Low carbon technologies can contribute to significantly reducing energy intensity, and therefore the country’s carbon intensity. This study seeks to foster the development of these technologies, through the analysis of the barriers that limit them, bringing economic (electricity consumption savings) and environmental benefits (reduction of greenhouse gas emissions).

Among these laws, two are related to the electricity sector: Electricity Industry Act and the Geothermal Energy Act, which if passed, would change the legal framework so some barriers could be eliminated.

This study has the objective of identifying barriers that limit the development and implementation of low carbon technologies, as well as strategies of solution that enable the development of such projects.

For analytical purposes, these barriers were identified in two sections: on one hand, those that currently limit the development of power generation projects, by exploiting energy from low carbon and, on the other hand, those related to energy efficiency. This analysis was performed under the following methodology:

1. **Review of the current applicable legal framework.** - Applicable law in Mexico was reviewed for the use of renewables in the generation of electricity.

2. **Integrating barrier classification.** - Different types of barriers were identified in this study.

3. **Identification and prioritization of technologies (for renewables) and strategic sectors (in the case of energy efficiency and cogeneration).** - We identified and refined renewables with both more technical and economic
feasibility as those sectors in which energy efficiency and co-generation are key to reducing electricity demand.

4. **Barrier identification**.- a literature review of studies conducted by various public and private institutions was carried out, including the Mario Molina Center; similarly, the experiences of other countries with respect to these issues were reviewed in order to identify possible solutions.

5. **Interviews with key stakeholders, systematization and analysis of such results**.- interviews were carried out with key stakeholders from both the public and private sectors, universities and civil society organizations, vendors, developers and end users involved in the topics of the present study; in order to know the opinion of professionals on the matter.

6. **Development of thematic workshops with key stakeholders, systematization and analysis of results**.- topics discussed were: biomass, biogas, co-generation and energy efficiency in the areas of Federal Public Administration (APF), states and municipalities, Small and Medium Businesses, large consumers and residential.

7. **Barrier prioritization**.- we conducted a ranking of the barriers identified as priorities.

8. **Identification of preliminary alternative solutions**.

**4 Results**

**4.1 BARRIERS IN TAKING ADVANTAGE OF RENEWABLE ENERGIES**

Mexico has extensive experience in renewables, particularly in the case of hydroelectric and geothermal plants, and recently with wind farms. Based on the analysis of feasible scenarios for achieving the goal of generating 35 percent of electricity from renewables by 2024 (MMC 2014), as stipulated in the General Law on Climate Change (LGCC, acronym in Spanish) and the Law for the Exploitation of Renewables and Financing for Energy Transition (LAERFTE, acronym in Spanish), the most viable associated technologies for their short and medium term use should include: wind, small hydro, geothermal, solar photovoltaic, biomass and biogas (from municipal solid waste and wastewater). Despite public policies promoted by the Federal Government to achieve energy transition and have a higher share of renewable sources in electricity generation, barriers that limit achieving the goal still remain. Among the priority barriers identified are:

- **Lack of knowledge of the proper sequence of processes.** The available information on the processes that must be carried out and the order to follow is unclear or insufficient.

- **Centralization.** Most of the negotiations with the different agencies must be performed in Mexico City, increasing investment costs.

- **Long time to fulfill the entire processes.** The time required to obtain permits and authorizations affects the economic feasibility of the project (See Table 1).

<table>
<thead>
<tr>
<th>Technology</th>
<th>Approximate time for processes (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biogas</td>
<td>470</td>
</tr>
<tr>
<td>Geothermal</td>
<td>431</td>
</tr>
<tr>
<td>Wind, biomass, photovoltaic, hydro</td>
<td>410</td>
</tr>
<tr>
<td>Co-generation</td>
<td>530</td>
</tr>
</tbody>
</table>

**Source:** Mario Molina Center, 2014.
Regarding this, the Mario Molina Center proposes the following flowcharts to simplify the authorization process for renewables and co-generation projects, which are shown in Diagrams 1 to 4.

4.1.2 Regulatory

There are not enough regulations, laws or government incentives to encourage the adoption of these technologies or the existing ones do not incorporate schemes to facilitate their insertion. This includes: (a) lack of an explicit national policy for the adoption of low-carbon energy; (b) subsidized electricity rates, and (c) bureaucratic or undefined processes that facilitate implementation of clean technologies, such as:

- **Discount rate.** The leveled cost is calculated using a discount rate that favors the use of fossil fuels, even though the Ministry of Finance and Public Credit (SHCP) has reduced it from 12 to 10 percent, it still limits the investments in renewables, as they are higher than the first. However, this concept disappears from the Electricity Industry Act (LIE, acronym in Spanish) and is replaced by "Return on Investment" that must fulfill projects of the State’s productive businesses (Article 130).

- **Internalization of externalities as part of planning in the power sector.** Calculating the costs of electricity generated by different technologies is not yet considered in externalities’ economic valuation; in addition, the recently passed LIE eliminates this concept explicitly, but remains in LAERFTE and the Special Climate Change Program, in which valuing is mentioned considering the Life Cycle Assessment (LCA).

- **Lack of complete transposition of the Public Private Partnership Act (APP) at a state level.** In some states APP has not been adapted to local conditions by local congresses and those governments and municipalities are not in a position to partner in renewable projects even if they would represent boosting the local economy.

4.1.3 Strategic Planning

Deficiencies in specific plans in the medium and long terms for the adoption of low carbon technologies where necessary resources are implemented (financial, technical, intersectoral, etc.) to achieve objectives. These include:

- Planning the transmission network. Lack of knowledge of the region’s potential in renewables to foster their economically suitable development.

4.1.4 Technology and technique

This refers to the current provision in the country of alternative low-carbon technologies, whether to build and implement a new project or to replace conventional technologies. This barrier includes trained staff available for their implementation and operation. For example:

- Inventory of available natural resources. Specify the usable potential in the national inventory of renewables to identify by type of technology in specific areas by region.

4.1.5 Economics and finance

This refers to high acquisition costs that limit their access and extensive periods of return of investment projects that make the adoption of low carbon technologies unattractive as well as to weaknesses or lack of specific financial schemes that stimulate the acquisition of low carbon technologies, such as:

- Subsidy to electricity rates. Subsidizing electricity rates sends the wrong signals and limits investment in renewable electricity for self-sufficiency.

4.1.6 Social and cultural

Are those related to resistance to change involving the use of renewables or rational use of energy, commonly associated with the lack of knowledge of the benefits that this entails.

- Failures in social management. There is resistance from the population to allow, within grounds, the installation of infrastructure for the use of energy, considering that they are not partakers of the benefits that it entails.

- Lack of knowledge of the population of the environmental problem dimension: People don’t know and have no awareness of environmental issues (climate change, waste management, waste water treatment, etc.) and energy (energy security, emissions, scarcity, etc.) at a global and national level.
4.1.7 Barriers for wind energy

The development of this technology was limited in its beginnings because of poor transmission capacity in the state of Oaxaca. Through Open Season mechanism, infrastructure was developed sufficiently enough to create a significant market for wind projects in the area. Land leasing required by wind farms as a barrier was also identified. This rapid development has generated speculation in exchange for the land rent that has led to the failure of long-term contracts.

4.1.8 Barriers for geothermal energy

The barriers associated with this technology were linked with the budget and planning of the state-owned company. With the Energy Reform and the Electricity Industry Initiative Act private investment is seen as a major player in the sector, but barriers such as those related to uncertainty, by both risks of investment as well as exploitation the geothermal resources concessions, remain.

4.1.9 Specific barriers for mini-hydro energy

The mini-hydroelectric energy is a renewable that can be more competitive with fossil and feasible to supply electricity to communities, mostly marginalized, where the service they receive is poor or there is lack of it. Its main barriers are in the prohibition that exists in some rivers of the country, making it difficult to obtain the necessary permits for the river exploitation and in the ecological costs stipulated in the NMX-AA-159-SCFI-2012 regulation, which has a methodology that overprotects the associated ecosystems.

4.1.10 Specific barriers for biogas

Two sources of biogas were considered in this study: municipal solid waste (landfills and bio-digesters) and wastewater (sludge digesters), both issues are under municipal jurisdiction, so their priority barriers are associated with municipal management going from budget allocation to the development of technical skills of personnel involved in the operation of disposal sites of solid waste such as sewage water treatment plants. Another identified aspect is the regulatory one; more specifically, existing regulations on solid waste, both NOM-083-SEMARNAT-2003 as the General Law for the Prevention and Management of Waste does not address the issue of recovery of methane from landfills nor alternatives for energy recovery of organic waste digesters.

4.1.11 Specific barriers for biomass

The analysis of this source helped determine that there are complex barriers that prevent establishing it as a potential source of electricity generation. The long recovery of investment is one of the major obstacles to be solved, along with the problem of continuous biomass supply, and the variables it has. It is noteworthy that in addition to generating electricity, thermal exploitation could have major benefits, although this aspect is outside this study’s scope.

4.1.12 Specific barriers for solar photovoltaic energy

The viability of such projects is limited to two specific areas: isolated areas not connected to the electricity grid and residential sector with high consumption rates. One of the main identified barriers is the consideration paid by the CFE for electricity surpluses, since it is low it inhibits the economic feasibility of these projects. Moreover, the lack knowledge of the economic benefits that solar panels can make to the high-consumption residential and commercial sectors is another barrier that could be eliminated to encourage the adoption of this technology.

4.2 Barriers for the adoption of energy efficient measures in final electricity use

For over two decades, Mexico has implemented programs and projects aimed at the efficient use of electricity such as Daylight Savings Time, Green Mortgage, ILUMEX, Sustainable Electricity, Energy Efficiency in the Agro-Food Sector (PEESA) or Energy Efficiency in Municipal Street Lighting, among others, whose major driving forces are CFE, National Commission on the Efficient Use of Energy (CONUEE) and the Trust for Energy Savings (FIDE).

Electricity consumption sectors in Mexico are made up of: the federal civil service (APF, acronym in Spanish), states and municipalities, large consumers,
small and medium businesses and residential sectors. According to a study made by the CONUEE, the APF is the largest energy consumer in the country, with 38 percent of the national total. In this item we considered what’s related to the operation of Petroleos Mexicanos (PEMEX) and the Federal Electricity Commission (CFE), companies in which there is a high potential for improving energy efficiency and expansion of co-generation projects, but they remain outside this study’s scope due to the nature and extent of their production processes and their respective value chains.

Among the identified priority barriers are:

1. **Regulatory.** These barriers are related to the lack of linkage of the obligations established by the Mexican Official Standards (NOM) on energy efficiency with other local legal requirements, inhibiting their compliance, for example:
   - Failure to comply with the implementation of the energy efficiency NOM in buildings. The implementation of NOMs in buildings has been limited because SENER and CONUEE do not have sanctioning mechanism of such regulations in case of a breach.

2. **Financial.** Correspond to those barriers that limit access to financing schemes such as:
   - Insufficient financing for energy efficiency projects. Difficulty in obtaining loans from private banks for the development of energy efficiency projects, given the complexity to demonstrate the generated savings.

3. **Technical and technological.** These barriers are associated with the lack of trained professional technicians in energy diagnosis and ad-hoc recommendations to the needs of each sector, also motivated by the lack of knowledge from the same companies.
   - Lack of national leadership to promote energy saving measures. The vast majority of public and private businesses lack qualified personnel on the subject of energy efficiency and energy in general, to guide them to improve their operations.

4. **Social and cultural.** Related to the lack of awareness of the benefits of energy savings. Among these barriers are:
   - Null basic training of an energetic culture. There is no culture in the population to choose the most efficient technologies on the market, as well as bad habits in wasting energy.

4.2.1 **Barriers in the Federal Civil Service (APF)**

The barriers in this sector focus on the lack of investment in the replacement of more efficient equipment and a shortage of trained personnel, which complicates the elaboration of energy diagnosis and therefore, energy savings plans. The implementation of energy efficiency projects under public-private partnership mechanisms is a viable alternative for the APF. The ESCO model (ie, energy service companies) are presented as feasible options to support the implementation of energy efficiency projects in the public sector, as they assume the operation and maintenance of equipment.

4.2.2 **Barriers in States and Municipalities**

For this sector, the identified barriers are mainly financial and regulatory, such as lack of financial resources for investment in energy efficiency projects; short periods of management councils limit the execution of long-term projects and in the same direction, we identified as a barrier the lack of regulation application of energy efficiency.

4.2.3 **Barriers in large consumers**

In particular, one of the main barriers for the sector is access to capital, as large investments are needed for the implementation of energy efficiency projects. The ESCO models are a good alternative, although the penetration of these schemes has been low.

Another key barrier is training in the following three aspects:
   - Consultants.- improving the quality of energy assessments.
   - User of new technologies.- training in the operation of new equipment.
   - Developers of commercial buildings.- suitable design considering bioclimatic elements.

Finally, we identified the lack of trained personnel in energy matter in most of the companies, thereby making it difficult to perform internal diagnostics which promote efficiency.
4.2.4 Barriers in small and medium-sized businesses (PYMES)

For the PyMES’ sector, there are two main barriers. The first stems from not considering the nature and structure of this type of Mexican company, making this approach to being limited only to large consumers, since this structure is very diverse and scattered, so the levels of consumption and energy saving are generally low, at least by the ESCO investment standards. Publicly funded programs such as FIDE can reduce this barrier, but still needs greater publicity of such programs.

4.2.5 Barriers for the residential sector

The sector’s main barrier is the untargeted subsidy to electricity, by not encouraging the use of more efficient technologies and energy savings, since the period of recovery of investment is very long due to the low cost of energy. On the other hand, there’s no culture among the population for the rational use of energy, as well as the selection of efficient electrical equipment and the maintenance they require. This barrier requires a long-term strategy that includes actions aimed at social housing, population’s niche where the greatest potential for energy savings is concentrated.

4.3 Barriers for the co-generation and efficient co-generation

A main barrier is economically related to high initial investment costs required by systems. In the absence of national quality equipment and low cost, they need to be imported despite their high prices. That’s why potential companies find difficulty in obtaining credit, or have resistance to use them on undertakings outside their main activity. Preliminary solution alternatives identified focus on designing awareness campaigns and wider dissemination of information including success stories, so that industrialists, public administrators, developers and financiers, and anyone interested can make informed decisions. This strategy would encourage the participation of small and medium industries in co-generation projects as a viable solution to increase competitiveness.

5 Conclusions and recommendations

According to the analysis of current planning of the electricity sector towards 2027 (SENER, 2013), we observed that the share of clean energy sources in power generation is reduced and its growth trend does not provide the basis for meeting the goal of generating 35 percent of electricity with these energies in 2024. This requires considering priority measures such as:

5.1 Priority measures

- **Development of detailed national and regionalized renewable inventories**: In international practice, some governments are making the first studies to identify potential clean energy that they have to reduce investment risks and encourage the use of renewables.

- **Proper planning of the national electricity system expansion**: If LIE is approved, CENACE would be responsible for this activity, and along with the private sector it could encourage the development of clean energy generation in remote areas of the interconnection points.

- **Reduction of the social discount rate**: This variable is relevant in the assessment of projects related to climate change. Despite being reduced by the Treasury (SHCP) from 12 to 10 percent, it is still unfavorable for investments in renewables for the electricity sector; as they lose competitiveness with fossil fuels, since they don’t get lower investment costs or production for their dispatch. According to LIE, this barrier could change the definition, by the SHCP, of ”return of investment” for the CFE.

- **Dissemination, decentralization and streamlining of procedures**: Simplification and dissemination of requirements, costs and times that must be met for authorization processing, permits and licenses for the operation of power plants with renewables.

- **Rethink the renewable share target for 2024**: Given the time required to manage new projects, the goal of generating 35 percent with renewables by 2024 looms complicated. So intermediate goals of participation or new mechanisms to detonate a lower demand, to avoid high costs of generation could be defined in the long-term.

Achieving the goal of clean energy established by Mexico not only involves intervening in the supply
of electricity, but also the definition of actions that promote a more rational use of it, so it requires:

- Promoting good practices in the use of electricity and energy
- Increasing availability of efficient technology
- Increasing verification of compliance with existing NOM’s
- Regionalization of actions to promote energy efficiency
- Improving structuring of electricity tariffs

Moreover, there are additional actions such as raising public awareness on environmental issues and the overall development of technical skills in Mexico.

6 References

- MMC (2014). Mario Molina Center, Recommendations on climate change policy in Mexico: Scenarios to achieve 35 percent of electricity generation in Mexico with clean energy in 2024 and its projection to 2030, Mexico
Figure 1: Procedures to authorize electricity projects generated by renewable energy

Source: Mario Molina Center, 2013.
Figure 2: Specific procedures with CONAGUA for renewable energy

Source: Mario Molina Center, 2013.
Figure 3: Procedures to authorize co-generation projects

Source: Mario Molina Center, 2013.
Figure 4: Procedures to authorize efficient co-generation projects

Source: Mario Molina Center, 2013.