Human Development Report 2007/2008

Fighting climate change:
Human solidarity in a divided world

Human Development Report Office
OCCASIONAL PAPER

Decarbonizing Growth in Mexico

Odón de Buen

2007/21

Outline

I. Energy profile and trends in Mexico
II. Actual and projected carbon-equivalent emission trends by sector
III. Policies through which government and industries are seeking to reduce the carbon intensity of growth and overall carbon emissions
IV. Financial and technological constraints restricting the decarbonisation of growth and the potential role of international cooperation in reducing these constraints.
V. Conclusions

I. Energy profile and trends in Mexico

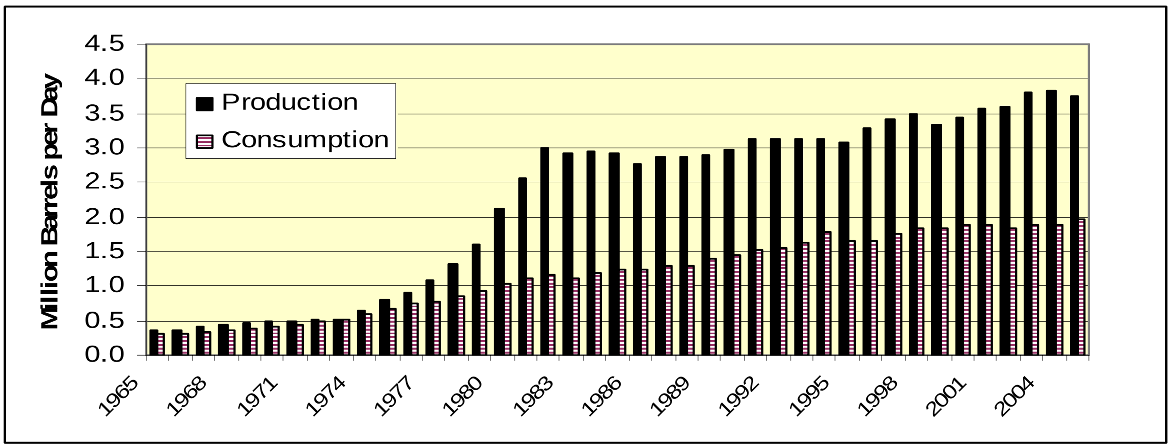
a. Mexico´s energy profile

Mexico is a country with nearly 103 million inhabitants living in a territory of approximately 2 million square kilometers. The annual population growth rate is 1.18%. Of the total population, a fourth part lives in rural areas. The number of households is close to 24 million (INEGI, 2007).

The country's economy is diversified and the most important sources of income are oil revenues, tourism, manufacturing exports and remittances of Mexican citizens living abroad. Annual GDP is close to US$650 billion. Economic growth in 2006 was 4.6% with an annual inflation rate of 3.98% (Banxico, 2007).

Mexico is one of the most important oil producers in the world, with an average daily production of 3.8 million barrels, of which 47% are for domestic consumption. Natural gas consumption averaged 4.8 billion cubic feet per day in 2005, mostly as gas associated with oil production (Fig.1) (BP, 2006).

Figure 1. Evolution of oil production and consumption in México (1965-2005).



Source: SENER 2007. Sistema de Información Energética. www.sener.gob.mx

Total proved oil reserves of Mexico were estimated in 48 billion barrels by the end of 2005 with a ratio of reserves to production equal to 10. With regards to natural gas, total reserves were estimated in 0.41 trillion cubic meters with a ratio of reserves to production equal to 10.4 (BP 2006).

Total energy supply in 2005 was 6,649 Pjoules and was comprised of oil and condensates (45.7%), natural gas (36.2%), hydro (4.2%), coal (5.7%), biomass (5.3%) nuclear (1.8%), and others (1.1%) (Table 1) (SENER, 2006).

Table 1.Mexico´s Energy Supply, 2005

Energy source	**Petajoules**
Coal	379
Oil and condensates	3,041
Natural gas	2,408
Hydroelectricity	278
Nuclear energy	117
Biomass	350
Other	76
TOTAL	**6,649**

Source: SENER, Balance Nacional de Energía 2005.

Total energy use was 7,365 Pjoules in 2005, with 2,322 Pjoules consumed by the energy sector while 4,083 Pjoules went to end-users. Greatest energy end-user was the transportation sector with 45.6 % of total consumption while industry participated with 30.7% (SENER, 2006) (Table 2).

Table 2. Energy supply and consumption by sectors in México (2005).

Concept	**PJoules**
Total energy supply	7,365.0
Energy sector consumption	2,322.0
Non energy use	306.6
Final energy use	4,083
Transportation	*1,864*
Industry	*1,253*
Residencial, Comercial and Public Services	*842*
Agricultura	*123*

Source: SENER, Balance Nacional de Energía 2005.

In the transportation sector, most of the 1,684 petajoules used were by means of gasoline (64.1%), followed by diesel (26.3%) (Table 3).

Table 3. Energy consumption by the transportation sector. México (2005).

Energy source	**PJoules**	**%**
Gasoline	*1,195.0*	64.10
Diesel	*490.4*	26.30
Querosene	*111.8*	6.00
LPG	*58.2*	3.12
Fuel oil	*4.4*	0.24
Natural gas	*0.7*	0.04
Electricity	*3.9*	0.21
TOTAL	**1,864.4**	**100.00**

Source: SENER, Balance Nacional de Energía 2005.

In terms of energy used by type of transportation, more than 90% was done with cars and trucks, while air transportation was the second with 6.05% (Table 4).

Table 4. Energy consumption by types of transportation, México (2005).

Type of trasportation	PJoules	%
Cars and trucks	*1,690.7*	90.68
Air	*112.8*	6.05
Ocean	*33.6*	1.80
Trains	*23.5*	1.26
Electric	*3.8*	0.20
TOTAL	***1,864.4***	**100.00**

Source: SENER, Balance Nacional de Energía 2005.

In the industrial sector 32.1% of energy consumption was as natural gas, while 28.3% was electricity, 11.1% as fuel-oil, 8.6% as coke from oil, 8.0% as sugarcane bagasse, 5.5% as coke from coal3.2% as diesel, 2.8% as LPG (Table 5). Among end-users, the major energy consumers within the industrial branches were steel with (17.9% of the total), sugar (9.3%), cement (11.4%), chemical (9.6%) and mining (5.4%) (SENER, 2006).

Table 5. Energy by industry sub-sectors and energy sources, México (2005).

INDUSTRY	Fuel oil	Coal	Coke	N. Gas	Diesel	Elect.	Bagasse	LPG	*Subtotal*
Steel	11.5	-	62.8	122.8	0.8	26.4	-	-	*224.3*
Chemicals	14.7	-	5.0	78.4	3.9	17.8	-	0.6	*120.4*
Cement	41.8	4.9	72.0	6.7	0.3	-	-	-	*125.7*
Sugar	16.2	-	-	-	-	0.3	100.1	-	*116.7*
Petrochemical	5.1	-	-	22.2	0.3	17.8	-	-	*45.4*
Mining	7.1	-	5.6	28.9	4.4	19.3	-	2.6	*67.9*
Paper	14.0	-	-	14.8	0.9	9.7	0.2	0.3	*39.9*
Glass	5.1	-	0.6	26.3	0.1	4.1	-	0.1	*36.3*
Beer	8.6	-	-	7.4	0.1	2.8	-	0.4	*19.4*
Bottled drinks	1.9	-	-	3.0	2.7	2.9	-	0.8	*11.3*
Auto manufacturing	-	-	-	2.0	0.4	6.3	-	0.3	*8.9*
Construction	-	-	-		6.7	1.6	-	-	*8.2*
Rubber	0.7	-	-	4.3	1.2	1.7	-	-	*7.9*
Aluminum	-	-	-	1.1	0.0	3.0	-	-	*4.1*
Fertilizers	-	-	-	3.5	0.1	0.8	-	-	*4.4*
Tobacco	-	-	-	0.2		0.2	-	-	*0.4*
Other	12.0	-	30.6	80.8	18.6	240.8	-	29.6	*412.4*
TOTAL	**138.8**	**4.9**	**176.6**	**402.5**	**40.5**	**355.1**	**100.4**	**34.8**	***1253.5***

Source: SENER, Balance Nacional de Energía 2005.

Of the 842 Pjuoles consumed by the aggregation of the residential, commercial and public services´sectors, 83.6% went to the residential, 13.6% to the commercial and 2.8% to public services (street lighting and water pumping). The consumption by the aggregation of sectors was done mainly through LPG (39.1%), followed by wood (29.4%), electricity (26.5%), and natural gas (4.4%). Finally, in the agricultural sector diesel was the main energy-consumption source (69.7%), followed by electricity (23.7%), and LPG (6.6%) (SENER, 2006).

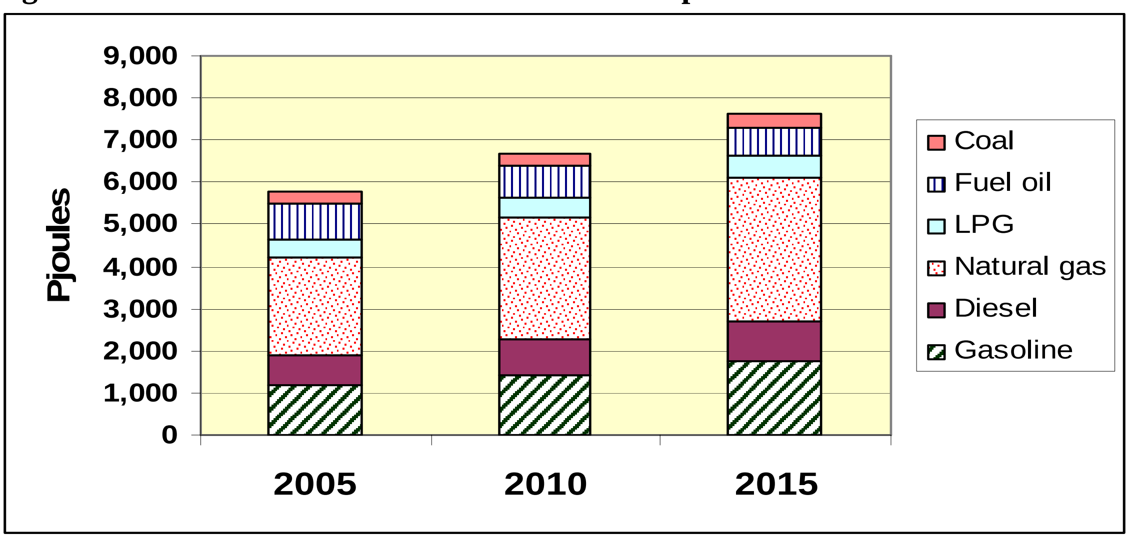
With respect to electricity generation, 223,000 GWh were generated for public service in 2006, of which 43% came from fuel oil, 23% from natural gas, combined-cycle plants (operated by independent power producers), 14% from hydro, 8.8% from coal, 5% from nuclear and 3% from geothermal. A very small fraction was generated with wind (SENER, 2007).[1] An additional 29,600 GWh were generated for self-service, mostly with diesel and natural gas (CRE, 2007).

According to the International Energy Agency, Mexico´s energy intensity has generally improved since 1990. By 2002 there had been a 14% reduction in energy consumption per dollar of GDP. However, in 2003 and 2004 this trend was reversed. However, the average annual growth rate from 1995 to 2004 was minus 1.3% (IEA, 2005).

b. Energy trends in Mexico

Ten-year projections of energy consumption that are prepared annually by the energy ministry (SENER 2006a, 2006b, 2006c, 2006d) show annual growth, for the 2005-2015 period, of 5.1% for electricity use. Fuel consumption (including fossil fuels used for power generation) will grow an estimated 2.84% per year in the period. By fuels, gasoline will have an annual growth of 3.92%, diesel 3.19%, natural gas 3.93%, coal 2.29%, and LPG 1.16%. Fuel oil will have a negative anual growth rate of -2.19% (Fig. 2).

Figure 2. Estimated evolution of fossil fuel consumption in México.



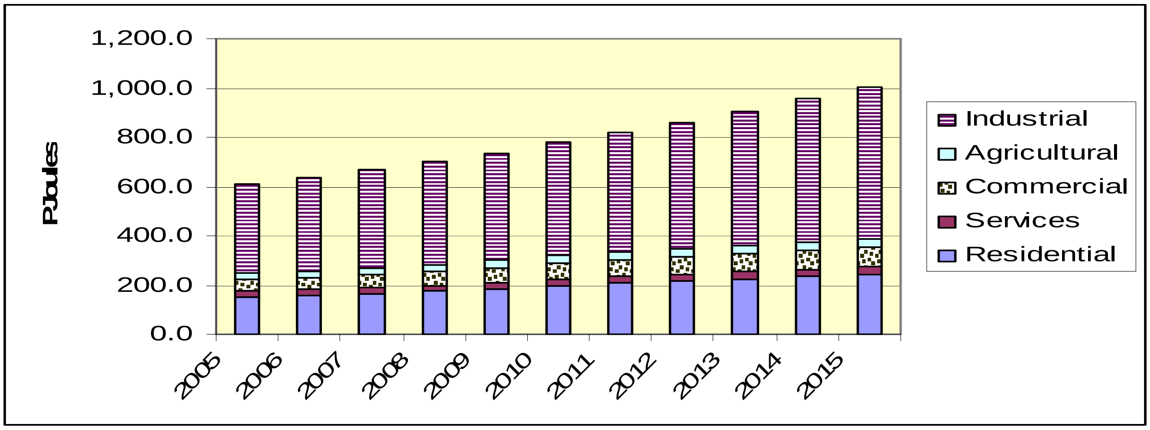
Source: SENER 2006b, 2006c, 2006d and 2006e

In the electricity sector, SENER´s projections show a decoupling in the growth of the use of fossil fuels in relation to its final use. Fossil fuel consumption for power generation will grow an estimated 3.5%, while consumption as electricity is estimated to be growing at

[1] http://www.sener.gob.mx/work/sites/SenerNva/resources/LocalContent/7178/1/Generacion_Bruta.XLS

5.1% per year. As end-users, industrial and commercial sectors will be growing above that rate (5.6% and 5.7%, respectivelly) and residential will grow below overall growth (4.67%) (Fig. 3) (SENER 2006d).

Figure 3. Estimated evolution of electricity consumption by endusers in México.



Source: SENER 2006e

II. Actual and projected carbon-equivalent emission trends by sector

a. Actual carbon-equivalent emission by sector

The latest national Greenhouse Gas (GHG) inventory was prepared by the National Ecology Institute (INE) for 2002. For that year, GHG emissions for the six gases listed in Appendix A of the Kyoto Protocol were estimated at 643,183 Gg of carbon dioxide equivalent (CO_2 eq), with the caveat that figures for the category of LULUCF are still preliminary (INE, 2006).

The results of the National Greenhouse Gas Inventory (NGHGI) show contribution of GHG emissions from the different categories in terms of CO_2 eq as follows: energy, 61% with 389,497 Gg; LULUCF, 14% with 89,854 Gg; waste, 10% with 65,584 Gg; industrial processes, 8%, with 52,102 Gg; and agriculture, 7% with 46,146 Gg (Table 6).

Table 6. Total CO2eq emissions in 1990 and 2002 (LULUCF not included) in México.

Source	**1990**	**2002**
Energy	312,027	389,497
Fossil fuel use	*279,863*	*350,414*
Fugitive emissions	*32,164*	*39,082*
Industrial processes	32,456	52,102
Agricultura	47,428	46,146
Waste	33,357	65,584
TOTAL	***425,268***	***553,329***

Source: INE, Inventario Nacional de Emisiones 1990-2002.

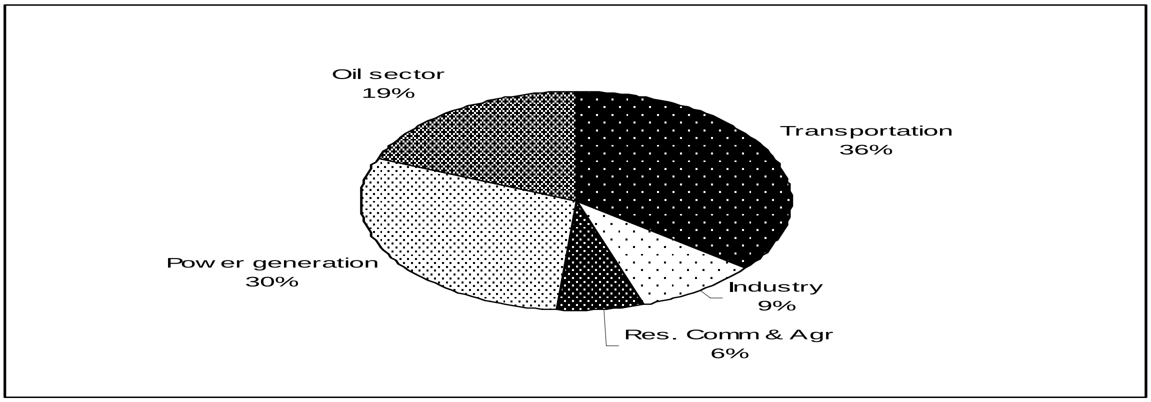
In terms of GHG emissions in CO_2 equivalent by type of gas, CO_2 totalled 480,409 Gg, representing 74% of the total; methane (CH_4), with 145,586 Gg (23%); nitrous oxide (N_2O), with 12,343 Gg (2%); and the remaining 1% was made up of 4,425 Gg of hydrofluorocarbons (HFCs), 405 Gg of perfluorocarbons (PFCs), and 15 Gg of sulfur hexafluoride (SF_6).

The results of NGHGI also indicate that a growth in emissions from 1990 to 2002 of approximately 30% in CO_2 eq, which represents an average annual growth of 2.2%, except for Land-Use, Land-Use Change and Forestry (LULUCF).

By sectors, energy generation contributed 24% of the country's total emissions in 2002, while transport 18%, manufacturing and the construction industry 8%, residential, commercial and agricultural sectors 5%; and fugitive methane emissions 6%. Together, fixed and area sources (including energy generation, manufacturing and the construction industry and other energy sectors, not including transport) represented 37% of the total. GHG emissions in the energy category, expressed in CO_2 eq, showed an increase from 312,027 Gg to 389,497 Gg from 1990 to 2002, which represents a 25% increase..

An estimate of CO_2 emissions from direct fossil fuel combustion based on energy use in 2005 comes to a total of 396,000 Gg. By sectors, the transportation sector had the greatest share of those emissiones with 36%, while power generation had 30%, the oil sector 19%, industry 9% and the sum of the residential, commercial and agricultural sectors with 6% (Fig. 4).

Figure 4. Estimated contribution of direct CO2 emissions from fossil fuel combustion by sectors in 2005.



Sources: Prepared by the author based on SENER 2006 and IPCC 2006.

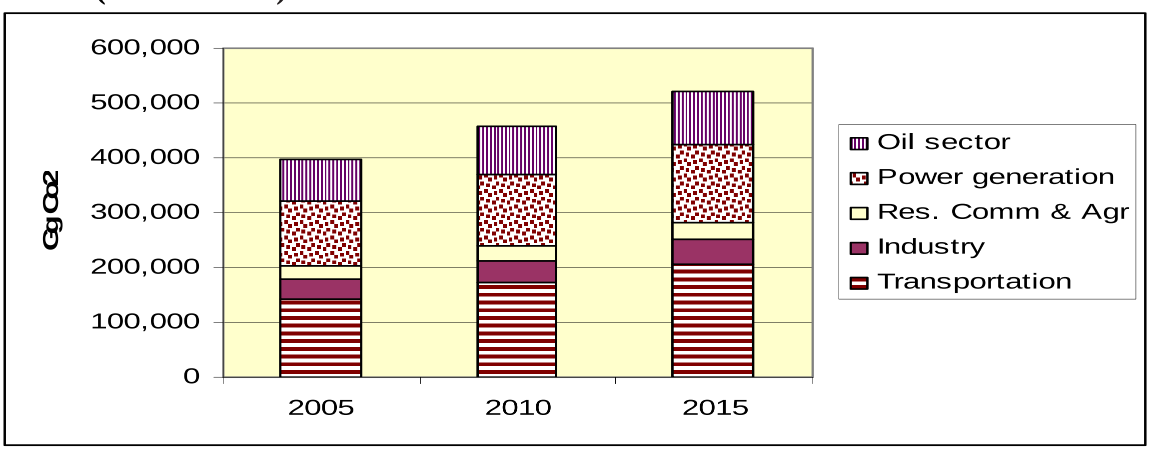
In terms of fuels, the numbers for the estimated 2005 CO2 emissions from fossil fuel combustion (including that for power generation) show natural gas as the highest contributor with 33% of the emissions, while gasoline has 24%, fuel oil 17% and diesel 13%.

b. Projected carbon-equivalent emission trends by the energy sector.

An estimate of CO2 emissions from direct fossil fuel combustion based on SENER´s ten-year projections of energy consumption results on a 31% growth from 2005 to 2015 in direct CO2 emissions (SENER 2006a, 2006b, 2006c, 2006d).

By fuels, the greatest growth would occur in the combustion of gasoline and natural gas with 47%, while fuel oil´s would be reduced in 20% (Fig 5).

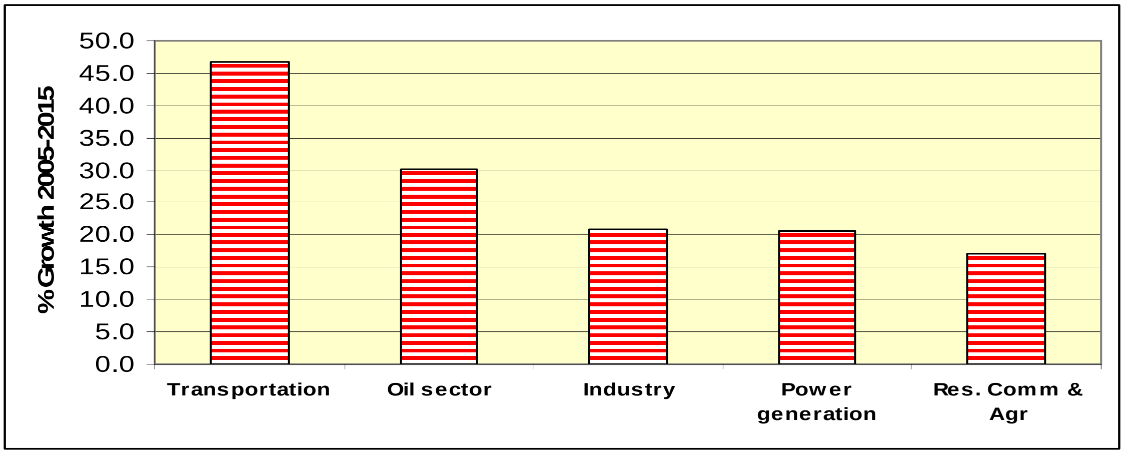
Figure 5. Estimated evolution of direct CO2 emissions from fossil fuel combustion by sectors (2005 to 2015).



Source: Prepared by the author based on SENER 2006b, 2006c, 2006d, 2006e and IPCC 2006.
.

By sectors, the transportation will emmit 47% more CO2 in 2015 than in 2005, while the oil sector will grow by 30%, industry and the power sector by 21%, and the aggregation of the residential, commercial and agricultural sectors by 17% (Fig. 6).

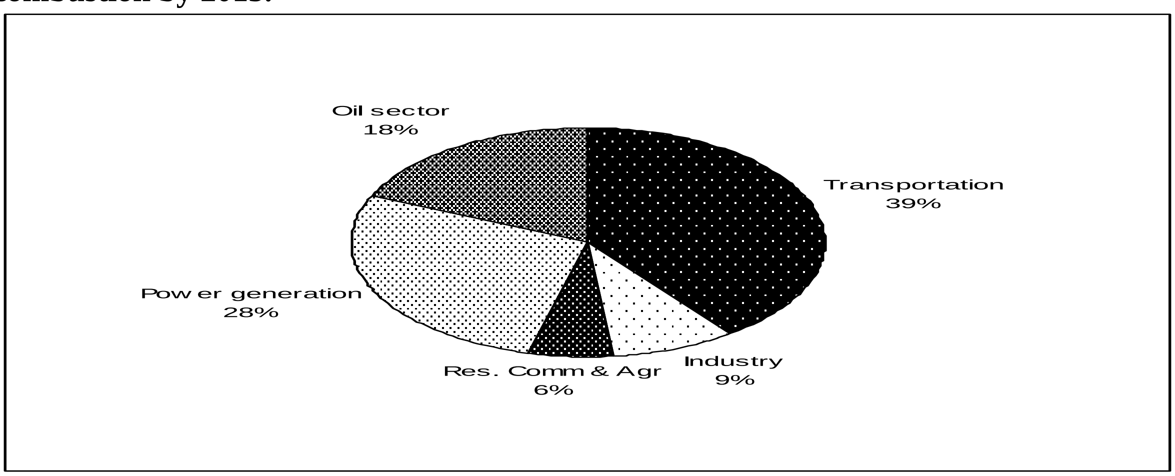
Figure 6. Estimated growth in direct CO2 emissions from fosil fuel combustion from 2005 to 2015.



Source: Prepared by the author based on SENER 2006b, 2006c, 2006d, 2006e and IPCC 2006.

This trend will modify the relative weight of the sectors as the transportation sector will go from 36 to 39%, power generation from 30 to 28%, and the oil sector from 19 to 18% Industry (9%) and the sum of the residential, commercial and agricultural sectors (6%) would keep their relative weight (Fig. 7).

Figure 7. Estimated relative weight by sectors in direct CO2 emissions from fosil fuel combustion by 2015.



Source: Prepared by the author based on SENER 2006b, 2006c, 2006d, 2006e and IPCC 2006.

As electricity end user, it is estimated that by 2015 the industrial sector will represent 62% of total electricity use, while the residential sector will represent 25%.

III. Policies through which government and industries are seeking to reduce the carbon intensity of growth and overall carbon emissions.

a. Government promoted energy efficiency and conservation in Mexico

Given the high level of dependency of México on fossil fuels for the operation of its economy, any efforts to conserve energy and/or to use it more efficiently will have a direct and positive effect on its CO_2 emissions.

The efforts undertaken in Mexico to use energy more efficiently have been driven by a number of factors and are characterized by the continuous institutional development over the past nineteen years that has produced a number of very successful programs, mainly in the efficient use of electricity. The institutions directly involved in this process have been the National Commission for Energy Conservation (Conae) and the Federal Electricity Commission (CFE) through the Electricity Sector Energy-Savings Program (PAESE), the Trust Fund for Electricity Savings (FIDE) and the Trust Fund for the Thermal Insulation Program of Households in the Mexicali Valley (FIPATERM). The national oil company (PEMEX) has also been involved in this process through its internal program.

The Electricity Sector Energy-Savings Program (PAESE) was created in 1989 as part of CFE and as an evolution of a previous program operating since 1982 (the National Program for Rational Electricity Use – PRONUREE). PAESE basically operates with a network of specialized professionals which provides support to end-users on issues related to electricity-efficiency improvement. More recently, its work has concentrated in CFE´s own installations (mainly buildings).

The Trust Fund for Electricity Saving (FIDE) is a private, non-profit organization created by CFE in 1990 and is supported by a small internal tax on CFE's suppliers and by loans from international development banks. FIDE´s objective is to promote actions that encourage and foster electricity conservation and its rational use. FIDE has provided financing for hundreds of energy audits and the purchase of several million units of energy efficient lamps, motors and AC units, thus achieving important energy savings in industrial and commercial installations of the private sector, as well as municipal lighting and pumping systems. As a main result, it has contributed significantly to the development of the energy efficient equipment and systems market, and a solid and highly skilled consultant pool (FIDE 2006).

The National Commission for Energy Conservation (Conae) is an agency that is part of Mexico´s Energy Secretariat, with technical and operational autonomy and the objective to serve as a technical advisory body for the agencies and entities of Mexico's public and private sectors on issues related to energy savings, energy efficiency and renewable energy use. The most remarkable programs developed by Conae, in terms of scope and impact, are the mandatory energy-efficiency standards (NOM), the federal buildings program, the technical support to PEMEX internal program, and the programs undertaken in the private industrial and service sectors.

Since 1989, a number of programs have been implemented in México by FIDE, CFE and Conae.

Thermal insulation in Mexicali.

The first systematic effort undertaken to achieve energy conservation in Mexico was designed and implemented through CFE by PRONUREE to reduce energy consumption from air conditioning use among residential end-users in the city of Mexicali, Baja California.[2] In 1989, based on PRONUREE´s program design, CFE created a trust fund, the Trust Fund for the Thermal Insulation Program of Households in the Mexicali Valley (FIPATERM), which has the objective of providing financing for thermal insulation of high energy-consumption residential users.

The program has promoted the widespread installation of thermal insulation on the roofs of a large fraction (more than 30%) of Mexicali´s households. FIPATERM has provided low interest loans, allowing the CFE residential customers to pay the cost of the insulation through the electricity bill. By the year 2000, FIPATERM achieved the insulation of more than 60 thousand roof-tops in Mexicali. The program now offers loans for door and window insulation, as well as for the purchase of efficient equipment, such as air conditioners, refrigerators, and CFLs. It also includes the performance of energy audits to identify the feasibility of energy-savings measures in the households. By the first semester of 2004 FIPATERM had granted credits for close 60 million US$ for all of the measures.

ILUMEX.

ILUMEX was the first large-scale, energy-efficiency program designed and implemented in Mexico. The program had the support of a 10 Million US$ grant from the World Bank's Global Environmental Facility (GEF). CFE provided an equal amount and the Government of Norway granted 3 Million US$. The program was implemented in 1995 in Guadalajara and Monterrey, the two largest cities in México after México City. More than two and a half million CFLs were installed through ILUMEX up to the year 1999 when the program concluded, resulting in energy savings of more than 300 million kWh and an important reduction of GHG emissions (de Buen, 2005).

FIDE´s Incentives Program.

This program was operated with resources from a loan granted by the Interamerican Development Bank (IDB) and additional financial resources from CFE and FIDE. The resources were used for rebates to end-users that purchase high-efficiency technologies. This program included the use of a seal (Sello FIDE) that identified those products that could be subject to the rebates. The program concluded in 2004 and a follow up is being negotiated with the IDB. Through this program, the entire three-phase induction motors markets was transformed, as well as 40% of the lighting systems market (T-8 fluorescent lamps and low-loses ballasts), and 80% of the market for compressed-air equipment with capacity higher than 20 HP (FIDE, 2006).

[2] Mexicali is located in the State of Baja California on the Mexico-US border.

Energy-Efficiency Standards.

One of the main mandates that Conae has had from its inception has been the implementation of energy efficiency standards for a number of energy-using equipment and systems. This process started in 2003 and 18 standards for equipment and systems are presently in place and are applied to more than 5 million units which are commercialized in Mexico every year (CONAE, 2006).

Energy-efficiency standards have represented significant energy savings. According to a study by Mexico's Power Research Institute (IIE) done with collaboration of the Lawrence Berkeley National Laboratory (LBNL) more than 52,000 GWh have been saved as electricity in 10 years by Conae's energy-efficiency standards, which the equivalent to a fourth of total power generation in México in 2005 (Sanchez I, 2006).

Daylight Savings Time.

Daylight Savings Time is a measure by which clocks are moved one hour forward at the beginning of the spring and one hour back in the fall to make better use of natural light. This measure came into effect countrywide in Mexico in 1996. This was possible due to a concerted national consensus process led by FIDE with the support of CFE, Conae and SENER. Energy conserved by this measure over the past ten years since it was first applied amount to approximately 11,000 GWh, equal to the electricity consumed by all of Mexico´s households in a period of more than three months (FIDE, 2007).

Federal Administration Buildings Program.

This is a mandatory energy conservation program for the largest buildings of the Federal Administration was introduced in 1999 and is managed by Conae. By 2002, the program had incorporated 896 buildings, representing 3.8 million square meters of office space. This program, which requires mandatory reports on electricity consumption and the energy-saving measures undertaken, saved 110 GWh from 1999 to 2002 (CONAE, 2006).

Pemex Energy Conservation Campaign.

Pemex, with Conae´s technical support, has been implementing an energy conservation program for more than ten years, mostly as a process of best-practices implementation. It has been a process that evolved from the analysis of isolated systems (such as cooling towers and gas furnaces) to the development of an Internet-based audit system that led to a permanent energy efficiency campaign with significant environmental and economic results (de Buen, 2003). According to Pemex, during the 2000-2003 period the oil company reduced its fuel consumption, gas leaks and gas combusted to the atmosphere for an equivalent of 36.6 Million BOE, with an estimated value of 762 Million US$ (PEMEX 2004).

These efforts were part of the actions that resulted in a reduction of Pemex´ CO2e emissions as they went from 51.1 million tons in 2001 to 42.1 million tons in 2005

(PEMEX 2006a).

Cogeneration.

According to CONAE and under an optimistic scenario, Mexico has a cogeneration potential which is close to 15,670 MW. Of this estimation, PEMEX facilities (Petrochemical and Refining) have the higher potential, with nearly 4,500 MW (CONAE 2005).

Ten years after the study was made public only about 10% of CONAE's estimated potential has been developed. According to the Regulatory Energy Commission (CRE), by January of 2007 a total of 33 cogeneration permits (requested after 1992) had been granted. Total capacity for these projects is 1,108 MW. Of this total, a little more than 1,000 MW were in operation (as three of the plants with permits were still under construction) (CRE 2007).

Recent changes in laws governing Pemex are been aimed to increase cogeneration in Pemex and several projects are now under study (PEMEX 2006).[3]

b. Renewable energy in Mexico

A number of projects and regulatory initiatives have been attempted in México to harness significant renewable energy potentials but have not been very successful as very little of that potential is being exploded.

CFE´s wind projects

CFE has included in its construction plans a series of wind power plants located in Oaxaca. This follows many years of only having 2.7 MW in a quasi-experimental plant in that location. To date, close to 80 MW are now in place, though they are not formally operating. Also, a bid for an additional 101 MW is now in a negotiations process (CFE, 2007).

Regulatory instruments

The first policy instrument established in Mexico to promote power generation using renewable energy (wind and small hydro) was implemented by the CRE in 2001 as a regulatory instrument, which is known as the Interconnection Contract for renewable-energy sources. This contract allows self-supply, renewable-energy projects to have a preferential treatment as intermitent energy and takes advantage of the differentiated power costs and rates throughout the day and the seasons of the year.

Given the fact that CFE was going to charge self-supply projects under this contract for capacity backup (which made them uneconomical), the regulatory instrument was modified three years later to recognize capacity contributions to the grid at peak demand periods.

[3] PEMEX 2006. Iniciará PEMEX el primer proyecto de cogeneración de energía eléctrica. Boletín de prensa 05.01.2006. http://www.pemex.com/index.cfm?action=content&sectionID=8&catID=40&subcatID=3743

This regulatory instrument helped increase the number of permits for renewable energy projects (wind and small hydro) and, by the end of 2006 there were 26 permits for a total of 1,450 MW (of which 1,258 MW were for wind energy projects). This has not, though, resulted in their construction, as only 89 MW of all the renewable energy projects are in operation (none of them wind energy projects) (CRE 2007).

The Law for the Use of Renewable Energy Sources (LAFRE).

A law promoting renewable energy (the Law for the Use of Renewable Energy Sources—LAFRE) has been in discussion for the last three years in México. The latests version of this initiative includes the purpose of promoting renewable energy use, cogeneration and the use of biofuels. The proposal establishes, among other lines of action: (1) that SENER will draft a Renewable-Energy and Cogeneration Promotion Program, and will co-ordinate its implementation; (2) that there will be open access to the grid (unless CFE has any technical limitations); (3) that renewable energy will be paid by -at least- 95% of total short-term cost of the most expensive generation plant of the supplier, at the time and in the region where is purchased; (4) that SENER will establish the minimum participation percentages of renewable energy for electricity generation, in the short, medium and long term; and (5) that SENER, jointly with the National Council on Science and Technology, will establish a Trust Fund to support renewable energy R&D (SENER 2006).

In December, 2005, Mexico´s House of Representatives voted in favor of this proposal and it was sent for discussion and approval by the Senate. The Senate has kept the initiative under consideration and it is not clear at this point in time if it will be open for new arguments in order to convert it into law.

Biofuels

During the last decade there have been a number of attemps to promote the use of biofuels in Mexico. Most of these attempts have been driven by the sugar industry and have been resisted by Pemex under the argument that it would have a cost that the company cannot pay. More recently, a law initiative has been approved by the House of Representatives to mandate the use of ethanol in the gasoline sold by Pemex (which, by law, has the monopoly of gasoline distribution in México). This initiative was analyzed by the Senate and sent back to the House of Representatives with modifications. The initiative remains under analysis.

One successful initiative that relates to biofuels is the plant operating with landfill gas in the city of Monterrey. This plant, which started operations in 2002, has a capacity of 7.42 MW, supplies electricity for street lighting municipal systems in the region.

Solar water heating

Solar energy has been used in México for more than 50 years to heat water for residential and commercial instalatons and a relative large number of small manufacturers and distributors have been operating in the country for decades. The technology is not, though, widely used. Only about 3% of the energy needs for this end use in the residential sector are covered with this technology. This is mostly a result of the subsidies that LPG (the predominant fuel for water heating in Mexico) had until the beggining of the present decade and the high interest rates that were paid for loans in Mexico for about several decades.

Modest attempts by Conae and FIDE to promote solar water heating have had very limited impact. In 2002, Conae organized the largets manufacturers to promote their products in public places and through the Internet. Not much later FIDE started a program aimed at CFE´s workers, whom have the right to a large amount to free electricity and tend to use largely inneficient electric power heaters.

More recently, the Fund for Shared Risk (FIRCO) of the agriculture ministry (SAGARPA) used grants to pay for a fraction of solar water heating systems in a few slaughterhouses. FIRCO is considering some kind of grant and/or loan to generalize its use in agroindustrial installations (FIRCO 2006).

Finally, the Government of Mexico City mandated, in 2006 a through an environmental standard, that all new public-use instalations (such as hotels and sport clubs) have to heat 30% of their hot water needs with solar energy (GDF 2006).[4] The impacts of this standard are still to be evaluated.

c. Private sector initiatives.

In the private sector recent efforts have taken place that have an effect on the carbon intensity of their activities and of Mexico´s economy in general. In most cases these efforts are not directly driven by an interest in reducing CO2 emissions, but as a result of the high prices of natural gas and electricity of the last few years. In some cases, especially for companies with international operations, the efforts are also driven by environmental policies defined by their headquarters abroad.

Specifically, there is a voluntary CO2 emissions accounting and reduction program under the name of “Programa GEI México” that has been in operation in México under the auspices the Secretaria de Medio Ambiente y Recursos Naturales (SEMARNAT), the Comisión de Estudios del Sector Privado para el Desarrollo Sustentable (CESPEDES), with technical support from the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD).

As part of this program, 30 companies have committed to calculate and report their greenhouse gas emissons (Table 7).

[4] GDF 2006. NORMA AMBIENTAL PARA EL DISTRITO FEDERAL NADF-008-AMBT-2005. SECRETARÍA DEL MEDIO AMBIENTE. Gobierno del Distrito Federal. México DF

Table 7. Companies listed as part of the "Programa GEI México"[5]

GROUP I

- Amanco México
- Altos Hornos de México
- Grupo Bimbo
- Cementos Holcim Apasco
- Cementos Cruz Azul
- Cementos Lafarge
- Cemento Moctezuma
- CEMEX México
- Ford Motor Company S.A. de C.V.
- Grupo Cementos de Chihuahua
- Grupo Modelo, S.A. de C.V.
- Grupo Porcícola Mexicano, S.A. de C.V.
- Mittal Steel Lázaro Cárdenas S.A. de C.V.
- NHUMO S.A, de C.V.
- Industrias Peñoles
- Petróleos Mexicanos
- Siderúrgica Lázaro Cárdenas Las Truchas, S.A. de C.V. (SICARTSA)
- Siderúrgica Tultitlán, S.A. de C.V.
- Sumitomo Corporation de México, S.A. de C.V.
- Tetra Pak

GROUP II

- Cervecería Cuauhtémoc Moctezuma
- Caterpillar México
- Minera Autlán
- SIMEPRODE

GROUP III

- Boehringer Ingelheim Vetmedica
- Cerraduras TESA
- Honda de México
- Hitachi GST México
- John Deere
- Tecnológico de Monterrey, Guadalajara

Individually, companies report on their activities through their annual reports to stockholders. What follows is a description of some of the most siginificant efforts done in Mexico by the private sector to reduce energy consumption

BASF

[5] http://www.geimexico.org/reportes.html

BASF is one of the largest petrochemical companies in the world and has manufacturing operations in Mexico. As an international company, at their major production sites around the world it operates the Verbund concept which links production and energy streams together in an intelligent manner and develop innovative solutions and products that also help their customers save energy (BASF 2007). Under this perspective, BASF has been one of the companies that established the Asociación de Empresas para el Ahorro de Energía en la Edificación (AEAEE), an NGO that promotes better materials and building practices for low-energy-consumption homes and buildings in México (AEAEE 2007).

BIMBO

Grupo BIMBO is a bread producer with more than 44 plants in Mexico, more than 72,000 employees and a fleet of thirty thousand vehicles that serve a network of close to one million points of sales (BIMBO 2006). In 2004, with an investment of 3.5 Million US$, it saved 320 GWh of electricity and 870,000 Gcal in LP and natural gas, and 130 million liters of transportation fuels (CONAE 2005).

CEMEX

Besides being part of Programa GEI México, CEMEX—a cement producer that is one of the largest companies in the world that was originated in México—is part (together with Cementos Lafarge and Cementos Holcim Apasco) of the Cement Sustainable Initiative (CSI). The CSI is a global effort by 18 major cement producers that account for more than 40% of the world's cement production and who believe there is a strong business case for the pursuit of sustainable development. The CSI includes CO2 management, and reporting & communications (WBCSD, 2007).

In particular, CEMEX has increased its indicator for the use of alternative fuels in 20% from 2004 to 2005 by using used tires under a process in which emissions are controlled (CEMEX 2005).

CYDSA

Cydsa is a Mexican industrial petrochemical company with plants in eight cities, annual sales for more than 480 US$ Million, close to 4,000 employees and exports to more than fifty countries. According to their annual report for 2005 it has energy conservation programs in two of its more energy intensive plants (CYDSA 2006).

FEMSA

FEMSA is the largest beverage company in Latin America, exporting its products to the United States, and select countries in Latin America, Europe and Asia, with more than 11,700 US$ Million in revenues and more than 97,000 employees (FEMSA 2007).

In 2005 FEMSA invested more than 2 U$ Million in energy conservation measures and saved 140 GWh in electricity and reduced its gas consumption per unit produced by 9%. It has also been using compact transportation units in downtown Mexico City that use electricity and recycled 12,000 Tons of aluminum. It also recycled 64,000 Tons of glass between 2004 and 2005, saving an equivalent of 22.1 GWh (FEMSA 2006).

Wal-Mart

Wal-Mart Mexico has close to 800 units (wholesale and retail stores and restaurants), net sales of more than 14,000 US$ Million and employs more than 140 thousand people (Wal-Mart 2006).

Wal-Mart Mexico has had an energy conservation program since 1999 and has a 20% energy use reduction goal for 2012. In 2006 it invested 10 US$ Million in energy efficiency and conservation measures and saved 2.7 GWh in the last three months of 2006 and reduced 1.8% of total energy in the year. It recycled **125,847** Tons of cartboard and, **2,624** Tons of plastic (Wal-Mart 2007).

d. Other efforts

Use of natural gas.for power generation

Since the year of 2000, as privately owned power plants there were allowed to sell power to CFE started operating, there has been a significant impact in CO2 emissions by the power sector. By 2006, 59.43 TWh were generated by these independent power producers using combined cycle plants based on natural gas (CFE 2007). As combined cycle plants are 35% more energy efficient than conventional thermal plants and as natural gas emmits 18% less CO2 per unit of energy, an estimated 20,600 Tons of CO2 has been avoided in this process (compared to the conventional thermal power plants based on fuel oil that had dominated CFE´s growth since the mid 1970s).

Mitigation in the transportation sector

Even though the transportation sector is the main contributor to Mexico´s present and future GHG emissions, very timid efforts have been made to reduce its impacts. In this direction a project by the name of Metrobus is now in operation in México City. Metrobus is a 20 km dedicated bus-lane built against the central reservation of the city's main north-to-south arterial route and carries more than 260,000 passengers daily The system replaced 372 standard buses and microbuses that served Insurgentes with 80 articulated buses. Estimated annual environmental benefits include a reduction of 35,400 tons of CO2.[6]

Clean Development Mechanism

The Mexican Committee for Emissions Reduction and GHG Sequestration Projects (COMEGEI) was created in 2004 in order to facilitate CDM project implementation in Mexico. According to its creation decree, the COMEGEI was created "to identify opportunities, to facilitate, to provide, to disseminate, to evaluate and to approve, emissions reduction and GHG sequestration projects in the United Mexican States". The Committee is

[6] http://en.wikipedia.org/wiki/Metrob%C3%BAs

formed by the Secretaries of Environment and Natural Resources, Energy, Economy, Agriculture, Communications and Transportation (SEMARNAT 2007).

By the end of 2006 COMEGEI had issued 148 Letters of Approval for CDM projects in Mexcico. The great majority of these projects (128) are aimed at reducing methane emissions in the agricultural sector (mainly for bird and pig farms), while three are implemented to reduce methane emissions in landfills. Only 14 of these projects have to do with energy production, with five related to wind power projects (that are still not generating electricity) and four to mini-hydro plants (SEMARNAT 2007).

IV. Financial and technological constraints restricting the decarbonisation of growth and the potential role of international cooperation in reducing these constraints.

Estimated growth of CO2 emissions that result from México´s energy use (at about 30% in the next ten years) represent an important challenge in view of the need to stabilize and reduce GHG emissions worlwide and the role that Mexico has in the international arena for the size of its population, its economy and its process of development.

In this context, Mexico has a clearly dispersed situation with regards to energy conservation, renewable energy and cogeneration issues. On one side, Mexico has energy efficiency and conservation programs that have been very successful. On the other side, renewable energy and cogeneration still make a relativelly small contribution to the national energy supply as policies have either not been put in place or have failed to fullfill its objectives.

The reasons for this situation may vary, but perhaps the most important are the oil abundance in the country and the control of state-owned monopolies of energy supply and the fact that the oil company is an significant source of revenue for the national budget. The fact that there are fewer advances with regard to energy supply (such as greater use of renewable energy) than in energy demand –where decisions are made by end-users – is a clear symptom of this situation.

To be able to mitigate its emissions, Mexico has to consider and implement, with a sense of relative urgency, a series of measures to decarbonize its growth. In very general terms, the type of measures that are required to reduce the carbon intensity of an economy include:[7]

- measures that reduce the energy intensity of the economy (e.g., more efficient lighting, cars, and industrial processes),
- measures that reduce the carbon intensity of the energy used (e.g., renewable energy resources, nuclear power, natural gas, and more efficient fossil-fueled electricity plants), and
- measures that integrate carbon sequestration into the energy production and delivery system (e.g., integrated gasification combined cycle plants with carbon separation and storage).

We will use this clasification to establish the constraints restricting the decarbonisation of growth in México and the potential role of international cooperation in reducing these constraints.

a. Measures that reduce the energy intensity of the economy (e.g., more efficient lighting, cars, and industrial processes).

---

[7] Interlaboratory Working Group. 2000. Scenarios for a Clean Energy Future (Oak Ridge, TN; Oak Ridge National Laboratory and Berkeley, CA; Lawrence Berkeley National Laboratory), ORNL/CON-476 and LBNL-44029, November.

Mexico´s good results in energy conservation are still a fraction of the technical and economic potential for actions of this type. Very general estimates put the potential in 20% of present consumption in specific installations. Also, undefined impacts can result from changes in the way people and goods are mobilized.

In general and by sector, there are a number of opportunities.

- *Transportation.* The largest opportunities (in terms of volume) for energy efficiency and conservation are located in the transportation sector, though these oportunities require wide-range and long-term policies to have an impact. From policies aimed at the technology of the vehicles (motors and fuels) to policies that affect large infrastructure systems (from mass transport to urban planning), there are is a large menu of options that could help reduce Mexico´s tendency to be vey inneficient in the way people and goods are mobilized.

- *Residential.* Even though the most significant impacts of the national energy efficiency programs have been in the residential sector (trough the mandatory energy efficiency standards and specific programs such as ILUMEX, FIPATERM and FIDE´s) there is an important potential in the growing demand for air-conditioning as the Mexican government plans to continue with a very aggresive housing policy that would bring up to one million new homes every year for the next six years (CONAVI 2007). In particular, prevalent building practices do not include thermal insulation in extreme climates which is the type of environment where half of the present dwelling stock is now located and homes can last for several decades. It has been proven that thermal insulation can reduce up to 30% of the electricity consumption of a household with savings that average 1 MWh per year.

- *Commercial.* The fastest growing economic sector in México in the last five years has been the commercial sector, and this sector has been growing in weight in the Mexican economy (Banxico 2007). The most significant potentials in this sector can be found in lighting and air-conditioning systems. Other important possibilities have to do with the operation systematization of the installations, by using monitoring and automatic control systems.

- *Industrial.* The energy-efficiency improvements in this sector through better practices in the operation of the installations can be considerable (that can be helped with monitoring and control systems). Also, the energy efficiency potentials in the steam generation systems are also significant among small and medium enterprises. There is also an important potential in the use of efficient electric motors, even though the energy efficiency standards and FIDE´s programs have had a significant impact.

- *Municipal.* Also with good results on greater energy efficiency from mandatory standards for street lighting and electric water pumping, and of FIDE´s programs for both end uses, there are a number of opportunities in those systems in the context of municipal services.

There are a number of identified barriers to end-use energy efficiency, some of the common to all sectors and other more specific to a given sector.

- *Higher upfront costs.* Most energy efficiency investments require investing upfront, which limits those end users that have credit limitations or some level of doubt about the technical feasibility of a given measure.

- *Energy prices for some types of energy do not reflect its real cost*. Energy pricing policies established by the Federal government grant subsidies to certain sectors, particularly the agricultural (water pumping) and the residential sectors. These subsidies represent in some cases more than 50% of the real cost of energy, which reduces energy-saving measures feasibility for energy users.

- *Lack of confidence in related technology*. In spite of the large variety and quality of existing and proven energy-saving measures, potential users of these technologies are still skeptical of their technical feasibility thus increasing the rate of return for any investment in this type of technology.

- *Poor financial market development related to energy conservation efforts*. In spite of the energy conservation potential and the volume of transaction that it could represent for the financial markets, there are no specialized bodies within the Mexican banking system for this type of projects.

- *High transaction costs (real and perceived)*. In order to identify potential energy-saving investments, it is always necessary to develop some type of energy audit, which allows quantifying the investment needed and the resulting energy-savings. In many cases, the audits have costs that may costs, impending their realization and/or the measures that may be identified in the process.

- *Lack of technical capability.* The lack of technical capability to design, build, commission, operate and supervise large public transport projects is a barrier to the expansion of these systems.

- *The builder makes decisions that the operator cannot change a with opposite interests*. A common barrier in the buildings´ sector has to do with the fact that those who invest in the design and construction of a building make many decsions that determine its energy intensity and that are very expensive (thus not feasible) to change once the installation is operating. Generally, the builder looks to reduce the cost of building and that is generally reflected in higher energy consumption for lighting and comfort.

- *The considerable time, resources and political capital that are involved in infrastructure projects*. Even as there may be significant positive environmental impacts from infrastructure projects that improve public transportation, some of these projects require more time and resources than what those who make the decisions have availabel or are willing to take.

In order to overcome these barriers, a number of actions can be taken in México with international cooperation.

- *Technological information and promotion.* Direct access to examples of succesful technological applications for energy conservation can help technical people, investors and policy makers to integrate it into their projects. This access can be in the form of technical visits, fairs, courses and web sites that are designed to address the needs and the technical knowledge of technical people, investors and policy makers in México.

- *Research on market niches and their potential.* Due to the fact that there is limited information on the way energy is used in México (p.e.: technology, vintage, rate of renovation, patterns and intensity of use) it would be useful to conduct market surveys and specific measures to address this issue, thus helping size the market and its potential.

- *Assistance in the development of technical an institutional capacities to design, implement and manage projects and programs.* Many opportunities for energy efficiency go unused as large public (at federal state, and municipal level) and private (large industrial and commercial consortia) lack technical capabilities to help organize the institutional efforts in the process from demonstration projects to large-scale programs.

- *Support the development of public policies which facilitate and accelerate technology adoption.* Public policies, particularly those that mandate specific levels on energy intensity or the application of a set of technologies to increase the energy efficiency of specific installations (such as buildings) have been proven to be susccesful in developed countries. In México, insufficient institutional development and information limits their ability to design and implement these type of policies. Thus, successful examples of public policy to reduce energy intensity of specific systems and their difussion among policy makers and stakeholders can help their implementation in México.

- *Promotion of best practices for Mexico's industrial and commercial sectors.* Aside from those public policies which mandate certain conducts or promote investments in specific energy-efficiency equipment and systems, there are a number of best practices which can be adopted voluntarily by private enterprises. This kind of initiatives is commonly used in the context of the most developed countries, providing added value to products and services offered by companies. The knowledge and adoption of such best practices can help Mexican companies which export a number of their products and services.

- *Greater application of CDM.* Given Mexico´s high level of dependence on fossil fuels to provide energy services there are many opportunities to conserve energy that can be implemented under the Clean Development Mechanism. Also, new approaches of CDM for energy efficiency and conservation projects may increase the volume of projects. According to information provided by SEMARNAT, it is estimated that Mexico has a GHG emission reduction and carbon sequestration potential close to 81 million tons between 2008 and 2012, figure that could represent a total income of approximately $US500 million.[8] Greater international collaboration in this field would thus increase its deployment.

[8] Instituto Nacional de Ecología, January 31st., 2005: www.ine.gob.mx/

b. Measures that reduce the carbon intensity of the energy used (e.g., renewable energy resources, nuclear power, natural gas, and more efficient fossil-fueled electricity plants).

There is clear evidence that Mexico possesses considerable renewable-energy resources.

- *Wind energy*. Wind resources in Mexico are clearly extensive and almost unexploited. Some estimates have put the potential in more than 30,000 MW while, as mentioned above, present capacity is no greater than 100 MW (considering La Venta II, that is not yet officially in operation) (NREL 2003).

- *Bioenergy*. Bioenergy opportunities in Mexico have been roughly evaluated, although they are varied and extensive. Generalized use of biogas from landfills is imminent all along the more than 2,400 municipalities in Mexico (CONAFOR 2006). The use of biogas from cattle raising activities is already under serious evaluation, moved by environmental concerns (FIRCO 2006). On the other hand, agricultural and forest by-products and residues, aside from its use in energy farming, are technically and economically feasible, and only require the will of promoters to undertake the respective projects. Finally, the fact that this kind of projects has a high mitigation value due to methane emissions makes them more attractive in the context of the Clean Development Mechanism of the UNFCCC Kyoto Protocol.

- ***Solar water heating*.** There are a number of opportunities in Mexico for the use of solar water heater. The fact that solar resources in Mexico are extensive, that the price of fuels used for water heating (LPG and natural gas) are no longer subsidized, as well as favorable macroeconomic conditions (historically low interest rates), has led to a favorable environment for a wider use of this technology that could lead to growth rates up to ten times present rates (of close to 10% per year).

- ***Rural electrification*.** According to CFE, 95% of the total population has electricity services. Therefore, it still necessary to electrify more than 70,000 communities with a reduced number of inhabitants, According to some analysis, any electricity needs that require an extensions of the distribution grid by one or more kilometers can be economically done with renewable energy (FIRCO 2006). The federal government supports rural electrification through financial transfers to state and municipal governments to invest in infrastructure and social development work, although these resources are not labeled to be destined to a specific use and local authorities generally have other urgent needs. This particular situation, together with federal budgetary restrictions and the poverty these communities suffer, has made more difficult to achieve electrification in general and to do it with renewable energy in particular.

In spite of the large renewable-energy potential to be used in Mexico, there are a number of barriers that restrict the development of this potential, even though there are competitive unit costs for a number of applications.

- *Insufficient information on renewable-energy resources*. The lack of reliable and accurate data, as well as long term time series of resource assessment are a significant barrier for renewable-energy projects, because this affects directly the reliability on resource availability and quality of the projects, also increasing its financial risk, thus increasing interest rates and reducing project feasibility.

- *High transaction costs for renewable-energy projects*. Renewable-energy projects face relatively higher costs than those conventional electricity generation projects. This is due mainly to the following reasons: (1) although most of renewable-energy projects are small in size, they have to comply with the same number of requirements of larger projects; (2) environmental impact assessments are more complex compared to those developed for fossil-fuel projects, because renewable-energy projects are located in larger areas with a greater variety of fauna and flora which have to be considered within the assessment; and (3) there is not enough experience for the development of this kind of assessment, therefore terms of reference are defined discretionarily.
- *Lack of confidence in related technology*. In spite of the large variety and quality of existing renewable energy technology, potential users of these technologies are still skeptical of their technical feasibility thus increasing the rate of return for any investment in this type of technology.
- *Laws and regulations have been openly designed and established to favor centralized generation over distributed generation*. Dispatch rules, prices paid for energy and power, and back-up rates have been defined to favor the national power monopolies over distributed generation alternatives that can be considered by large energy end-users.
- *Tendency to favor electric grid expansion over renewable-energy use*. About 5% of Mexico´s population lives in areas without access to electricity. It can be easily demonstrated that it is cheaper to use off-grid renewable-energy systems than expanding the centralized electricity grid. However, rural electrification decision-makers favor the expansion of the electricity grid, most of the times because it is the only technical capability available, instead of developing renewable-energy projects.

These barriers can be overcome with actions such as:

- *Technological information and promotion.* Direct access to examples of succesful technological applications of renewable energy applications can help investors and policy makers to consider it an option to their particular needs. This access can be in the form of technical visits, fairs, courses and web sites that are designed to address the needs and the technical knowledge of technical people, investors and policy makers in México.

- *Evaluation of renewable energy resources in Mexico.* As lack of reliable and accurate data, as well as long term time series of resource assessment are a significant barrier for renewable-energy projects it would be useful to support and perform large scale campaigns to gather data on wind, solar, bioenergy and ocean energy resources.

- *Assistance in the development of technical an institutional capacities to design, implement and manage projects.* The potential for renewable energy projects is much larger than present technical capacity and an intense implementation of these kinds of projects will require a large and concerted efforts to train enough qualified technical people to have a successful process of large-scale adoption of renewable energy.

- *Support the development of public policies which mandate renewable energy use.* Public policies that support the development of renewable energy projects in the most developed countries have proven to be succcesful. In México, insufficient institutional development and information constraints have limited the ability to design and implement these type of policies. Thus, successful examples of public policy to promote renewable energy projects and their difussion among policy makers and stakeholders can help their implementation in México.

- *Greater application of CDM.* Given Mexico´s high level of dependence on fossil fuels and the large estimated potential for the use of renewable energy there are many opportunities that can be implemented under the Clean Development Mechanism. According to information provided by SEMARNAT, it is estimated that Mexico has a GHG emission reduction and carbon sequestration potential close to 81 million tons between 2008 and 2012, figure that could represent a total income of approximately $US500 million.[9] Greater international collaboration in this field would thus increase its deployment.

c. Measures that integrate carbon sequestration into the energy production and delivery system (e.g., integrated gasification combined cycle plants with carbon separation and storage).

According to CONAE and under an optimistic scenario, Mexico has a cogeneration potential which is close to 15,670 MW (Table 8). Of this estimation, PEMEX facilities (Petrochemical and Refining) have the higher potential, with nearly 4,500 MW. Estimated potential opportunities above 1,100 MW can be found separately in the chemical, food, steel, cellulose, paper and cement industries (CONAE 2006).[10]

Table 8. Cogeneration potential in Mexico (National Cogeneration Potential, National Commission for Energy Conservation)

SECTOR	***Capacity (MW)***
Petrochemical (PEMEX)	3,026
Chemical	1,943
Refining (PEMEX)	1,469
Food	1,416
Steel	1,388
Cellulose and paper	1,335
Cement	1,179
TOTAL	**15,689**

Source: Conae. Potencial Nacional de Cogeneración

[9] Instituto Nacional de Ecología, January 31st., 2005: www.ine.gob.mx/
[10] Comisión Nacional para el Ahorro de Energía, *Potencial Nacional de Cogeneración,* January 31st., 2005: www.conae.gob.mx/wb/distribuidor.jasp?seccion=1916

This potential has olny been partially exploided, as a number of barriers for cogeneration and self-supply projects are present in Mexico and have been identified by project developers that have attempted to promote these types of projects.

- *Laws and regulations have been openly designed and established to favor centralized generation over distributed generation*. Dispatch rules, prices paid for energy and power, and back-up rates have been defined to favor the national power monopolies over distributed generation alternatives.

- *The law forbids private transactions*. This means that those who have cogeneration and self-supply projects cannot commercialize electricity surplus in an open market.

These barriers can be overcome with actions such as:

1. *Technological information and promotion.* Direct access to examples of succesful technological applications of cogeneration and distributed generation can help investors and policy makers to consider it an option to their particular needs. This access can be in the form of technical visits, fairs, courses and web sites that are designed to address the needs and the technical knowledge of technical people, investors and policy makers in México.

2. *More detailed analyses of costs of distributed power generation vs central generation* . The benefits of distributed generation are not evident to policy makers and very little has been done to quantify the costs and benefits of distributed generation.

3. *Support the development of public policies which mandate distributed generation.* Successful examples of public policy to promote distributed generation and their difussion among policy makers and stakeholders can help their implementation in México.

V. Conclusions.

As one of the most important oil producers in the world, Mexico depends highly on fossil fuels to operate its economy. Close to 90% of its energy supply dependes on oil and condensates (45.7%), natural gas (36.2%), and coal (5.7%). With respect to electricity generation, 43% came from the combustion of fuel oil, 23% from natural gas and 9% from coal.

In terms of energy end-use, transportation represents the highest energy user with a dominating 45.6 % of total consumption, a share with a tendency to grow. It is estimated that energy use for this sector will grow close to 50% in ten years, with its corresponding GHG emissions.

Some good signs show that there is a long-term effort to be more efficient and less oil dependent. Mexico´s energy intensity has generally improved since 1990 and the electricity sector has been shifting towards natural gas. Also, SENER´s projections show a decoupling in the growth of the use of fossil fuels in electricity generation in relation to its final use.

But the contribution of GHG emissions from the energy sector remains high (61%) and estimates of CO2 emissions from direct fossil fuel combustion show a 31% growth from 2005 to 2015 in direct CO2 emissions.

Regardless of Mexico´s success in energy efficiency, many opportunities are there to decrease the economy´s energy intensity and its dependence on fossil fuels.

Mexico´s good results in energy conservation are still a fraction of the technical and economic potential for actions of this type, particularly in the transportation sector and in the growing services sector. The country´s considerable renewable-energy resources are poorly harnessed. And, ten years after the study on cogeneration potential was made public, only about 10% has been developed.

International cooperation could certainly help México towards decarbonisation of its economy. Access to state of the art technology and to capital to access this technology; to training in project design, construction and operation of renewable energy and public transportation systems; to best practices in the design, construction and operation of energy using systems; and to best practices in the design and implementation of policies and programs to promote and facilitate adoption of all the possible technical and financial alternatives will be extremely helpful in the process towards the decarbonisation of Mexico.

REFERENCES

AEAEE 2007. Asociación de Empresas para el Ahorro de la Energía en la Edificación, A.C. http://www.ahorroenergia.org.mx/(Accessed:2007, April 1st)

Banxico 2007. Principales indicadores**.** Banco de México. http://www.banxico.org.mx/ (Accessed:2007, March 1st)

BASF 2007.Emissions of greenhouse gases. http://www.corporate.basf.com/en/sustainability/ (Accessed:2007, April 1st)

BIMBO 2005. Administración de Energía en Grupo Bimbo. Presentación en el Seminario México-Unión Europea para la Promoción de la Tecnología en Eficiencia Energética y Energía Renovable. http://www.conae.gob.mx/work/sites/CONAE/resources/LocalContent/2820/1/images/Hector_Uribe.pdf

BIMBO 2006. Informe Annual 2005. Grupo Bimbo. http://www.grupobimbo.com.mx/relacioninv/uploads/reports/Informe%20Anual%202005%20Final.pdf (Accessed:2007, April 1st)

BP 2006. Statistical Review of World Energy 2006. British Petroleum. http://www.bp.com/

CEMEX 2005. Informe de Competitividad Responsable 2005. http://www.cemexmexico.com/rs/icr05/ar.asp. (Accessed:2007, April 1st)

CFE 2007. Centrales de generación**.** Bases de licitación previas a convocatoria**.** Comision Federal de Electricidad (CFE) http://www.cfe.gob.mx/es/LaEmpresa/generacionelectricidad/ (Accessed:2007, March 1st)

CFE 2007. Generación de electricidad**.** Comision Federal de Electricidad (CFE) http://www.cfe.gob.mx/es/NegociosConCFE/licitaciones/Basesdelicitacionesdeobra/proyinvfinanc/centgen// (Accessed:2007, March 1st)

CIA 2007. https://www.cia.gov/cia/publications/factbook/geos/mx.html#Econ

CONAE 2005. Comisión Nacional para el Ahorro de Energía, Potencial Nacional de Cogeneración, January 31st., 2005: www.conae.gob.mx/wb/distribuidor.jasp?seccion=1916

CONAE 2006. Informe de Labores 2005. Comisión Nacional para el Ahorro de Energía http://www.conae.gob.mx/work/sites/CONAE/resources/LocalContent/3802/3/informedelabores2005.pdf, Mexico

CRE 2007. Permisos para generación privada. Comisión Reguladora de Energía. http://www.cre.gob.mx/estadisticas/stat98/electr.html. (Accessed:2007, March 1st)

CYDSA 2006. Reporte Anual 2005. http://www.cydsa.com/Espanol/contenido/infofin/anual/pdf05/informeanual2005.pdf. (Accessed:2007, March 1st)

De Buen O. 2005. Ilumex: Desarrollo y lecciones del primer proyecto mayor de ahorro de energía en México Cambio climático. Una visión desde México. Editado por Adrián Fernández y Julia Martínez con colaboración de Patricia Osnaya. Instituto Nacional de Ecología. México DF.

DOE. 1997. Technology opportunities to Reduce U.S. Greenhouse Gas Emissions. Prepared by National Laboratory Directors for the U.S. Department of Energy . http://www.ornl.gov/~webworks/cppr/y2003/rpt/110512.pdf. Octubre de 1997.

FEMSA 2006. Acciones para el cuidado del Medio Ambiente. http://www.femsa.com/es/assets/003/15669.pdf (Accessed: 2007, March 26th)

FEMSA 2007. 2006 Annual Report. http://www.femsa.com/en/assets/003/16511.pdf (Accessed: 2007, March 26th)

FIDE 2006. Resultados del Horario de Verano. Fideicomiso para el Ahorro de Energía Eléctrica. http://www.fide.org.mx/servicios/resultados.htm (Accessed: 2007, February 26th)

FIDE 2007. Ahorros directos de Energía Eléctrica por Sector y Programa hasta el segundo trimestre del 2005. Fideicomiso para el Ahorro de Energía Eléctrica. www.fide.org.mx/resultados/index.html (Accessed: 2007, February 15)

GDF 2006. NORMA AMBIENTAL PARA EL DISTRITO FEDERAL NADF-008-AMBT-2005. SECRETARÍA DEL MEDIO AMBIENTE. Gobierno del Distrito Federal. México DF

IEA 2005. Key World Energy Statistics, International Energy Agency http://www.iea.org/dbtw-wpd/Textbase/nppdf/free/2005/key2005.pdf (Accessed: 2005, november 18)

INE. 2006. México Tercera Comunicación Nacional ante la Convención Marco de las Naciones Unidas sobre el Cambio Climático. Instituto Nacional de Ecología. Secretaría de Medio Ambiente y Recursos Naturales. Octubre de 2006. México DF.

INE, 2006. INVENTARIO NACIONAL DE EMISIONES DE GASES DE EFECTO INVERNADERO 1990-2002. Instituto Nacional de Ecología. SEMARNAT. Septiembre 2006. México.

INEGI, 2007. Estadísticas Sociodemográficas. Instituto Nacional de Estadística, Geografía e Informática. http://www.inegi.gob.mx/est/default.aspx?c=2343. (Accessed: 2007, February 15)

INEGI, 2007. Instituto Nacional de Estadística, Geografía e Informática, January 31st., 2005: http://www.inegi.gob.mx/est/contenidos/espanol/rutinas/ept.asp?t=mviv01&c=3398.

Instituto Nacional de Estadística, Geografía e Informática (INEGI) (2006a) Población total annual según sexo. http://www.inegi.gob.mx/est/default.asp?c=119 (Accessed: 2006, November 15)

----- (2006b) Producto interno bruto anual por actividad económica de origen. Variaciones anuales. http://www.inegi.gob.mx/est/contenidos/espanol/rutinas/ept.asp?t=cuna17&c=1663 (Accessed: 2006, November 15)

Interlaboratory Working Group. 2000. Scenarios for a Clean Energy Future (Oak Ridge, TN; Oak Ridge National Laboratory and Berkeley, CA; Lawrence Berkeley National Laboratory), ORNL/CON-476 and LBNL-44029, November.

IPCC. 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T., and Tanabe K. (eds). Published: IGES, Japan.

Petróleos Mexicanos (PEMEX) (2006) Anuario Estadístico 2006, http://www.pemex.com/files/content/Anuario__2.pdf , Mexico

PEMEX 2004. Pemex a la vanguardia en ahorro de energía. Boletín de Prensa 08.09.2004 de Petróleos Mexicanos. http://www.pemex.com/index.cfm?action=content&sectionID=8&catID=40&subcatID=2284. (Accessed: 2007, February 17)

PEMEX 2006. Iniciará PEMEX el primer proyecto de cogeneración de energía eléctrica. Boletín de prensa 05.01.2006. http://www.pemex.com/index.cfm?action=content&sectionID=8&catID=40&subcatID=3743

PEMEX, 2006a. Reporte de Emisiones de Gases de Efecto Invernadero de Petróleos Mexicanos 2005 Agosto de 2006 Dirección Corporativa de Operaciones Subdirección de Disciplina Operativa, Seguridad, Salud y Protección Ambiental Gerencia de Protección Ambiental. México DF

Sánchez R. Itha y Chu P. Henry A. 2006. Assessment of the Impacts of Standards and Labeling Programs in Mexico (four products). Report No. 12933ITF FN LBL 001. Instituto de Investigaciones Eléctricas. Palmira, México D.F..

SENER . 2006. Balance Nacional de Energía 2005. Secretaría de Energía. México D.F.

SENER . 2006a. Energías Renovables para el Desarrollo Sustentable en México. Secretaría de Energía. México. Enero de 2006.

SENER . 2006b. Prospectiva del mercado del gas licuado de petróleo 2006-20015. Secretaría de Energía. México D.F.

SENER . 2006c. Prospectiva del mercado de gas natural 2006-20015. Secretaría de Energía. México D.F.

SENER . 2006d. Prospectiva de petrolíferos 2006-20015. Secretaría de Energía. México D.F.

SENER . 2006e. Prospectiva del sector eléctrico 2006-20015. Secretaría de Energía. México D.F.

SENER 2007. Sistema de Información Energética. http://www.sener.gob.mx/wb2/SenerNva/informesIndicadores. (Accessed: 2007, February 15)

WAL-MART 2006. http://www.walmartmexico.com.mx/files/2005informeanual.pdf (Accessed:2007, April 15th)

WAL-MART 2007. Sustentabilidad Ambiental de Wal-Mart de México http://www.walmartmexico.com.mx/files/2006rsSP.pdf (Accessed:2007, April 15th)

WBCSD 2006. The Cement Sustainabilty Initiative (CSI). The World Business Council for Sustainable Development. http://www.wbcsd.ch/DocRoot/8bcnob9cWHdt5PSI0mH8/csi-brochure.pdf. (Accessed:2007, April 15th)