies which have jurisdiction over the greater Mexico City area are continuing to introduce innovative solutions to providing for increasing demand for public and private transport. They include:

- Metrobus Bus Rapid Transit system, operating articulated buses that stop at designated platform stops along bus only lanes, opened its first line in 2005 and continues to expand. A seventh Metrobus line is scheduled to open in late 2017 and will use double decker buses.

- Smartcard payment "Tarjeta CDMX" for Metrobus and metro payments. The low initial cost card can be topped up with small amounts making it affordable and practical for most residents. It is widely used and has largely replaced the need for paper tickets.

- EcoBici public bicycle system, which was launched in 2010 with 84 stations and 1,200 bicycles, has now expanded to 444 stations and 6,000 bicycles due to its popularity[11]. There are now over 100,000 users of the system. Bicycle rental is paid for using a smartcard.

- The Mexicable is a 4.8 km long public cable car opened in 2016 and services hillside suburbs.

These innovative solutions are contributing to modal shift towards more sustainable and energy efficient transport options.

## 6.2 Challenges

- In Mexico, growing demand for both public and private transport continues to outstrip supply. This is evidenced through congestion on roads and overcrowding on public transport. In 2017, telematics company TomTom measured Mexico City as the most congested in the world, where drivers experience an average 66% increase in travel time compared with free flow conditions[12].

- While innovative public transport and non-motorised mode projects have been put in place in the greater Mexico City area, the overall passenger transport system is somewhat fragmented. Smartcards can only be used on some services (Metrobus and metro) but not the local feeder buses. Many people are put off travelling on public transport due to significant overcrowding issues on the services, which also adds to concerns about personal security. More investment and better coordination between all the funders involved in providing transport in Mexico City are needed.

- Facilitating of the uptake of private electric vehicles will require intervention to help solve information barriers, the chicken-and-egg problem of EVs and public charging infrastructure. Two sectors, which have never previously had significant interaction, the electricity sector and the transport sector, will need to develop an understanding of each other's business and coordinate to plan an effective and efficient roll out of infrastructure to support electric vehicles.

[11] Data from: https://www.ecobici.cdmx.gob.mx/sites/default/files/pdf/welcome_pack_1.pdf
[12] TomTom (2017), TomTom Traffic Index 2017: Mexico City retains crown of 'Most Traffic Congested City' in world, http://corporate.tomtom.com/releasedetail.cfm?releaseid=1012517, Retrieved on May 31, 2017.

- Many electric vehicles will be able to charge at home overnight and this should be encouraged through time of use price signals to optimise use of the existing electricity generation, transmission and distribution infrastructure, and minimise overall system $CO_2$ emissions. However, public charging infrastructure is also needed to act as a public signal and to increase the utility of existing vehicles for longer trips.

- There is very little public information on electric vehicles and their benefits. Currently only plug-in hybrid electric vehicles[13] (PHEVs), such as the Chevrolet Volt, are included in the *Ecovehiculos* website where consumers can compare. Pure battery electric vehicles (BEV) are not currently included in this website. It would be hard to show BEVs on a comparative basis currently as the PHEVs already score the maximum of 10/10 on greenhouse gas emissions (122 $gCO_2$/km for the Chevrolet Volt) with some lower efficiency internal combustion engine use included in achieving that score. In Table 2.11 above the figure for a typical EV, the Nissan Leaf, is 84 g/km based on the 2014 electricity generation mix. A re-rating or extension of the current scoring system would be required to show consumers how efficient and low $CO_2$ electric vehicles are in comparison with the gasoline equivalents.

- Public transport provides significant benefits in $CO_2$ reduction and air quality improvement over private vehicles, and there is a greater opportunity for further benefits through electrification of public transport. While there has been improvement in the air quality emissions from diesel-fuelled vehicles over time, diesel engines remain a significant source of air pollution and are operating where there are very high levels of public exposure. Electrification of public transport can deliver zero emissions in urban corridors. The fixed route nature of public transport helps make recharging easier. Transport for London has recently committed to introducing Europe's largest fleet of electric buses to help tackle air quality issues in the city[14]. Double decker electric buses are also being piloted in London[15].

### 6.3 Recommendations

**Recommendation 29:** *Push for greater coordination around transport planning and energy efficiency between all levels of government.*

Transport planning and funding, as well as energy use in transport involves many different levels of government and a range of players, particularly in Mexico City. Greater coordination would help smooth the way to better-integrated projects.

**Recommendation 30:** *The government should prioritize funding to public transport and non-motorized modes over additional road infrastructure.*

Public transport and non–motorised modes are the most energy efficient, and in many cases, more equitable than private vehicle transport, and can deliver $CO_2$ emissions reductions and air quality improvements. Funding should be prioritised to these modes over additional road construction, in Mexico City in particular.

**Recommendation 31:** *The government should update and extend the vehicle fuel economy standards.*

The current Mexican vehicle fuel economy standard applies for the period 2013 to 2016. The government is investigating

[13] PHEVs typically operate distance of around 25-60 km in all electric mode, and have a supplementary gasoline or diesel engine for longer journeys. Pure or battery electric vehicles (BEV) have only battery storage and have a typical real world range of 120-400 km.
[14] Transport for London (2016), Mayor unveils first fully electric bus routes for central London, https://tfl.gov.uk/info-for/media/press-releases/2016/september/mayor-unveils-first-fully-electric-bus-routes-for-central-lond, Retrieved on May 31, 2017.
[15] Build Your Dreams (2016), First pure electric double deck buses on streets of London, http://www.byd.com/news/news-325.html, Retrieved on May 31, 2017.

extending this for light duty vehicles so that it aligns with the US standards for the period 2017- 2025[16]. Introducing heavy-duty vehicle fuel economy standards is also being considered, which would align with the US standards for the period 2018-2027. Mexico should finalise these standards as soon as possible to give certainty to the market as well as benefit from the emissions reductions they will deliver.

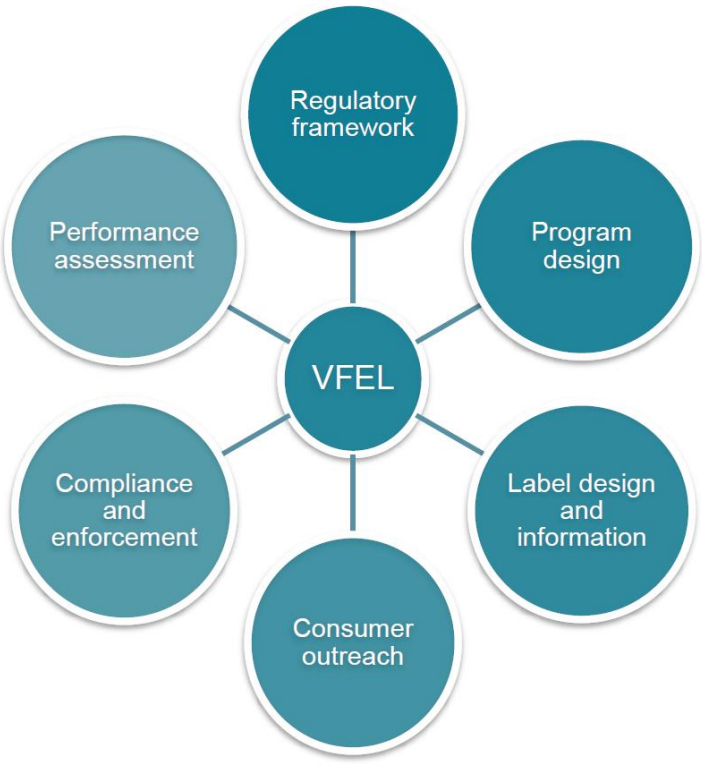
The currently vehicle fuel economy standard does not cover pure electric vehicles (BEVs). These should be incorporated into any future vehicle fuel economy standard, as it would be a particularly powerful and low cost way to accelerate the uptake of electric vehicles in Mexico.

**Recommendation 32:** *Consider mandatory fuel economy labelling of vehicles at point of sale and in advertising.*

Many people only consider the upfront purchase cost of a vehicle and not its on-going fuel running costs when making their purchase decisions. Mandatory vehicle fuel economy labels (VFEL) at point of sale and information in advertising (including online advertising) helps highlight this important consideration and the benefits of more fuel-efficient vehicles to consumers.

Mexico should consider adopting the best practice recommendations on providing vehicle fuel economy consumer information produced by APEC[17]. There are six key elements of best practice consumer information on vehicle fuel economy, centred on a vehicle fuel economy labelling scheme, as shown in Figure 2.5. Mexico already has one of these in place through the vehicle fuel economy standard.

**Figure 2.5- Key elements of best practice consumer information on vehicle fuel economy (VFEL)**




[16] Miller, J., Du, L., and Kodjak, D. (2017), Impacts of World-Class Vehicle Efficiency and Emissions Regulations in select G20 countries, International Council on Clean Transportation, http://www.theicct.org/sites/default/files/publications/ICCT_G20-briefing-paper_Jan2017_vF.pdf, Retrieved on May 31, 2017.
[17] A Review and Evaluation of Vehicle Fuel Efficiency Labelling and Consumer Information, Programs APEC#215-RE-01.27, APEC, 2015 http://publications.apec.org/publication-detail.php?pub_id=1689

**Recommendation 33:** *Set policies that accelerate the uptake of electric vehicles such as fiscal incentives, promoting charging stations construction, government leadership on EV usage, among others.*

Electric vehicles are a technology that can provide a step change in energy efficiency in Mexico's largest energy consuming sector. They also provide significant climate change and air quality benefits. Policies should be investigated and set which can help accelerate the uptake of EVs, for both passenger and freight transport covering both light and heavy vehicles. A distinction needs to be made in policy between electric vehicles and non-plug-in hybrid vehicles.

Recommended policies include:

- **Enhanced fiscal incentives to support the uptake of EVs, such as feebates.** Any purchase price subsidies for EVs need careful design, as when these are removed they can backfire and slow adoption rates.

- **Setting domestic targets for EV uptake.** These provide a signal to vehicle manufacturers and consumers about the Government's support for the technology.

- **Under the electricity market reforms, ensure it is easy for private companies to set up retail public charging stations for EVs.** Currently the reforms propose that only CFE will be able to retail electricity to basic users such as residential consumers and small shops[18].

- **Government can show leadership by buying EVs for its fleets.** Government leadership is critical in showing its support for the technology and normalizing EV use.

- **Set EV charging connection standards.** Connection standards have not yet been set which is resulting in unnecessarily complex and high cost charging stations. Figure 2.6 shows a charging station in Mexico City[19], which provides for a wide variety of different fast and slow charging standards. Catering for this number of standards is unworkable on in the medium to long term. Charging connection standards will help give certainty to manufacturers as to what technology to provide in vehicles, to consumers as to which vehicles to buy and to reduce costs of public charging stations.

[18] Presentation to PREE expert group by Dr. Diego Villarreal Singer, Deputy Managing Director of Electric Industry Coordination, SENER, March 2017.
[19] Photo: Pramesh Maharaj, PREE expert group member, March 2017.

**Figure 2.5 - EV charging station in Mexico City with outlets for different charging standards**


- **Develop a domestic database of public charging stations.** The database should be compiled by one agency and be an authoritative, open source of all information on public EV charging. The database should be freely accessible by anyone wanting to provide information on EV charging locations, such as smartphone app developers and vehicle manufacturers for use in on-board vehicle navigation systems. This approach has been successfully adopted in Norway as NOBIL, a partnership of the Norwegian Electric Vehicle Association and Norwegian government agency, Enova.

## 7. POLICY MEASURES- ELECTRICITY SECTOR

### 7.1 Achievements

Fully realizing Mexico's energy efficiency potential is becoming an important policy priority, as rising incomes and urbanization increase electricity consumption. Mexico has already implemented a variety of measures to foster efficiency, including compact fluorescent lamps (CFLs) giveaways and incentives for appliance retrofits, equipment standards and building codes, municipal efficiency programs, industrial sector initiatives, and federal public sector engagement with energy services companies with limited resources and staff

**7.1.1 Mexico's energy efficiency policy creates long-term clean energy and efficiency goals, regarding the total generation and consumption of clean energy electricity in Mexico, as well as measures on sustainable use of energy.**

The electricity sector energy efficiency policy of Mexico is ambitious and aligned with the National Development Plan (PND), based on its goal "*México Próspero*", Objective 4.6, which seeks to promote energy efficiency throughout the entire energy sector (from generation to end use). Energy efficiency is a key component for addressing the anticipated growth in electricity demand in Mexico over the next 15 years that is expected to exceed 3.5%/year.

The Transition Strategy to Promote the Use of Cleaner Technologies and Fuels (Transition Strategy) is aimed at boosting Mexico's energy transition and delivering an efficient and low-carbon economy and society. The strategy includes medium (15-year) and long-term (30-year) actions. These actions comprise a shared responsibility of the three levels of government, private and academic sectors and society in general. A first version of this Strategy was published in December 2014 and an updated version is currently being produced and will contain clean energy and energy efficiency goals, as well as a roadmap to develop an efficient and competitive energy market.

The National Program for the Sustainable Use of Energy (PRONASE) establishes strategies, objectives, actions and targets to achieve optimal use of energy in all processes and activities for exploration, production, processing, distribution and consumption.

The Roadmap of Energy Efficiency is the guide for implementing actions to meet energy efficiency targets established in PRONASE, in accordance with the Energy Transition Law, Article 12. The roadmap contains programs and strategies to achieve a final energy intensity reduction rate of 1.9% from 2016 to 2030, and 3.7% from 2031 to 2050.

The potential electricity savings are estimated to amount to 28.5 Terawatt-hour (TWh) for the residential sector (70% of total electricity savings), 8.1 TWh for the industrial sector (20%) and 4.3 TWh for commercial, services and agriculture sectors (10%) by 2028.

### 7.1.2 Mexico is transitioning from a centralized utility (CFE) to a market-based approach with wholesale and retail power supply choices.

The reform brought an end to the existing order in the energy sector, turning PEMEX and CFE into "state productive enterprises" whose portfolios of responsibilities (which previously included issues such as the economy's energy security) have been pared back to focus on value creation. The Reform law also ended the state monopoly on oil and gas production, as well as on electricity retail sales. These changes have impacted policy and policymaking in Mexico, and therefore the outlook for the future energy supply mix and costs.

The unbundling of the *Comisión Federal de Electricidad* (CFE) and long-term auctions for energy, capacity and clean energy certificates provide new players with access to Mexico's power market on a competitive basis, as well as a cost-effective way to bring low-carbon generation into the mix. The Energy Reform package, initiated in 2013, established new structures for the oil, gas and electricity industries in Mexico.

### 7.1.3 Mexico's strategy is aimed at boosting energy transmission and delivering an efficient and low-carbon economy.

Long-term auctions for energy, capacity and clean energy certificates provide an entry point for new players on a competitive basis and a cost-effective way to bring low-carbon generation into the mix. A strengthened transmission and distribution system and reduced losses help to moderate the costs of electricity supply.

The first two auctions for new power supply, held in 2016, demonstrated strong private readiness to invest in new solar PV and wind generation, validating the innovative choice of market design. Investments in strengthening the grid and bringing down network losses, along with a continued switch away from fossil-fuel generation, all help to better manage electricity supply costs and thus provide a boost to Mexico's industrial competitiveness. This also provides an opportunity to reduce the costs of subsidies for residential electricity consumers.

### 7.1.4 While consumption of electricity is projected to rise, energy efficiency policies have gained momentum in recent years, with the government making laudable efforts to reduce energy consumption.

In the end-use sectors, residential consumption of electricity is projected to nearly double between 2014 and 2040. Rising incomes and living standards will create demand for appliances and cooling as well as new construction. Energy efficiency policies in the buildings sector have gained momentum in recent years, with Mexico making laudable efforts to reduce energy consumption through policies for equipment (standards), in buildings and the industrial sector.

## 7.2 Challenges

- Despite the willingness and plans for enhancing energy efficiency in Mexico, challenges remain with limited financial and staff resources.

- There remains sub-optimal coordination between different agencies responsible for efficiency programs.

- Most of the energy efficiency programs have just been developed and there is little experience yet in the execution and impact evaluation of those programs.

- This lack of experience is compounded by lack of enforcement and enforcement staff experience of energy efficiency standards, specifically for buildings.

- Building standards are developed at federal level, but local governments, which are responsible for incorporating them into local by-laws, enforcing and updating them, have limited funding and capacity to do so.

- Lastly, in 2018, with a new presidential administration, there will be a new strategy and new special programs that will most likely impact the staffing, funding, design, and effectiveness of today's programs.

### 7.3 Recommendations

**Recommendation 34:** *Establish an energy efficiency Public Benefits funds program.*

Consider promulgating a policy that establishes a dedicated and well-resourced energy efficiency fund generated from the sale of electricity. This is commonly referred to as a public benefits funds (or system benefits funds) and are based on a charge at the electricity distribution level or added to a customer's bill which is intended to cover costs related to services that a utility provides in the public interest to all customers.

Current funding for customer energy efficiency and related programs and initiatives is through appropriated (federal) funds and private-sector grants. This funding is allocated to a number of initiatives underway as part of the Energy Transition Law and articulated in the Energy Efficiency (EE) Framework. The long-term EE Framework under development will lay out a roadmap to accomplish goals and carry out initiatives. Among the key issues identified in the Framework document is financing and funding for implementing and sustaining the initiatives and for meeting goals.

One approach to securing large and sustained funding for initiatives is through the implementation of public benefits funds. Public Benefits funds (PBF) have become increasingly popular internationally as a way to enhance renewable energy and energy efficiency investments and deliver important public benefits. Public benefits funds are most commonly used in the United States, but there is also experience in Europe, Australia, Japan, China, Brazil, India, and other economies. In the international experience, it has been recognized that public benefits funds are particularly important to implement in conjunction with reforms in the electric utility sector.

The amount of funds collected for a PBF should depend on the expected use of those funds, and must be informed by political circumstances. Public benefits charges typically range from 2.5% to 5% of a customer's total energy bill. Funding stability for a minimum of 3-5 years should be sought because markets take time to build, and programs take time to implement effectively.

Every utility customer would pay into this fund and every utility customer would be eligible to receive the benefits of the application of these funds. Benefits of the application public benefits funds include but are not limited to:

- Nationwide reduced emissions of greenhouse gases and air pollution through efficiency and demand side management programs implemented for all customer classes.
- Significant environmental and social benefits at low cost to individual customers
- Financial support for a wide variety of technologies and programs including research and development.
- Reduced and affordable energy bills for low-income customers who can take advantage of programs to reduce energy consumption.
- Sustained and more substantial funding that is not dependent upon federal appropriations.
- Can help create a robust and indigenous energy efficiency/energy services industry including ESCOs that require relatively large and sustained funding sources to efficiently engage in projects.

**Example: Brazil's Public Benefit Fund**

Brazil is one of the very few developing economies to have demonstrated continued support for energy efficiency and energy R&D during the re-structuring process of its power sector. Regulation enacted in Brazil helped to create significant funds for energy efficiency and energy R&D projects, reverting the initial decline in funding and activities during the initial stages of the re-structuring and privatization process.

About USD 300 million are collected annually from utilities in Brazil. The allocation of resources has changed very significantly since the initial implementation of the wires charge in 1998. This is due both to successive rulings by National Electricity Regulator (ANEEL), as well as to laws passed in 2000 and 2004. Brazil created two separate funding schemes from a 1% levy on utilities' annual revenues (wires charges). A portion of the resources is administered by the utilities themselves under the supervision of ANEEL and the other part is managed by a board of representatives from government, academia and private sector.

The Brazilian experience suggests strong governance and management of the funds is required both for the regulated utility programs and for the centrally managed public benefit fund. Also, the experience in Brazil has demonstrated that it is necessary to clearly establish broad public energy policy goals in order to guide the regulator's and utilities' efforts to apply the resources available more cost-effectively.

**Recommendation 35:** *Institutionalize Integrated Energy Planning.*

Consider implementing a policy that requires recalibration of the overall policy and program balance between supply-side and demand-side (efficiency) considerations to achieve full integrated energy planning.

The current approach to future electricity supply (generation) is focused on new clean energy sources as spelled out in The Transition Strategy to Promote the Use of Cleaner Technologies and Fuels. This strategy is aimed at boosting Mexico's energy transition and delivering an efficient and low-carbon economy and society.

On the other side of the 'equation' is The Roadmap of Energy Efficiency, which is the guide for implementing actions to meet energy efficiency targets established in The National Program for the Sustainable Use of Energy (PRONASE).

PRONASE establishes strategies, objectives, actions and targets to achieve optimal use of energy in all processes and activities for exploration, production, processing, distribution and consumption. The roadmap contains strategies to achieve a relatively modest final energy intensity reduction rate of 1.9% from 2016 to 2030, and 3.7% from 2031 to 2050.

Through Integrated Energy Planning (IEP) one can identify the most cost-effective of the array of demand-side management (DSM), efficiency improvement measures and renewables, because the costs of delivering and saving a kWh of electricity—from improved lighting retrofits to centralized thermal generation plants to decentralized biomass generation facilities—are compared on a "level playing field'. An option is then recommended only if its cost is less than or equal to other competing alternatives. At particular times, for example, to meet additional peak demand, efficiency options, not always cheaper, may be preferable to conventional generating plants, thereby indicating specific niches for such peak-saving DSM options

Each dollar invested in electric energy efficiency measures can result in multiple dollars in total benefits for all customers, which include avoided energy and capacity costs, lower energy costs during peak demand periods like heat waves, avoided costs from building new power lines, and reduced carbon and other pollution. Incorporating high levels of less cost-volatile energy efficiency in long-term planning can protect utilities and their customers against historically volatile costs and large capital investments for traditional energy supply resources.

**Example: Denmark IEP Policy**

Integrated Energy Planning in Denmark was imposed under the new Electricity Act in 1994 to achieve a balance between investments in electricity conservation and the development of electricity supply. ELSAM and ELKRAFT, the two regional associations of vertically integrated power companies, are obliged to present 15-year plans to the government specifying how they will achieve their commitments on energy efficiency and environment policies. The Danish Independent Systems Operator drew up scenarios for generation and transmission, and the Ministry gave guidelines and coordinated an overall plan.

**Example: New Mexico IEP Policy**

The Efficient Use of Energy Act ("EUEA") provides the statutory requirements for incorporating energy efficiency as a resource. It directs "public utilities to develop all cost-effective and achievable energy efficiency and load management resources," (NMSA 1978, §62-17). The EUEA notes that integrated resource plans should consider energy efficiency as well as the traditional supply-side resources in formulating the plan (NMSA 1978, §62-17-10).

The New Mexico Public Regulation Commission ("PRC") sets out the rules for implementing statute. The PRC's energy efficiency rule, NMAC 17.7.2, was recently updated in 2014 (Case No. 13-00310-UT).The PRC mandates that electric utilities must file an IRP and a four-year action plan every three years. The Integrated Resource Planning ("IRP") rule states, "the utility shall consider all feasible supply-side and demand-side resources" when identifying possible resource options (NMAC 17.7.3.9.F). Energy efficiency requirements shall be considered when developing resource portfolios (NMAC 17.7.3.9.G(2)).

**Recommendation 36:** *Develop equipment standards and voluntary programs for water products.*

Consider a policy for developing NOMs and the voluntary *Sello FIDE* labelled products for water and plumbing products, focusing initially on water products that use hot water as saving hot water will also save energy used to heat it.

Nearly all buildings offer a potable water supply to occupants. Demands on the supply and treatment system are increasing significantly. Over the past nearly half century, progress has been made on increasing the efficiency of potable water end uses (plumbing and appliances) and removing those uses from the potable water supply that do not require such water (water for cleaning, irrigation, cooling, and those processes that can operate with non-potable water). Product efficiency improvements in the past three decades have been significant. Some have been mandated through federal government and local legislation and regulations, while others have resulted solely from the initiative of product developers and manufacturers directed at product improvement.

These regulations and improvements have not only saved potable water, but also energy through the savings of hot water and pumping. Every indoor high-efficiency water fixture saves energy. The amount of energy it takes to extract, treat, and move water to the building is very significant, including energy costs incurred by the building owner in additional booster pump and heating costs to raise water several stories. For example, it is estimated that approximately 13 percent of the U.S. energy use is water-related and in California, 19 percent of the state's electrical energy output goes to providing water for its population.

Unlike energy, water is not consumed. therefore, water efficiency is equivalent to water conservation. Indoor water merely changes form through use and can be recovered and treated for reuse. Water efficiency will reduce building utilities costs (water and energy), city utility cost (for pumping and treating), and reduce drawdown of aquifers and surface water. This will make more water available for 'downstream' users including municipalities and large users such as industry and thermal power plants.

**Example: US Environmental Protection Agency (EPA) WaterSense Partnerships**
The EPA WaterSense is a voluntary partnership program sponsored by the U.S. Environmental Protection Agency (EPA). It is both a label for water-efficient products and a resource for helping homes and businesses save water.

The WaterSense label makes it simple to find water-efficient products, new homes, and programs that meet EPA's criteria for efficiency and performance. WaterSense-labeled products and services are certified to use at least 20 percent less water, save energy, and perform as well as or better than regular models. WaterSense partners with manufacturers, retailers and distributors, homebuilders, irrigation professionals, and utilities to bring WaterSense to U.S. communities.

**Recommendation 37:** *Enhance the National Program for Energy Management to Require Training.*

Requiring the participating industries to certify the 'champion' or other staff by undergoing training and certification in energy efficiency, demand side management, energy efficiency practitioner, and/or building energy auditing. These certifications are available through the Association of Energy Engineers (Mexico chapter) and would be in addition to certification under ISO 50001 or ISO 9001.

Energy consumption by small and medium-sized enterprises (SMEs) in Mexico constitutes a quarter of total industry consumption. As in other economies, SMEs often lack awareness, quality data and resources to manage energy consumption. Mexico has no voluntary energy performance agreement program or incentives for industry to improve energy efficiency. There is also no law or regulation requiring industrial facilities to employ a plant energy manager, and it does not require periodic energy audits. Therefore, the government through CONUEE is fostering the application of energy management systems through the voluntary National Program for Energy Management Systems. This program is accompanied by learning networks to facilitate the implementation of the Energy Management Systems (EMS).

Currently, the network considers a formal agreement with 10 large industrial companies from different sectors. The key to success for the industries is to find a 'champion' within the company and that champion engages upper management to promote participation and obtain 'buy-in'. The single biggest driver for participation is the return on investment for the company.

Requirements for training and certification will enhance the potential for identifying energy and cost savings opportunities in industrial facilities. In addition, certification through the Association of Energy Engineers (AEE) Certified Energy Manager (CEM) certification program is accredited by the American National Standards Institute (ANSI) based on the International Standard ANSI/ISO/IEC 17024. ANSI Standard 17024 is well-recognized within the industry as the highest standard in personnel certification accreditation.

**Recommendation 38:** *Develop a framework and incentives to strengthen demand response, including adopting tariff reform to better reflect true costs and incentivize demand reduction and response programs.*

Demand response is broadly defined as changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale electricity market prices or when the electricity delivery system reliability is jeopardized. Demand response encompasses a broad range of technologies focused on avoiding, deferring, or shifting loads at certain times that reduce the capital or operational costs of the customer, the energy supply system and also helps maintain or enhance the electrical system reliability.

Adopting tariff reform changing the structure of tariffs to better reflect the true distribution costs, the hourly variations of electricity prices and the generation requirements to serve those hourly loads. Tariff reform will help incentivize industry to reduce load and, thus, save costs.

Appropriate tariffs for industrial customers will better enable the type of return on investment required to implement efficiency technologies and measures. Tariffs that contain appropriate demand charges will also drive the development of cost-effective distributed resources, such as rooftop PV, energy storage, and participation in demand response programs once available.

Implementing a demand response policy and program specifically targeted for the industrial sector. Under appropriate tariffs and demand response incentives, industrial consumers can be a valuable asset for a utility experiencing high cost peak demand service in stressed areas of their distribution system. As a feature of a demand respond policy, consider the development of a standard contract with the utility for demand response services that industrial and other large customers can adopt. Allow the use of 'aggregators' as an intermediary between the utility and customers that mediate the interaction between the two parties.

**Example: U.S. Demand Response Program**

PJM Regional Transmission Operator Interconnection coordinates the movement of wholesale electricity in 13 states and the District of Columbia in the Northeast part of the US. Acting as a neutral, independent party, PJM operates a competitive wholesale electricity market and manages the high-voltage electricity grid to ensure reliability for more than 51 million people. PJM's long-term regional planning process provides a broad, interstate perspective that identifies the most effective and cost-efficient improvements to the grid to ensure reliability and economic benefits on a system wide basis.

PJM as is a grid operator with no ownership of any infrastructure that must plan from the current minute into the future while ensuring participating utilities and power producers plan for long-term system reliability, stability, and resources. PJM coordinates price offers, control signals, and feedback, and uses metering to validate settlements as wholesale and retail organizations participate in the same market without any distinction between wholesale and retail transactions. PJM operates a demand response program that relies on customers to 'bid' into a solicitation to offer demand response services in exchange for payment. In 2014, the demand response potential for PJM was over 10,000 MW (7% of total system peak demand).

One participant in the PJM demand response program is the US Navy. Navy sites in Virginia and Maryland use backup generators to supply their own power, while the Navy in Maryland, raised the water temperature of their air-conditioning chillers to slow the consumption of electricity as part of the demand response program offerings. In 2010, the first year of participation, the Navy earned $40,000/MW of electric demand it did not consumed.

**Recommendation 39:** *Promote and encourage the development of micro-grids.*

A micro-grid, at its minimal level of functionality, enables local electricity generation, energy storage and load (power consuming devices) to operate independently of the main grid. When the power flow on the grid is interrupted, a micro-grid can utilize locally generated sources of energy to maintain essential services. The purposes for a micro-grid are to economically provide electricity to critical loads within the micro-grid, and to improve power quality, flexibility, and reliability by integrating and optimizing various sources of energy.

Promulgating policies and practices to enable industry (or small communities) to develop micro-grids that incorporate efficiency, renewable energy generation, and controls that allow industry to be isolated from the grid during disruption of service or other catastrophic events (such as hurricanes) and help relieve congestion on the transmission system during times of high demand.

A micro-grid can be designed to serve 'isolated' communities that have limited transmission and depend upon distributed diesel-generation, and be activated to relieve congestion on the grid by being used during times of high demand.

**Example: Huatacondo Microgrid**

The University of Chile has developed Chile's first microgrid project in a remote Andes Mountains community of 150 residents (mostly miners and their families) called Huatacondo. Prior to the microgrid installation, the community had its own electric network (operating independently from the macro-grid) operating 10 hours per day with power provided from a single diesel generator. The vision of the microgrid was to continue using that diesel generator but supplement it with distributed energy resources, namely solar PV, wind, and a battery system.

The microgrid includes a 150 kW diesel generator, 22 kW tracking solar PV system, a 3 kW wind turbine, a 170 kWh battery, and an energy management system. The energy management system provides online set-points for generation units while minimizing operating costs, taking into account renewable resource forecast, load, solar tracking, and water consumption.

## 8. POLICY MEASURES- APPLIANCES AND EQUIPMENT

### 8.1 Achievements

#### 8.1.1 CONUEE has Minimum Energy Performance Standards (MEPS) that include most energy-intensive appliances in the residential sector.

The National Commission for the Efficient Use of Energy (CONUEE) has maintained a Mandatory Energy Efficiency Standard Program that includes 30 Minimum Energy Performance Standards (MEPS), of which 24 are directed to regulate energy consumption in appliances and equipment, and six for systems. Most energy-intensive appliances in the residential sector, including refrigerator, air-conditioner, and lighting, have been covered by MEPS. Table 2.2 lists the appliances and systems currently covered by the MEPS program.

**Table 2.2 Appliances and systems currently under MEPS regulation in Mexico**

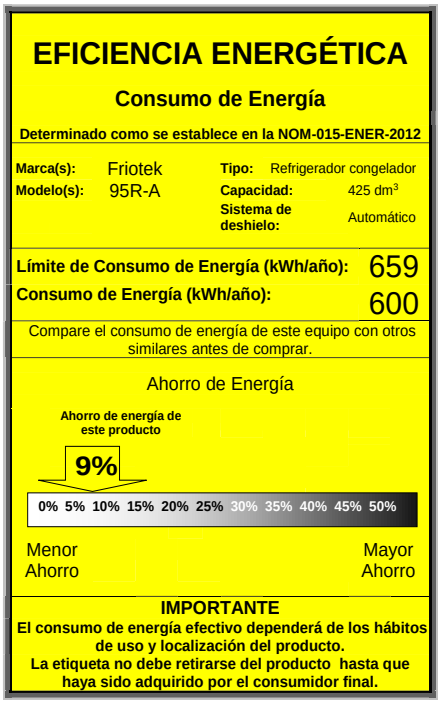
| Sector | Appliances/equipment/systems |
|---|---|
| Residential | Refrigerators and freezers, air conditioners (window, central, split and inverter), washing machines, water heaters, cooking stoves, domestic water pumps, compact fluorescents lamps, lamps for general uses (incandescent, linear fluorescents, street lighting), lamps for general use (LEDs), standby power |
| Industrial and Commercial | One-phase motors, three-phase motors, industrial thermal insulator, *tortilladoras* machines, commercial refrigeration, distribution transformers, new light vehicles |
| Agricultural and municipal | Submersible water pumps, vertical water pumps, LED luminaires, street lighting systems, deep well pumping systems |
| Building | Thermal insulation for buildings, residential and non-residential building envelopes, lighting systems for non-residential buildings, thermal and optical characteristics of glass and glazed systems |

*Source: Presentation to PREE expert group by Mrs. Norma Morales Martinez, Director for Standardization, National Commission for the Efficient Use of Energy (CONUEE), March 2017.*

#### 8.1.2 The government has mandatory energy labels for 13 products displaying energy consumption and comparative information.

The Mexican government currently stipulates mandatory energy labels for 13 consumer products. Figure 2.7 illustrates an example of the energy label, which not only reveals energy efficiency or energy consumption of a product, but also provides consumers with information for comparing the product's efficiency with MEPS.

**Figure 2.7 - Mandatory energy label currently employed in Mexico**




### 8.1.3 A robust regulatory framework has been established and testing laboratory infrastructure is well maintained through accreditation and round robin testing.

By following a well-defined process flow, stakeholders are involved in the development and implementation of MEPS. The implementation framework comprises testing laboratories, as well as certification, verification and inspection bodies, all of which are accredited in accordance with international standards. Table 2.3 lists the relevant Mexico Official Standards (NOMs) and the equivalent international standards for the accreditation process. After-market check is performed on a routine base to ensure compliance with energy performance standards. The testing laboratory infrastructure is maintained through accreditation and round robin testing.

**Table 2.3 - NOMs and standards relevant to the accreditation of testing laboratories, certification bodies, and verification/inspection bodies**

| Accreditation Subject | Standards |
|---|---|
| Testing Laboratory | NMX-EC-17025-IMNC-2006<br>ISO/IEC 17025:2005<br>General requirements for the competence of testing and calibration laboratories |
| Certification Body | NMX-EC-17065-IMNC-2014<br>ISO/IEC 17065:2012<br>Conformity assessment<br>Requirements for bodies certifying products, processes and services |
| Verification/Inspection Body | NMX-EC-17020-IMNC-2014 |

| | |
|---|---|
| | ISO/IEC 17020:2012<br>Conformity assessment<br>Requirements for the operation of various types of bodies performing inspection |

*Source: Presentation to PREE expert group by Mrs. Norma Morales Martinez, Director for Standardization, National Commission for the Efficient Use of Energy (CONUEE), March 2017.*

Overall, MEPS and mandatory labels are working properly in Mexico in a robust regulatory framework with a clear process flow and a well-maintained accreditation infrastructure that incorporates 69 testing laboratories, 8 certification bodies, and 201 verification bodies. In 2015, SENER, in collaboration with the Lawrence Berkeley National Laboratory (LBNL), evaluated the impacts of MEPS in Mexico, with positive results[20].

### 8.1.4 Additionally, a voluntary energy label comprising more than 2,000 products is run by the Electric Energy Savings Trust Fund (FIDE).

In addition to MEPS and mandatory label, the Electric Energy Savings Trust Fund (FIDE) maintains a voluntary energy label program, known as *Sello FIDE*. As of February 2017, 2924 products from 83 companies were awarded to use the label. The voluntary labels need renewal once per year.

### 8.1.5 Long-term projects that subsidize the procurement of high-efficiency appliances.

In addition to standards and labels, long-term projects that subsidize the procurement of high-efficiency appliances are in place with annual budget in the range of 50 million pesos, representing Mexico's continuous efforts toward promoting high-efficiency products. Some of the projects apply a payback-on electricity bill scheme that helps consumers minimize the upfront cost.[21]

## 8.2 Challenges

- Although efforts were made by CONUEE to harmonize the energy efficiency standards and testing methods with international versions for products such as three-phase motors, refrigerators, and air-conditioners, a comprehensive benchmark has not been done.

- Gathering product information and energy performance data of the appliances in the Mexican market seems to be challenging due to the limited manpower and resources at CONUEE. The lack of local market information may affect the determination of optimal energy efficiency requirements in terms of market transformation.

- *Sello FIDE* currently does not require after-market check, which is generally considered crucial in maintaining the credibility of a voluntary label program.

- There is relatively low public awareness for the voluntary energy label program, which diminishes the label's impact on consumer purchasing decisions.

[20] Presentation to PREE expert group by Mrs. Norma Morales Martinez, Director for Standardization, National Commission for the Efficient Use of Energy (CONUEE), March 2017.

[21] *Ibidem.*

## 8.3 Recommendations

**Recommendation 40:** *Benchmark energy efficiency standards with other APEC economies.*

Benchmarking is informative and helps identifying gaps and opportunities. Information may be available through APEC's Energy Standards and Information System (ESIS) managed by the Collaborative Labelling and Appliance Standards Program (CLASP).

Table 2.4 shows an example of benchmarking of self-ballasted LED lamps. Luminous efficacy requirements in different economies range from 65 lumens per Watt (lm/W) to 115 lm/W. The large discrepancy arise partly from the fast advancement of LED lighting technology. It also reflects, to some extent, the product portfolio available on the market in different economies. When incorporating with local market study in a specific economy, the information in Table 2.4 becomes useful for determining the energy efficiency requirements of a policy instrument.

**Table 2.4 Energy efficiency requirements of omnidirectional self-ballasted LED lamps in voluntary label programs**

| Economy | Luminous efficacy for low Correlated Colour Temperature (CCT) products (lm/W) | Luminous efficacy for high CCT products (lm/W) | Effective Date |
|---|---|---|---|
| US (ENERGY STAR) | 70 (Colour Rendering Index >90)<br>80 (Colour Rendering Index <90) | 70 (Colour Rendering Index I>90)<br>80 (Colour Rendering Index <90) | Jan. 2017 |
| China | Grade 1: 105<br>Grade 2: 85<br>Grade 3: 65 (2700/3000K/3500K) | Grade 1: 115<br>Grade 2: 95<br>Grade 3: 70<br>(4000K/5000K/6500K) | Nov. 2014 |
| Japan (Top Runner Program) | 98.6 (Warm light, lamp color) | 110 (daylight, neutral white, white) | 2017 |
| Chinese Taipei (Energy Conservation Label) | 110 (2700/3000K/3500K) | 115 (4000K/5000K/6500K) | Mar. 2017 |

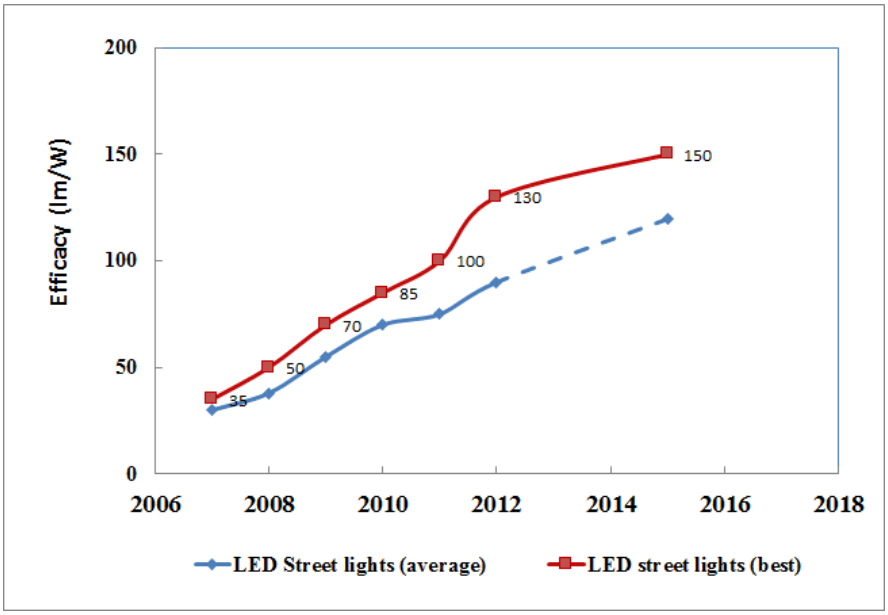
*Source: Presentation to PREE expert group by Mrs. Norma Morales Martinez, Director for Standardization, National Commission for the Efficient Use of Energy (CONUEE), March 2017.*

**Recommendation 41:** *Increase resources in CONUEE for Minimum Energy Performance Standard (MEPS) implementation to enable a more proactive establishment and revision of standards, particularly in fast-moving technologies such as LED lighting.*

A proactive approach in standardization requires additional resources and is beneficial especially for LED lighting technology, which has been advancing quickly in the past few years. For example, Figure 2.8 depicts the progress of LED street lighting efficacy, which has almost doubled within 5 years from 2010 to 2015, and is expected to improve

continuously in the foreseeable future. CONUEE should observe the progress, and conduct market surveys frequently in order to update the standards effectively and help market transformation in Mexico.

**Figure 2.8 - LED street lights efficacy**




*Source: Industrial Technology Research Institute (ITRI) research and data. (2016)*

Figure 2.8 shows the evolution of luminous efficacy of LED street lights on the market. A survey was conducted by the Industrial Technology Research Institute (ITRI) in a long-term project, in which market products were collected and tested using standardized laboratory procedures. The blue line represents the average, and the red line represents the best efficacy of market products in each year.

**Recommendation 42:** *Based on the survey results, CONUEE should consider including products such as TV sets in the MEPS program and the label program. Likewise, in the industrial sector, usage of equipment such as compressors, fans, and blowers, should be included in the survey and the MEPS.*

TV sets normally represent a significant portion of residential energy consumption, which is likely to increase as population and household income continue to grow. Although *Sello FIDE*, the voluntary energy label, includes TV sets in the program, the MEPS only regulates standby power of TV. The nationwide residential energy survey will in no doubt reveal valuable information for policymaking. CONUEE is encouraged to investigate the survey result and prioritize appliances to be regulated by MEPS, in order to increase MEPS coverage of residential energy consumption in an effective way.

In the industrial sector, the majority of electricity consumption comes from motor-driven devices, of which a significant proportion are fluid machinery such as compressors, fans, and blowers. CONUEE has already included motors in MEPS and has harmonized the standards with international ones. Nevertheless, these fluid machinery products require additional attention, as their energy efficiency is influenced not only by the motor but also by the fluid dynamic performance. In some products, motor is an integral part of the system and is not easy to regulate separately. Many economies are developing efficiency standards for fluid machinery, some of which are already available for reference.

**Recommendation 43:** *Consider replacing incandescent lamps directly with LED technologies, bypassing compact fluorescent lamps (CFLs).*

As indicated in a recent IEA report[22], some programs supported by the Mexican government are still promoting the replacement of incandescent light bulbs with compact fluorescent lamps (CFLs). Given the rapid improvement in the performance and decrease in the cost of LED lighting technology, directly replacing incandescent lamps with LED may significantly boost the saving in energy consumption, leading to long-term financial benefit. As of February 2017, the price of LED light bulb in some economies has been brought to a level close to CFLs.[23]Managers of relevant lighting programs in Mexico are encouraged to compare the benefits of adopting CFLs and LED, especially in terms of their life cycle cost, before making policy decisions.

**Recommendation 44:** *Evaluate the subsidy projects and payback-on-electricity-bill scheme carefully for their effectiveness in reducing overall energy consumption. Consumer behaviour may affect the final result of energy saving.*

Mexico has implemented many long-term subsidy projects to improve energy efficiency, and their impacts need to be evaluated in order to avoid unexpected results from unsuitable program design. Policymakers need to consider the project effectiveness in reducing overall energy consumption, because longer operation time for a higher efficiency appliance may lead to a net increase in overall energy consumption.

**Recommendation 45:** *Increase public awareness of the Sello FIDE, the voluntary label program.*

Awareness of *Sello FIDE* is currently rather low in Mexican society. FIDE should continue to increase consumers' understanding and influence purchase decisions. Consider to include the promotion of voluntary energy labels in energy efficiency education, starting from elementary level. Requiring the label in all public procurement is also an effective way to promote the labelling and to trigger private-sector investment in manufacturing and importing energy efficient products.

**Recommendation 46:** *Regularly review Sello FIDE impacts on the market transformation of different products, and upgrade the energy efficiency requirements accordingly.*

A successful label program can trigger market transformation. It is recommended to frequently survey the market shares of products with different energy efficiency, and upgrade the efficiency threshold of *Sello FIDE* to ensure that the labelled products always represent the top-tier group on the market. High quality surveys will inform policy and program decisions that eventually transform the market toward higher efficiency.

[22] Energy Policies beyond IEA Countries - Mexico, pp. 67-68, International Energy Agency, 2017
[23] Online prices in LEDinside. http://www.ledinside.com/pricequotes/led_bulb

# APPENDIX A: PEER REVIEW TEAM MEMBERS

**Mr. Takato Ojimi**, Peer Review Team Leader, President, Asia Pacific Energy Research Centre (APERC), Japan.

**Dr. Kazutomo Irie**, Peer Review Expert on Overall/Institutional Context, General Manager, Asia Pacific Energy Research Centre (APERC), Japan.

**Ms. Elvira Torres Gelindon**, Peer Review Expert on Energy Data Collection and Monitoring, Senior Researcher, Asia Pacific Energy Research Centre (APERC), Japan.

**Mr. Borwornpong Sunipasa**, Peer Review Expert on Energy efficiency goals, targets, and strategy, Plan and Policy Analyst, Department of Alternative Energy Development and Efficiency. (Thailand)

**Dr. Zhang Shicong**, Peer Review Expert on Government and Buildings, Deputy Director, China Academy of Building Research. (China)

**Mr. Pramesh Maharaj**, Peer Review Expert on Industrial Sector, Programme Manager Industrial, The Energy Efficiency and Conservation Authority (EECA). (New Zealand)

**Ms. Elizabeth Yeaman**, Peer Review Expert on Transport Sector, General Manager Transport, Energy Efficiency and Conservation Authority (EECA). (New Zealand)

**Mr. Graham Parker**, Peer Review Expert on Electricity Sector, Emeritus Senior Staff Engineer, Pacific Northwest National Laboratory. (The United States of America)

**Dr. Ming-Shan Jeng**, Peer Review Expert on Appliances and Equipment, Senior Principal Researcher and Division Director, Industrial Technology Research Institute. (Chinese Taipei)

**Mr. Martin Brown-Santirso**, Senior Researcher, Asia Pacific Energy Research Centre (APERC), Japan.

**Mr. Diego Rivera Rivota**, Researcher, Asia Pacific Energy Research Centre (APERC), Japan.

# APPENDIX B: CONSULTATION AND DISCUSSION PRESENTATIONS

- *Legal framework and public policy of energy efficiency*, by Mr. Santiago Creuheras Diaz, Director General for Energy Efficiency and Sustainability, Ministry of Energy (SENER).

- *Law of Energy Transition (LTE)*, by Mr. Santiago Creuheras Diaz, Director General for Energy Efficiency and Sustainability, Ministry of Energy (SENER).

- *Municipal Energy Efficiency and Sustainability Project (PRESEM)*, by Ms. Adriana Aragon Tapia, Director of Energy Sustainability, Ministry of Energy (SENER).

- *Energy Efficiency policy and programs*, by Ms. Gabriela Reyes Andres, Director for Sustainable Use of Energy, Ministry of Energy (SENER).

- *CONUEE and the Energy Transition Law*, by Mr. Sergio Segura Calderon, Director for International Cooperation, National Commission for the Efficient Use of Energy (CONUEE).

- *Energy Efficiency Standards in Mexico*, Mrs. Norma Morales Martinez, Director for Standardization, National Commission for the Efficient Use of Energy (CONUEE).

- *National Project for Energy Efficiency in Municipal Street Lighting,* by Mr. Cruz Ernesto Hernandez Ramirez, Deputy Director General for Promotion and Innovation, National Commission for the Efficient Use of Energy (CONUEE).

- *Learning Networks on Energy Efficiency Systems in Mexico,* by Noe Villegas Alcantar, Director for Large Energy Users and Energy Management Systems, National Commission for the Efficient Use of Energy (CONUEE).

- *Energy Services Companies (ESCOs) development in Mexico*, by Mr. Hebert Leon Sanchez, Director Energy Efficiency in Buildings, National Commission for the Efficient Use of Energy (CONUEE).

- *Transportation and Energy Efficiency in Mexico*, by Mr. Javier Garcia Osorio, Director for Transport and Mobility, National Commission for the Efficient Use of Energy (CONUEE).

- *Information, Evaluation, and Statistics*, by Mr. Francisco Salazar Neumann, Director for Information and Energy Systems, National Commission for the Efficient Use of Energy (CONUEE).

- *Restructuring the Mexican Electricity Market*, by Dr. Diego Villarreal Singer, Deputy Managing Director of Electric Industry Coordination, Ministry of Energy (SENER).

- *Development Program for the National Electric System*, by Mr. Nelson Delgado Contreras, Deputy Managing Director of Electricity Generation Programs, Ministry of Energy (SENER).

- *The Energy Transition Fund (FOTEASE)*, by Mrs. Jessica Rodriguez Aguilar, Director for Renewable Energies, Ministry of Energy (SENER).

- *Sello FIDE,* by Mr. Jose Suarez Esquivel, FIDE Label Program Coordinator, Electric Energy Savings Trust Fund (FIDE).

- *EDUCAREE, Education Program for Savings and Rational Use of Electric Energy,* by Mr. Carlos Leon Hinojosa, Energy Efficiency Training Manager, Electric Energy Savings Trust Fund (FIDE).

- *International Cooperation on Energy Efficiency,* by Dr. Rocio Palacios Espinosa, Deputy Director for Energy Efficiency, Ministry of Energy (SENER).

- *Energy Information and Statistics in the Energy Sector,* by Mr. Francisco Cafaggi Felix, Director for Statistics and Energy Balances, Ministry of Energy (SENER).

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Asia Pacific Energy Research Centre
Inui Building, Kachidoki, 1-13-1, Kachidoki,
Chuo-ku, Tokyo, 104-0054, Japan
Phone: (81) 3-5144-8551
E-mail: master@aperc.ieej.or
Website: http://aperc.ieej.or.jp/

For
Asia-Pacific Economic Cooperation Secretariat
35 Heng Mui Keng Terrace
Singapore 119616
Tel: (65) 68919 600
Fax: (65) 68919 690
Email: info@apec.org
Website: www.apec.org


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