

CLIMACAP

Climate and Energy Policy reviews for Colombia, Brazil, Argentina, and Mexico

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1. Introduction

The Integrated Climate Modelling and Capacity Building Project in Latin America, known as the CLIMACAP project, is financed by the European Commission, DG CLIMA. It is a 36 month project, and started in December 2012. The project is led by the Energy research Centre of the Netherlands (ECN), and is implemented in partnership with leading European and Latin-American universities, think-tanks and institutes. The project is collaborating closely with the parallel LAMP initiative, funded by the US EPA and USAID. This brings approximately another 7 modelling groups to the modelling exercise.

The project aims to strengthen modelling capacity to support climate change mitigation strategies of key Latin American countries and regional groupings, as well as to generate cross-model comparison analyses and scenarios up to 2050 that focus on issues such as the economic impacts of policy measures, mitigation costs and potentials, and costs and pathways for reaching specific emission reductions.

The main output from the project will be a special issue of the journal Energy Economics: "Climate Policy in Latin America: implications and impacts for energy and land use". It is anticipated that 11 papers will be co-authored by EU, Latin American and North American researchers, to be ready by November, 2014 in time for the Lima UNFCCC Conference of the Parties (COP 20), covering the following topics:

- Baseline scenarios.
- Climate Policy.
- Technology diffusion.
- Agriculture and land use (including biomass).
- Macroeconomic effects of climate policy.
- Climate policy scenarios in Brazil.
- Climate policy scenarios in Argentina.
- Climate policy scenarios in Mexico.
- Climate policy scenarios in Colombia.
- Energy investment opportunities in Latin America: a multi-model comparison.
- Climate policy in Brazil and Mexico: a multi-model comparison.

A policy review was undertaken as a basis for the modelling exercise in the CLIMACAP/LAMP projects. It primarily informed the development of the different scenarios and calibration of the models. The different country overviews were undertaken by respective national teams. It is reproduced here as a reference to other Latin American and global modelling teams that may undertake similar exercises in future.

2. Policy Review: Colombia

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2.1 Identifying energy policy objectives and their link to Climate Change.

2.1.1 Colombian Energy Sector Stakeholders and Main Competences

The energy sector is a complex system with portfolio of vast energy different sources. Colombia is the first coal producer in Latin America; which account for the 51% of the primary energy mix, followed by crude oil with a 32%. Most of the coal is exported, where only 7.6% is used for own consumption and thus, coal burning has a small share in secondary mix (UPME, 2012). Electricity has a share of 24% in the secondary production mix; while oil products, mainly diesel, gasoline and fuel oil, have the largest share, with a total of 54% (see **Figure 1**).

The transport sector represents the highest energy consumption (38.3%), followed by industry (26.3%) and residential sector (21.2%) as it is shown in **Figure 1**, Colombia has been traditionally a country with a large share of hydro power, such that nowadays the installed capacity mix has a share of 67.4% of hydro power, and 32.1% of thermal plants. Moreover, and given the hydro power potential, there are more than 3 GW of hydro power plants under construction to come on line in the next decade. **Figure 1** shows the share of installed capacity by source; of particular interest, renewable energy, different from hydro power, has a small participation, only run-of-river or small hydro is the only one that has have a representative diffusion in Colombia. Projects on wind, solar and geothermal energy are limited to prototypes, and these sources are still in an exploratory stage of development.



Α

В



Figure 1 – Current status of Energy Sector. (a) Primary energy production, (b) Secondary energy production, (c) Finally energy consumption by energy, (d) Electricity installed capacity by source. Data from: UPME (2009) and XM (2011)

The structure of the energy sector in Colombia is shown in in **Figure 2**. At the top of the organigram, the system is headed by Congress and the Presidency of the Republic; both entities are responsible for issuing the laws that govern the sector. The second is the **Ministry of Mines and Energy (MME)**. The MME main general functions are: (i) develop and manage policies related to the hydrocarbon chain and biofuels; (ii) formulate policies related to the generation, transmission, distribution and supply of electricity, rational use of energy and alternative sources; (iii) adopt Mining and Energy Development Plans and the Power Expansion Plans; (iv) Issuing technical regulations for electric power, oil, gas and biofuels; (v) Develop policies for non-connected areas; and (vi) define prices for liquid fuels. In order to comply the functions mentioned above, The Ministry has two main branches (Vice Ministry of Mines and Vice Ministry of Energy), and six ascribed bodies, whose specific functions are described below.

National Agency of Hydrocarbons (ANH) and National Agency of Mining (ANM): These institutions are responsible for identifying the hydrocarbon and mining potential of the country, proposing and managing the exploration and exploitation activities, setting regulation for prices, establishing contracts, among other related activities.

Regulatory Commission of Energy and Gas (CREG): The CREG is the regulator body of both electricity and gas. The CREG introduce regulation into the market, with the aim to incentive the competition between generators, transmitters and distributors, in order to control monopolies and to protect the final user.

Institute of Planning and Promotion of Energy Solutions for Non-Connected Areas (IPSE): This institution has as functions to execute the different plans and programs created by the MME in regions that are not connected to the grid; to develop studies of demand and energy needs; and to support the building of plans.

Colombian Geological Service (SGC): The SGC, also known as **Ingeominas**, is in charge of developing basic research related with subsoil resources, nuclear power, geological threats, and others.

Planning Unit of Mining and Energy (UPME): The main functions of UPME are: to establish the mining and energy requirements it the country based on different projections, and the path for satisfying those requirements; to develop the National Plan of Mining, National Plan of Energy, and the National Plan for Expansion of the Electric Sector. These functions are extended in the next section.



Figure 1 – Structure of the Energy Sector in Colombia Source: Own elaboration, information from (MME, 2012)

2.1.2 Energy Planning and Institutional Framework

As mentioned above, the institution responsible for making the country's energy planning is UPME, which is defined as "a Special Administrative Unit of National order, of technical character, ascribed to the Ministry of Mines and Energy, governed by Law 143 -1994 and the Decree No. 255 of January 28, 2004" (UPME, 2009). This institution has three sub directions of interest for the present study: Energy Planning, Mining Planning, and Information. The main functions of each sub directions are:

Energy Planning Sub Direction:

- Develop and update the National Plan of Energy and the National Plan for Expansion of the Electric Sector.
- Set the energy requirements of the population and the economic agents in the country, in both connected and non-connected areas.
- Evaluate the economic and social benefits of exports and imports of energy resources.

- Design and Promote different programs, plans and projects related to savings and energy efficiency.
- Support and conduct feasibility studies of the different projects developed by MME and IPSE, for non-connected areas.
- Set the maximum volumes of oil to be distributed in each municipality.

Mining Planning Sub Direction:

- Develop and update the National Plan of Mining Development, according to the macroeconomic policy and the priorities set by MME.
- Coordinate with MME and other entities of the mining sector, the evaluation and implementation of the National Plan of Mining Development.
- Conduct nationally and internationally market research of different minerals, in order to support the decision making processes of MME.
- Evaluate the impact of mining in the economy of Colombia.

Information Sub Direction:

- Coordinate the organization, operation and maintenance of the official data base of the mining and energy sector, in order to ensure the availability and quality of the information.
- Elaborate an annual balance of the mining and energy sector.
- Prepare and disseminate the statistics and official indicators of the sector.

Given the functions previously described, the most recent documents and keys for the energy planning, published by UPME are:

- Program of Rational and Efficient Use of Energy and non-conventional Sources PROURE.
 Action Plan 2010-2015
- Reference Expansion Plan: Generation and Transmission 2010-2024
- Plan of Supply and Transport of Natural Gas (2010)
- Petroleum Chain (2009)
- Natural Gas Chain 2003-2005
- Coal Chain (2012)

2.1.3 The Electric Sector and tools for power expansion.

Colombia adapted the model used in the UK for its deregulation, despites the differences in terms of generation technology composition. The process started the deregulation of electricity in 1994, and the spot market initiated operations in July 1995. The process was supported by Laws 142 and 143 (Congreso de la República de Colombia, 1994a, 1994b). The underlying reasons for reforms were the two previous blackouts in 1983 and 1992–1993, the impossibility of the government financing the required expansion, and the desire to increase the efficiency of the sector (Arango, Dyner, & Larsen, 2006).

Nowadays, Colombia's power system is working as a market, where pool prices are settled in a bidding process, and not cost based. It is composed with both free-contract market and a spot market. All generators submit a day-ahead offer to match system demand and provide the 7

system electricity dispatch; thereafter, there is a balance for the contract market and the residual demand is sold at pool price. The principles for the market are: (i) Creation of a competitive market with the aim of improving the efficiency of energy sector. (ii) Regulation of monopolies for avoiding abuse in price and to protect the user. (iii) Opening to the private sector to stimulate competition and incorporate new capital sources. The Electric Law created the CREG (Regulator of Electricity and Gas), which is responsible for the regulation of the power market.

The Colombian electricity industry is considered to be one of the most open markets in the developing world (Arango et al., 2006; Larsen, Dyner, Bedoya V, & Franco, 2004). The power market initiated with a Capacity Charged, taken from the British power market; it has the intention to provide reliability to the system (Arango, 2007). Thereafter, given that the Colombian power system is hydro based, there was a need to change from a power-based capacity mechanism to an energy-based capacity mechanism (Restrepo E, Arango, & Vélez A, 2012). The reliability charge was put in place to overcome this need with the Resolution CREG 009 – 2010 (Diario Oficial, 2010). About 77% of electricity in Colombia is generated by hydropower; this high dependence brings a need to guarantee energy supply in drought periods from another resources. The Reliability Charge is a mechanism that came into force in 2006, replaced the Capacity Charge, and pays to generators a fee for the energy provided in scarcity conditions. This incentive does not promote any specific generation technology(Cramton & Stoft, 2008).



Figure 2 – Structure of the Electricity Market in Colombia Source: Own elaboration, information from (UPME, 2004; XM, 2011)

The current structure of the power system is shown in . The final users (regulated and unregulated) pay for the energy consumed to the marketers, and these in turn pay to distributors for their service. Marketers also have to pay to the operating company for the use of the grid and the energy trade in the basket. Marketers can also buy energy directly from

generators, according to the price agreed in a contract. By the other hand, the operator pays to transmitters for use of the grid, and to generators that trade their energy in the basket. Finally, other countries can buy power directly from generators, or from the market operator.

2.1.4 Non-conventional sources participation and Electricity Efficiency

The MME created in 2010 the Rational and Efficient Use of Energy Program (PROURE) (Prias, 2010), which is oriented to diminish the energy intensity, improve the efficiency and promote the non-conventional energy. This action plan has a 10 year time horizon. From 2010 to 2015, the program's aim is to define strategies and projects focused on the objectives of the plan; while in the next five years those strategies would start to be implemented. The main guidelines of the program related with the energy sector are listed below.

- Development of tax and economic incentives, and a sanctions regime for waste of energy, breaching of current regulations and tricking to the final user.
- Promoting academic training in energy efficiency.
- Capacity building for technological development, innovation and knowledge management in the productive sector, in order to consolidate a culture of sustainable energy.
- Promoting the awareness of the availability of conventional and non-conventional energy sources.
- Promoting the adoption of new technological and energetic models for fuel substitution in the context of distributed generation.
- Diversifying the energy basket with security criteria, by characterizing the renewable resources and identifying the potential energy and the associated costs.
- Promoting incentives and concessions schemes for non-interconnected areas, looking for incorporating the non-conventional sources in energy services.
- Defining direct subsidies for energization of rural and isolated areas, designated to cover capital costs. Restructuring of current fossil fuels subsides in non-connected areas to promote renewable energy.

The government has set a target of 5% of participation on non-conventional sources in the energy basket, 4% equivalent to biomass usage in thermal applications and transport, and 1% in electric generation. The non-conventional sources include Small hydro, solar, wind, geothermal energy, and biomass utilization. In electricity generation, this 1% corresponds to 3.5% of the national grid in 2015, and 6.5% in 2020. The total installed capacity in non-connected areas is 118 MW, 108.5 MW are generated with diesel plants. The purposed target for 2015 is to increase the coverage to 20%, with the additional 12% covered by renewable resources. The target for 2020 is a 30% of coverage with renewable energy.

The PROURE program is divided into six subprograms: Institutional strengthening, education and capacity building in R&D, financial strategy and market driving, protection to final user and information rights, targets management and monitoring, and promotion of non-conventional energy sources. The present review has special interest in the last subprogram, **promotion of**

non-conventional energy sources; Table 1 presents the available information on renewable potential, and a preliminary estimation made by UPME.

Energy source	Available information
Solar operau	Multiannual average radiation of 4.5 kWh/m ²
Solar energy	Map of radiation. Highest radiation in the Atlantic cost
Wind energy	Map of wind power density. Highest density in the Atlantic Cost
Small hydro	Maximum potential of 25000 MW
Sman nyuro	Inventory of main basins. Map of annual average hydro-energy
Piomass	Maximum potential of 16267 MWh/yr.
DIUITIdSS	26.9 MW of installed capacity. Map of biomass potential
Geothermal energy	Qualitative potential of different areas

Table 1 – Preliminary estimation of renewable potential Source: UPME 2009

Besides the efficiency and renewable use targets, UPME has established action lines for new projects. The main action lines of this subprogram are directed towards a deeper estimation of energy potential, maps upgrade, promotion of applied research, development of pilot plants, and promotion of information systems.

The current regulations have presented a sustainable impact on biofuels targets. In particular, the PROURE program promotes different subprograms which are on consolidation stage. Some of this subprograms are the integration of non-connected areas, efficient equipment for final use of energy, and efficiency in industry; whit the aim to fulfill the gap with sustainable elements.

2.1.5 Incentives for Renewables in the Electric Sector

Currently, Colombia does not have any specific incentive for renewables in the electricity sector. However, the Colombian Congress has adopted a number of laws and decrees which support increased use of non-conventional energy sources, including renewable energy. Law 697 was the first law adopted to specifically promote the use of non-conventional energy sources. Subsequent laws and decrees established implementation goals, tax exemptions, research grants, and reliability charge exemptions for small (< 20MW) projects (IADB & MME, 2010). Figure 3 summarizes the renewable energy polices that have been implemented since the Rio Conference in 2012; the specific incentives for biofuels are presented in Section 1.6.

Furthermore, indirect incentives for sustainable energy, such as loans and subsidies, are offered by different institutions and funds. **Bancoldex** (The Colombian bank of business development) is an institution that offers financial instruments to promote competitiveness, growth and development of companies. It has a partnership with **Colciencias** (The Administrative Department of Science, Technology and Innovation); both institutions have created a credit modality "*A Progresar*", which offers loans to projects of productive transformation and efficiency improvements. Financial alternatives with special focus in small and medium enterprises (SMEs) are the **FOMIPYME** found, from Commerce, Industry and Tourism Ministry, and **FINDETER** found, from Financial and Public Credit Ministry.

There are also international alternatives for finance, the **IDB** finances SMEs through the Multilateral Investment Found (**MIF**) and the Inter-American Investment Corporation (**IIC**); the Global Environmental Facility (**GEF**) offers monetary resources for projects related to renewable energy, adaptation and mitigation to climate change, management of water resources, etc, through **UNEP** and **UNDP** programs.

• Income tax reduction of 20% for solid waste utilization.
• Fund for the electrification of non-connected zones.
Target of 10% Bioethanol blend for 2006VAT exemption for bioethanol.
• Promotion of the efficient and rational use of Energy and alternative energies.
 Income tax exeption for electric sales from wind, biomass and agricultural resource. VAT exemption for importation of CO2 reduction systems.
Target of 5% biodiesel blend for 2008.Tax exemptions for palm oil.

Figure 3–Renewable energy policy in Colombia since Rio Conference, 1992.

Source: Own elaboration, information from(IADB & MME, 2010; IRENA, 2010)

2.1.6 Oil products, natural gas and biofuels

New frameworks for Hydrocarbon sector were created in the Political Constitution of Colombia, 1991; the performance of the market on the 90's attracted foreign investment from major companies such as Exxon Mobil, BP, and Occidental Petroleum. To stimulate the growth of the oil and gas sector, royalties were cut from a flat 20 percent rate to a sliding scale of 8 to 25 percent, depending on production levels. Overall, the state's share of revenue through royalties and taxes was reduced to 50 to 55 percent from a previous 70 percent. Foreign investments had rapidly increased in the last decade, from 500 Million USD in 2001 to almost 3500 Million USD in 2008.

To improve the regulatory model, **National Hydrocarbons Agency -ANH**, was created in 2003. The ANH auctions exploration licenses, which has driven the push to expand the territory with concessions. Meanwhile, **Ecopetrol**, the national company for hydrocarbons has begun to compete with privates and entered the Colombian stock exchange in November 2007. This was made to limit Ecopetrol monopoly. On the other hand, **Regulatory Comission on Energy and Gas (CREG)** was created in 1994. This entity has approved measures for commercialization and transportation for natural gas, as well on tariff design, quality and competence, limiting monopoly practices.

Law 693- 2001 (Diario Oficial, 2001) introduced the biofuels program after the Kyoto Protocol; this law and 939 of 2004 had the intention to diversify the energy matrix, especially with alternative fuels, by stimulating production and demand. However, the first bioethanol plant was open in 2008, and the first Biodiesel plant in 2009. Currently, the government demands a mix of 10% alcohol - 90% gasoline, and 10% biodiesel – 90% diesel. The initial goal was to move from 5% to 10% for 2009; however, it has been reduced to 8% in some regions due to the lack of sufficient ethanol supply. Main normative on biofuels sector is presented in Table 1 and 2. On 2012 the blends were at 10% and projections made by MME shows that this blends will increase to 15% by 2015. Projections on biodiesel demand show an increase of 2.8% annually; In contrast, bioethanol demand will increase in the same rate of gasoline (UPME, 2009b).

The Challenges of Colombian biofuels market are opening to external agents to improve competition, researching on biomass crops yields, reduction on fossil fuels, changing on land use especially on livestock land, and increasing the productivity in the whole biofuel chain. The blend for flex-fuel vehicles can voluntarily vary from E25 to E85; while mandatory ethanol blend was established on E10 for 2012, and B10 blend for biodiesel. For year 2013, the above levels could be modified by the GOC after consultation with the Biofuels Commission. Tables 1 and 2 resume the main normative in biofuels.

Table 1 – Biodiesel Normative

Law	Description	Target
Law 939 -2004	Impulse	Tribute incentives for biodiesel.
Res. 180212-2007	Biodiesel prices	Adjust some items that increase prices (income for
		producers)
Res.18127-2007	Wholesale margin	Control the wholesale margin
Res. 180769-2007	Retail margin	Control the retail margin

Table 2 – Bioethanol Normative

Law	Description	Target
Law 693 -2001	Impulse	Put an outline of 6 years to have blend fuels in cities
Law 055 2001	Inipuise	with population mayor of 500000 people.
Res. 180687-2003		Blend 10% +-0.5%
Res. 181069-2005	Technical	Domestic markets gradual entry dates; Requirements
Res. 181761-2005	regulations	transportation and handling wholesale / retail, Export
Res. 180671-2007		permitted only after satisfying domestic demand
Res.181088-2005	Pricos	Adjust prices
Res. 180222-2006	FILES	Aujust prices
Res. 181549-2005	Wholesale	Control the wholesale margin
Res. 181549-2005	Retail margin	Control the retail margin

2.1.7 Colombian Energy Sector and Climate Change

Colombia only contributes for 0.37% of global emissions. Despite that Colombia does not have GHG reduction commitment; the government is developing some programs and studies that promote the reduction of GHG emissions. In 2010, the Ministry of Environment and Sustainable Development (MADS)¹ published the *Second National Communication to the UNFCCC;* this document features the country's priorities for mitigation, vulnerability and adaptation to climate change, an inventory of GHG sources and sinks, and challenges and needs of the country on these issues (MAVDT, IDEAM, IHMEA, PNUD, & GEF, 2010). The strategies and plans oriented to the energy sector show that the oil sector has the greatest potential to reduce emissions, mainly by fuel substitution, and exploitation and use of gas.

Additionally, in 2012 MADS started the *Colombian Strategy for Low-Carbon Development* program (ECDBC), which aims to prevent the growth of emissions, building CO2 emission scenarios until 2040, and developing mitigation plans for each economic sector (MADS, 2013). This program has not published yet an official document, but the progress has been presented

¹ Previously known as Ministry of Environment, Housing and Territorial Development (MAVDT)

in workshops and on the official website of the Ministry of Environment and Sustainable Development (MADS, 2013). In the preliminary stages of ECDBD program, Industrial and Transport sectors have been identified as major GHG emitters. In the industrial sector cement and steel industries present the higher emissions; consequently, the next stage will assess the technological needs for climate change mitigation of these sectors. Costs and benefits associated with high blends of biodiesel and the use of public bicycle systems are being evaluated in the transport sector, as this is the second main GHG emitter in Colombia. The CO2 emission scenarios and mitigation strategies provided in those documents are presented in Chapter 3.

2.2 Review of national plans and measures

2.2.1 Electricity Expansion Plan

The UPME publishes an annual revision of expansion plan; this document presents the main objectives and projections in demand, generation and transmission of electricity. The most recent report is the Reference Expansion Plan: Generation – Transmission 2010-2024(UPME, 2010). In this report, the UPME presents a long-term analysis of the evolution of demand, installed capacity, generation resources and electricity market of the country, based on current infrastructure, future projects and demand projections. The document is based on the three GDP growth scenarios shown in Figure 4.



Figure 4 – GDP growth scenarios. Blue: Low, Green: Medium, Red: High. Source: UPME 2009

2.2.1.1 Demand Scenarios

The electric demand analysis is based on the following assumptions. The projections for energy consumption and power are shown in **Figure 5**.

- Three GDP growth scenarios (low, medium and high).
- Constant losses in transmission system, equivalent to 2.4% of energy sales.
- Constant losses in distribution system, equivalent to 15.4% of energy sales.



Figure 5 – Demand projections. (a) Energy consumption. (b)Installed Capacity. Red: High, Green: Medium, Blue: Low. Source: UPME

2.2.1.2 Generation Expansion

The generation scenarios were studied by using the MPODE model. First, projections of energy price were made under the three demand scenarios (see Figure 6); then, four expansion scenarios were purposed and analyzed. The next assumptions were included in the study:

- Historical hydrology from 1938 to 2009 for hydro generation.
- Reported projects under construction and date of entry to the electric system.
- Interconnection capacity of 500 MW between Colombia and Ecuador
- Interconnection capacity of 600 MW and 300 MW between Colombia and Central America.
- Demand projections mentioned before.
- Fuel price projections

Scenario 1 considers the necessary conditions in order to satisfy the national demand, medium fuel prices and international interconnections. (See Figure 7)

Scenario 2 considers the necessary conditions in order to satisfy the high demand scenario, medium fuel prices and 500 MW of interconnection capacity with Ecuador and 600 MW with Central America. (See Figure 8)

Scenario 3 sets a critical gas supply, including additional costs relating to a regasification plant construction. The international interconnection shows similar results to scenario 2.

Scenario 4 takes the same considerations that Scenario 2, but includes the retirement of some old generation units, equivalent to 211 MW. This situation does not affect the international interconnections; the results are similar to Scenario 2.





Red: High, Green: Medium, Blue: Low. Source: UPME





Figure 7– Scenario 1 for generation expansion. (a) Exports to Ecuador. (b) Imports from Ecuador. (c) Exports to Central America. (d) Imports from Central America

Red: High Demand, Green: Medium demand, Blue: Low demand. Source: UPME



Figure 8 – Scenario 2 for generation expansion - Energy interchange. Blue: Exports to Central America, Green: Imports from Central America, Red: Exports to Ecuador, Brown: Imports from Ecuador. Source: UPME

Based on the Reliability Charge mechanism, new capacity requirements were not observed in a mid-term (2010-2018). On the other hand, an increase of 1900 MW may be needed in the long term; if some old plants are removed from the system, this value could increase to 2050 MW(UPME, 2010). However, it is planed that by 2018 the Ituango hydro plant enters to the grid, with an installed capacity of 1200 MW.

At Least 600 MW of thermal generation should enter to the system by 2021, with the aim of diversifying the energy mix of the country; coil could be used with those purposes, given that it is one of the most abundant resources in Colombia.

The scenarios of energy exchange with Ecuador and Central America suggest that, despite Colombia could be mainly an exporter, this dynamic depends mainly on the projects and regulation of the other countries.

The expansion plan does not consider the inclusion of solar, wind and geothermal plants, given that, at the moment, there is not any project in the Electric Project Bank of UPME, and those energies are in an exploratory stage. However, small hydro has a representative participation in the grid, with an installed capacity of 533 MW, and there are several projects in evaluation, with a total capacity of 1300 MW (XM, 2011).

2.2.2 Energy Efficiency Standards and Building Codes

As efficiency indicators, the UPME has set some parameters for the different electricity consumers sectors of the country, presented in Table 2. The current sector share is consistent with these indicators, but the current energy share differs in energetics like coal, and natural gas. In order to reach the efficiency standards, the country has to reduce the use of coal and to increase the use of natural gas.

Table 2 – base indicators for energy efficiency.

Source: (Prias, 2010)

Energy intensity	ergy intensity Gcal/M COP \$00		0.87	
Electricity intensity	ectricity intensity kWh/M COP \$00		153.78	
Energy	Gcal/person		5.39	
consumption per				
capita				
	Diesel oil	21.4%	Biodiesel	3.3%
	Natural gas	18.3%	LPG	2.9%
	Electricity	15.3%	Recovery	1.2%
Energetic share	Engine gasoline	14.1%	Fuel alcohol	0.9%
	Firewood	7.3%	Petroleum	0.8%
	Mineral coal and charcoal	5.6%	Non-energy	3.9%
	Chaff	3.7%	other	1.1%
	Residential	21.2%	Agricultural and	5.2%
			mining	
Sector share	Industrial	26.3%	Construction	1.8%
	Commercial and public	5.0%	Other	2.2%
	Transport	38.3%		

2.2.3 Energy Savings Targets

The UPME estimates a final consume of electric energy of 66906 GWh and a saving potential of 20.22% for 2015, equivalent to 5.42% above the target of the government. Table 3 shows the estimated potential and target of UPME in energy saving by sectors.

Table 3 –	Potential	and targets	in energy	saving for	2015
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Source: (Prias, 2010)

Sector	Potential of energy saving	Target of energy saving
Residential	10.6%	8.7%
Industrial	5.3%	3.4%
Public and Commercial	4.4%	2.7%
TOTAL	20.2%	14.8%

In the official document of the PROURE program, the UPME presents the projections of energy savings for three scenarios (high, medium and low). The results, presented in **Figure 9**, show a target of energy savings for 2015 of 14.8% on the high scenario, 10.1% on the medium scenario, and 5.1% in the low scenario. The figure also shows the maximum energy saving potential of the country.



Figure 9 – Projection of electricity savings 2008-2025. [GWh/year]

Blue: Electricity demand with saving potential, Red: Saving potential, Green: high scenario target, Violet: medium scenario target, cyan: low scenario target. Source: (Prias, 2010)

2.2.4 Voluntary Agreements

Currently, Colombia has not signed any emission reduction agreement. However, the National Development Plan 2002 - 2006 has set a mitigation reduction goal of 250.000 tons of CO_2 . It was also considered a potential of emission reduction of 1.000.000 tons in the energy sector, 800.000 tons of CO2 in the transport sector, and 10.000 tons by use of methane in landfills.

The following development plans (2006 - 2010, 2010 - 1014) did not modify to the goals established in the year 2002 or included new ones, but they did focus on promoting clean development mechanisms to exploit the mentioned potential.

2.2.5 Energy Pricing Policies

2.2.5.1 Electricity pricing

The Colombian electricity market has **regulated** and **non-regulated** users. The **regulated market**, which is supplied directly by distributors, covers industrial, commercial and residential users with a demand below 55 MWh/month or power demands below 0.1 MW. For regulated user, the price is set by the CREG using the "Socioeconomic Stratum". By law, all urban areas of Colombia are ranked on a scale of 1-6 (Socioeconomic Stratum), so users from high stratum pay a price above the regulated price to subsidize lower strata users, who pay a price below average. The **non-regulated** users can negotiate freely in the wholesale market. The power market has a reference price, which is the pool price. The pool price is settled in a bidding process, and not cost based. It is composed with both free-contract market and a spot market. All generators submit a day-ahead offer to match system demand and provide the system electricity dispatch; thereafter, there is a balance for the contract market and the residual demand is sold at pool

price. Figure 10 shows the historical data of electricity price since February 2009 until February 2013, for both regulated and unregulated users.



Figure 10 – Historical data of electricity price in the Colombian market 2009-2013 Orange: Pool price, Grey: Regulated price, Blue: unregulated price, free contract. COP/kWh at 2013 prices. Source: (XM, 2013)

2.2.5.2 Fuels pricing

In Colombia, liquid fuels prices are set by government, and are calculated as the opportunity cost of marketing the products in the international market. However, fluctuations in international prices are not necessarily reflected at the national prices in recent years, due to the creation of the Price Stabilization Fund (FEPC) in 2007, which seeks for the elimination of fuel subsidies by avoiding falls in price. The natural gas price is set by CREG, and is calculated considering the production cost (wellhead price), transportation costs, distribution and marketing.

2.3 Review of the national strategy on climate change

2.3.1 Colombian Actors around Climate Change

Climate change gained importance in Colombia after law 164 – 1994, with the approval of UNFCCC (Congreso de la República de Colombia, 1994c). This law allowed the development of new policies, action plans and elaboration of official documents related to climate change, that are summarized Figure 11. In 2011, the **Executive Committee on Climate Change (COMECC)** was formed, through the document CONPES 3700 (DNP, 2011a). The COMECC is headed by the National Department for Planning (DNP), and has the participation of members of all ministries of the country (see Figure 12).

Law 164- 1994	• UNFCCC aproval.
Law 629- 2000	• Kyoto Protocol aproval.
2001	• First National Communication to the UNFCCC: First GHG inventory, identification of susceptible ecosystems.
2003	• CONPES 3242: National Strategy for the sale of Environmental Services for Climate Change mitigation.
2005	• Creation of Mitigation Group on Climate Change, as part of the MAVDT
2010	 Second National Communitation to the UNFCCC: inventory of GHG sources and sinks, priorities for mitigation, vulnerability and adaptation to climate change
2010	 National Development Plan 2010-2014: National Plan for Adaptation to Climate Change (PNACC), Colombian Estrategy for Low-Carbon Development (ECDBC), National Strategy for Reducing Emissions from Deforestation and Forest Degradation (ENREDD+)
2011	• CONPES 3700: Executive Committee on Climate Change (COMECC)
\bigvee	

Figure 11 – Main laws and documents about Climate Change.

Source: Own elaboration, information from (DNP, 2011a; UNDP, 2009)



Figure 12 – Conformation of COMECC Source: Own elaboration, information from (DNP, 2011a)

The Ministry of Environment and Sustainable Development (MADS) is responsible for the Executive Secretariat of the COMECC, while other ministries participate in interdisciplinary groups of each subcommittee (see Figure 13). On the other hand, COMECC has the support of other organs ascribed to MADS, such as Institute of Hydrology, Meteorology and Environmental Studies (IDEAM), and Institute of Marine and Coastal Research (INVEMAR); the Administrative Department of Science, Technology and Information (Colciencias); the advice of international institutions such as WWF, GEF, GIZ and UNDP; and the support of different consultant Universities, such as Andes University and National University of Colombia (UNAL).

COMECC is responsible for the formulation and implementation of three main plans, listed below.

- National Plan for Adaptation to Climate Change (PNACC)
- Colombian Strategy for Low-Carbon Development (ECDBC)
- National Strategy for Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (ENREDD+)

The formulation of those plans is currently in development; some preliminary results are presented in the next section.



Figure 13 – COMECC structure

Source: Own elaboration, information from (DNP, 2011a)

2.3.2 Plans, programs and other actions

2.3.2.1 Second National Communication on UNFCCC

The Second National Communication on Climate Change (SNCCC) was presented in 2010, as a result of the participation of different entities in Colombia. This document presents an inventory of gases sources, politics and plans for mitigation and adaptation, vulnerability scenarios, strategies in education, and obstacles in this area (MAVDT et al., 2010).

The results show that Colombia emits the 0.37% of GHG in the world. In 2004, the total amount of equivalent gigagrams of CO_2 was 180010, with the biggest share from agricultural activities (38.1%) and energy (36.6%), follow by LULUCF (14.5%), and solid waste (5.7%) (See Table 4). From this, the SNCCC has defined the *livestock, Transport* and *energy industry sectors*, as priorities in mitigation issues. MAVDT et al.(2010) highlighted the need of using more accurate methodologies for the estimation of GHG sources, and assessing a detailed study about CO_2 sinks in the country, in future studies.

	SECTOR	% eq CO ₂
	Transport	12.1
Energy	Energy industry	8.5
LIICIBY	Manufacturing and construction industry	7.3
	Others	9
	Enteric fermentation	18.5
Agriculture	Agricultural lands	18.1
	Others	1.5
LULUCF	Land CO ₂ emissions	4.1
	Forest and grassland conversion	9.2
Waste	Solid waste disposal on land and wastewater	5.7
Other sector	S	6

Table 4 – Inventory of GHG emissions by sector - 2004Source: (MAVDT et al., 2010)

On the other hand, the mitigation chapter of SNCCC presents an evaluation of mitigation potential in different sectors in a time horizon of 20 years (2010-2030); it considers energy efficiency, introduction of new technologies, energy saving programs and fuels substitution, the total estimated potential is about 197 Million tones CO₂.

Finally, the vulnerability analysis shows the urgent need to finance different programs for adaptation in different sectors such as coastal areas, agriculture, populations near to water bodies, and hydro generation infrastructure. Those programs should include risk management actions, land use programs, and reduction of environmental, economic and social impacts.

2.3.2.2 National Plan for Adaptation to Climate Change (PNACC)

90% of disasters in Colombia are caused by climate change. For this reason, DNP, MADS, IDEAM and UNGRD (National Unity for Disaster Risk Management) are currently developing a PNACC (DNP, MADS, IDEAM, & UNGRD, 2012), which is framed into the CONPES 3700 document. The main objective of the PNACC is to reduce the risk and socioeconomic impacts associated with climate change in Colombia. The final document will be presented in 2014, and will include (i) Conceptual framework and guidelines on adaptation to climate change; (ii) Roadmaps for regional plans, (iii) risk measurement protocols; (iv) guidelines for including climate change in land use plans; and (v) a portfolio of adaptation actions.

2.3.2.3 Colombian Strategy for Low-Carbon Development (ECDBC)

The ECDBC aims to decouple the growth of GHG emissions from national economic growth. This will be done through the design and implementation of plans, projects and policies directed to mitigate GHG and simultaneously strengthen the social and economic growth of the country. Because of this, the ECDBC work team is composed by representatives of the industrial, energy, mining, transport, housing, waste and agriculture.

The objectives of the ECDBC are (i) Identify actions to prevent the rapid growth of GHG emissions in key economic sectors, (ii) develop mitigation action plans for each sector, and (iii) develop the tools for the implementation of the plans, including monitoring and reporting systems (MADS, 2012a). To develop this, the ECDBC was divided into five components, shown in Figure 14.



Figure 14 – Components of ECDBC

Source: Own elaboration, information from (MADS, 2012a)

As preliminary results of component 1, MADS has presented some projections of GHG emissions using the LEAP model, that show how emissions can increase rapidly in the coming years, under a business-as-usual scenario (see Figure 15); the main objective of ECDBC is to develop strategies that lead the country through a low scenario (A. García, personal communication, August 20,2013).



Figure 15 – Baseline projections of GHG emissions. Red: Historical data, Green: BAU scenario, Blue: high and low tendencies. Source: (MADS, 2012a)

2.3.2.4 National Strategy for Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (ENREDD+)

Colombia has about 60 million ha of forest, (53% of the territory), and a destruction rate of 500 000 ha/yr. The government initiated the actions to reduce emissions from deforestation and forest degradation with the creation of ENREDD+ program (MADS, 2012b), with a time horizon of 4 years. So far, the program has identified the social, economic and environmental issues related to forests and climate change, which are presented in the document *Proposal for Preparation of REDD+* (R-PP). In the next stages of the program, the identified actions will be performed, such as implementation of forest monitoring systems, and integration of indigenous communities in the program (MADS, 2012c).

2.3.3 Baseline scenario

The GHG inventories that have been conducted in the country, and that are presented in the SNCCC (see Figure 16), show that most emitting sectors are energy, agriculture and LULUCF, with emissions of 66, 68 and 26 Mton CO_2 eq for 2004, respectively. On the other hand, although emissions of Industry and Waste are smaller than other sectors, they are increasing their emissions at higher rates than energy and agriculture. Finally, LULUCF emissions have the highest growth rate, 115% between 1990 and 2004.



Figure 16 – GHG emissions inventory [1990-2004] Source: Own elaboration, information from (MAVDT et al., 2010)

Given the above, the basic scenario should seek for stabilization of emissions from Waste and Industry, and for reduction of emissions in other sectors. If we consider the target of *National Plan Development* 2006-2010, 250.000 tons CO_2eq in four years, the final target for 2030 would be a reduction of 1.25 million tons. This value is only the 0.33% of the estimated mitigation potential. For this reason, the present study does not consider such target; instead, the actions presented in Table 5 are based on the potential estimated by MAVDT et al. (2010). Those actions represent an emission reduction of 5.5% per year.

MITIGATION ACTION	REDUCTION POTENTIAL
	[Mill ton CO ₂]
substitution of 50% of coal used in industrial boilers for natural gas	67.78
increase in occupancy of private vehicles, reduction of vehicles in circulation (from 5% in 2010 to 50% by 2030)	62.48
Replacement of 712 MW of non-renewable installed capacity for alternative sources (35% wind, 25% geothermal, 30% small hydro, 5% solar PV, and 5% cogeneration)	45
gas use and improvements in process efficiency of production, transportation and refining of oil	2
10 projects of mass transit systems (2010-2017)	6.4
Conversion of 14500 vehicles per year to natural gas	0.4 per year
Usage of 94 mill m ³ /yr of methane from landfills	5 (for 12 yr)

 Table 5 – Mitigation potential for different actions for a time horizon of 20 years
 Source: Own elaboration, information from (MAVDT et al., 2010)

2.4 Review of strategies and policies for access to modern energy sources

2.4.1 Rural electrification programs

Colombia has 1123 municipalities, 88 of these had no access to electricity in 2010 (ZNI). The National Development Plan 2010-2014 set a goal of supplying 39 municipalities with 24 hours a day of power, corresponding to 44.3% of ZNI. In order to reach this goal, the Colombian government created the Institute of Planning and Promotion of Energy Solutions for non-interconnected areas (IPSE) in 2004, (Decree 257, Diario Oficial, 2004). This public entity, ascribed to the MME, aims to *(i)* structure and evaluate sustainable energy projects to supply non-interconnected areas (ZNI), *(ii)* improve the quality of electricity service in these areas and ensure continuity, and *(iii)* improve the efficiency of processes, minimizing and mitigating environmental and social impacts.

In early 2013, the IPSE reported an advance of 23% of the target, with an additional coverage of 9 municipalities; and it has also approved enough projects to reach 100% of the target for December 1014 (DNP, 2011b). The Colombian government has shown interest in subsidizing sustainable projects in rural areas. Currently, the IPSE has a bank of 213 electrification projects; of which 104 have been approved since 2004. These projects include power generation from small hydro, photovoltaic panels, biomass, wind turbines, and construction and improvement of interconnection lines (IPSE, 2011).

2.4.2 Natural Gas penetration

The natural gas sector in Colombia has grown significantly in the last decade, with an increase in the consumption rate of 10.5% per year. However, there are still some limitations in supply and transport of this fuel (UPME, 2006). In the CONPES document 3244(DNP, 2003), the government defined the strategy for the consolidation of the natural gas sector in Colombia. The document shows the need to ensure the availability of gas in the short and long term. Although gas transport is a key factor for the gas supply, the government has set as a priority the strengthening of exploration and exploitation sectors, through incentives for these activities. Furthermore, Decree 3428 of 2003 established that transporters have to fill the domestic demand as a priority (Diario Oficial, 2003). Additionally, the Law 401, 1997, created the Special Fund Development Fee (Congreso de la República de Colombia, 1997), which is sustained by a charge paid by all users of the national system, equivalent to 1.5% of the transportation fee. This fund co-finances infrastructure projects related to construction of pipelines, and connections for low-income users.

2.4.3 Specific programs for slums and settlements

The *National Integral Neighborhood Improvement* program aims to improve the living conditions of the poor and extreme poverty, by (i) providing resources for infrastructure development in slums, (ii) improving the quality of life of people in precarious situations, and (iii) incorporating the settlements in the physical and social municipalities' structure. Currently, 28

the government has approved six projects that will favor 8.580 people by the end of 2014 (MVCT, 2013a).

2.4.4 Urbanization actions to improve access to assets for poorest

The Colombian government approved the "100.000 free housing" program through the law 1537, 2012 (Congreso de la República de Colombia, 2012). This program has the goal of building a hundred thousand free housing for population in extreme poverty. This project gives priority to families affected by natural disasters, residents in high-risk areas, and families displaced by violence. 104.933 homes were approved between 2011 and 2012, and are currently under construction. Today, over 3,000 of these homes have already been delivered to the recipients, and the project it is expected to end in December 2014 (MVCT, 2013b).

Additionally, the government has a program to subsidize the interest rate, which has the objective to benefit 140,000 families from July 3, 2012, with a reduction of up to 30% credit interest housing mortgage; and subsidies for vulnerable populations to access housing loans. (MVCT, 2013a).

2.4.5 Special Financing Programs for Energy Efficiency Appliances

Energy Efficiency and Unconventional Energy Sources (FNCE) programs have encountered difficulties in accessing to funding resources, as most resources come from the negotiation of Green Certificates, and this model has not been implemented in the country due to its complexity.

Because of this, MADS, et. al (2012) have presented the document "Proposes of financial schemes Applicable to Energy Efficiency and FNCE" that summarizes the most appropriate mechanisms for each technology, such as third-party financing, purchase with deferred payment, direct exploitation by thirds, and shared funding. It also presents the different international funds such as the World Bank, Inter-American Development Bank, GEF, GHG, etc., and some national funds previously described (See section 1.5). Finally, the document presents the National Organization for the Promotion and Development of Energy Efficiency Programs (ONPEE), which provides technical and financial assistance for the proper execution of projects.

2.4.6 Integral programs to reduce and alleviate poverty

Colombia has an Integral Program for Poverty Reduction, *Red Unidos*, which has the participation of 26 governmental institutions and is led by the National Agency for Overcoming Extreme Poverty (ANSPE). This program aims that 350.000 extreme poverty families can access to education, decent housing, food, work, and health, by the end of 2014 (ANSPE, 2013a). To accomplish this, Red Unidos is responsible for locating the poorest families, and assist them for accessing to subsidies and aids from other government programs, such as *"100.000 free housing"*, mentioned above, and *Families in Action subsidies*. Today, about 786.000 families are linked to the program, and 215.000 of these have escaped extreme poverty (ANSPE, 2013b).

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3. Policy Review: Argentina

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3.1 Argentinean Energy Sector Stakeholders and Institutional arrangements

In Argentina, the energy policy is performed in orbit the Secretary of Energy, depending on the Ministry of Federal Planning, Public Investment and Services (MINPLAN). The MINPLAN, created in 2003 (Decree Nº 27/2003) aims at advising the President and the Chief of Ministers about transport, communication, mining, energy, public services, households, sustainable use of hydro resources, and planning of public investment. The aims of the Secretary of Energy are:

- a) To elaborate, propose and execute the energy national policy, in coordination with the provinces. To propose a legal framework and control the development of the institutions.
- b) To analyze the development of the energy markets, developing strategic planning in the fields of electricity, hydrocarbons and other fuels; promoting the competence and energy efficiency in resources allocation.
- c) To collaborate in the elaboration, control and coordination of international or/and interjurisdictional cooperation and integration agreements.
- d) To control the national energy policy on hydrocarbons and fuels, during the exploration, exploitation, transport and distribution.
- e) To control the organisms or institutions on charge of the public services (as a result of both privatization and bestowal) in order to control the fulfillment of the regulatory framework.

The Argentinean Secretary of Energy is comprised by two Under Secretaries: The Undersecretary of Electricity Energy and the Undersecretary of Fuels as shown in figure 1.1.

The Undersecretary of Electricity Energy has two organisms: the National Direction for Promotion (DNPROM) and the National Direction for Prospective. The National Direction for Promotion is in charge of the *Coordination of Energy Efficiency (EE)* and the *Coordination of Renewable Energy (RE)*. The former aims at defining the policies and programs related to the efficient use of energy, supporting the creation of markets for technologies related to energy efficiency, implementing pilot projects and updating databases. The latter's core objective is the formulation of policies to promote renewable energies, in the framework of the national policies announced by the president during the conference of the UNCCC of 13th of December 2004. The main activities of the Coordination of Renewable Energy are: identification of renewable

energies projects, updating information about renewable technologies, coordination of international cooperation activities, and barrier identification for renewable energies.²

The Table of Environmental Issues and Climate Change works in coordination with other organisms in the framework of the Governmental Committee on Climate Change (see section 4.2), and with other groups in the area, for instance the group that is working on the Third National Communication of The Argentina to the United Nations Framework Convention on Climate Change (UNFCCC).



Figure 17: Argentinean energy sector structure

Source: Secretary of Energy web page

In 2004 the Central Government created a National Energy Company "ENARSA" (ENERGIA ARGENTINA SOCIEDAD ANONIMA), depending from the Ministry of Federal Planning, Public Investment and Services ³. This national company works in the energy business: exploration and exploitation of solid, liquid and gas hydrocarbons; transport, distribution, commercialization and industrialization of hydrocarbons and their derivatives; as well as transport and distribution of

² It is important to mention that additionally to the coordination of RE, there is a project for rural electrification with renewable energies (PERMER), financed by the national Government that will be address on section 5.2.3.

³ Law № 25.943 (Decree № 1529/2004)

natural gas; generation, transport, distribution and commercialization of power energy. It also aims at promoting the development of national industry and renewable energies.

It is noteworthy that there exist several isolated private and governmental initiatives directly related to renewable energies and energy efficiency⁴, which clearly shows a lack of coordination in policies and planning. The country also displays an important (and qualified) capacity in R&D oriented to the development of pilot projects on renewable energies and energy efficiency⁵.

Unlike to the case of other renewable energies, biofuels policies are in the orbit of the Undersecretary of Fuels. Additionally, another organisms are involved the planning and regulatory process. For instance, the agricultural Direction of the Secretary of Agriculture, Livestock, Fisheries and Food develops the programs for biofuels (Biodiesel and Bioethanol), and there is a special organism to assist the Ministry of Federal Planning, Public Investment and Services in the biofuels topic: The Interagency National Advisory Committee (Created by Article 3 of Act No. 26.093).

The General Direction for Planning and Coordination of Policies is responsible for advising the Secretary of Energy in the design and management of energy planning of hydrocarbons and energy resources in coordination with the rest of the areas of the secretariat. Within the most relevant activities of this Direction there is the elaboration of demand and supply scenarios as well as the technical coordination in conjunction with the national direction of prospective and the national direction of promotion of an integral national energy planning.

In this regard, it is important to notice that the institution is currently developing a Long Range Strategic Energy Planning which is not of public availability yet. Indeed, most of the policies and plans developed up to the moment (many of which will be mentioned in the next sections) were motivated by the energy supply problem, and the majority of them lack of a long term vision and a deep evaluation of their impacts over other sectors and the socioeconomic context.

3.2 Identifying energy policy objectives and their link to Climate Change

In Argentina the energy sector is an important (and growing) driving force for GHG⁶. In 2010 energy sector explained 50.52% GHG emissions, while in 2005 it represented 49%. Moreover, between 1990 and 2005 Energy net emissions grew 44%, displaying two different trends. In a

⁴ See for instance some of the private initiatives developed by the National Business Council for Sustainable Development: <u>http://www.ceads.org.ar/home.htm</u>

⁵ Some of these groups are: INENCO (UN Salta) solar thermal applications and solar thermal power generation, Laboratory of Catalytic Processes (FI UBA) hydrogen from ethanol, Laboratory of Human Environment and Housing and Energy (INCIHUSA), Research Centre Habitat and Energy (FADU UBA), Bioclimatic and solar architecture, and Policy Research Institute Built Environment (IIPAC) - Before IDEHAB Faculty of Architecture of the UNLP, Laboratory of Architecture and Sustainable Habitat -(LAyHS) - Before IDEHAB Faculty of Architecture of the UNLP, Research Group of Solar Radiation (GERSolar), Physics Division, Department of Basic Sciences, National University of Luján (UNLuján).

⁶ This is directly related to the increase of fossil fuels consumption as a result of recent policies that will be mention in section 2.4.

first one, in the 1990-1999 period the rate of growth of GHG was lower than the rate of growth of energy consumption, mainly due to the penetration of natural gas in power generation through combined cycles, reduction in natural gas vented, the incorporation of hydro power plants and a general modernization of the thermal generation park. Conversely, in the second period (2003-2005) energy emissions grew at a higher rate than energy consumption mostly due to increases in the use of fuel oil in electricity plants resulting from reductions in the availability in natural gas. (Fundación Bariloche and CEMSA, 2008)



Figure 2.1: Historical evolution of sectorial GHG.1990-2010 (Gg. CO₂ eq.) Source: Fundación Bariloche - CEMSA (2010)

One of the two main characteristics of the Argentinean energy sector are its high dependence on hydrocarbons which represent 85% out of TPES⁷ (Natural Gas 50%, Oil: 35%, Hydro: 5%; Nuclear: 3%; Charcoal: 1%; rest of renewables 5%); and the recent declination on natural gas and oil availability during the last decade. Also a 59% of the electricity generation capacity in 2011 was thermal. The impact of these characteristics on both energy security and Climate Change is straightforward: the lower the supply of natural gas (the most important Argentinean primary energy resource), the higher the demand for oil derivatives, and then the higher energy GHG emissions and energy imports.

In this framework, some of the most important Argentinean energy policies should be related to achieving Energy self-sufficiency energy and changing the energy matrix structure (particularly in the electricity mix), and they should be framed in a long term vision of the energy sector and its role in socio economic development and it relevance for Climate Change, previously mentioned. This would be particularly important considering the transversal characteristic of Climate Change.

⁷ TPES: Total Primary Energy Supply
Indeed, according to information gathered on interviews with key actors from the Secretary of Energy the energy policies and plans are framed in a group of principles, directly related to Climate Change and Sustainable development. In particular:

- Universalization of modern energy with equity and social inclusion.
- Promotion of Socioeconomic Sustainable Development
- Preservation of the environment
- Promotion of the efficient use of energy

Nevertheless, and despite the existence of different energy policies, still remains the formulation of a strategic national energy plan⁸, including the economic prospective of the country, its energy requirements and an evaluation of the best supply alternatives. This plan should also come from the coordination of all the policies and institutions (mentioned above) which should work under a consolidated vision of the country.

As follows, this document points out the most important policies and programs implemented (or to be implemented) by the national energy authority in the last years directly related to the leading identified objectives of the sector: *Energy Self-sufficiency, changes in the energy matrix structure, energy efficiency,* and *stimulation of economic development*. Their link with climate change will be mentioned whenever it is relevant.

3.2.1 Energy Self-sufficiency

Along the last decades Argentina has gone throughout a supply problem directly related to the reduction in the availability of natural gas and crude oil, which are crucial in the Argentinean energy matrix, with the consequent increase in energy imports and impact over the balance of payment.

Therefore, with the aim of increasing the reserves and production of hydrocarbons, the local government sanctioned in 2012 the Law 26.741⁹ on the sovereignty of the hydrocarbons resources. The relevance of this regulation for the Argentinean energy sector is twofold. On the one hand, the regulation states clearly "of public and national interest the hydrocarbons self-sufficiency, as well as its exploration, exploitation and transport". On the other hand, the 7th article of the law states the re-nationalization of the previously privatized national oil company Yacimientos Petroliferos Fiscales (YPF S.A.), which in 2011 had 34% of the national oil production

⁸ As it was mentioned, even though the Secretary of Energy is currently working on the formulation of an energy plan it is not public available yet.

⁹ Published in the Official Bulletin 07/05/2012.

and 30% of natural gas production¹⁰. It also establishes the National Government as a driver of the process.

Among the main objectives targeted in the law, are: the promotion of employment; the incorporation of reserves (in order to maintain the ratio Reserves / Production); the promotion of public-private partnerships for exploration and production; the promotion of industrialization and marketing of high value-added Hydrocarbons; and particularly the protection of consumer interests.

3.2.2 Change the energy matrix structure

3.2.2.1 Promoting renewable sources in the electric sector

Despite its high endowment of renewable energy resources¹¹ the share of renewable energy in the electricity mix is small, except for the case of big hydroelectric power plants that in 2012 represented 29% of the electricity generated. The share of wind and PV in total energy is very insignificant (0.2% in 2012).

The promotion of new renewable sources in power generation may be one of the most clear energy policy objectives related to Climate Change as can be inferred from regulations and programs. The first specific regulation was the Law for Wind and Solar Energy N° 25,019 in 1998, which was modified in 2007 by the Law N° 26,190 National Regimen for the Promotion of Renewable Sources for the Production of Electricity that sets a mandatory target of 8% of total electricity generated coming from renewable energies in ten years and establishes some economic instruments and price incentive to reach this objective.

Nevertheless, economic incentives provided by this regulation did not work well enough and in 2010 the Secretary of Energy launched a new program which aimed at fostering electricity generation from renewable sources the "Renewable Energy Generation Program (GENREN)". This has been the most important policy for promoting renewable energies. The program is based on a specific auction implemented by ENARSA for 1,000 MW from wind, biomass geothermal and small hydro plants (Recalde and Guzowski, 2012).

¹⁰ Dirección de Información y Análisis Regional – Dirección de Información y Análisis Sectorial. 2011. Complejo Petróleo y Gas. Serie "Producción Regional por Complejos Productivos"

¹¹ A complete revision on current availability and barriers for Renewable Energies in Argentina was performed in 2009 by Reeep, the Secretary of Energy and Fundación Bariloche, and its available at: http://www.energia.gov.ar/contenidos/verpagina.php?idpagina=3477

Additionally, there are different regulations to encourage electricity investments enacted in a context of shortness of energy supply in the electricity sector¹² that have also shaped a special framework for renewable investments.

The Resolution 220/2007, allows to sign up supply contracts between the Electricity Wholesale Electricity Market (MEM) and both auto and co generators. The Resolution 280/2008 allows municipalities and provincial suppliers to make available to the Dispatch organism hydro energy and wind energy up to 2000 kW. The Resolution 712/2009 allows supply contracts from renewable energies. Finally, the Resolution 108/2011 enables to sign up supply contracts from renewable energies for 15 year between the Wholesale Market and the supplier, with the characteristic that this resolution allows this kind of contract for both the projects that can support the power and those that, attending to the renewable characteristics, cannot do so.

Finally, in the framework of an agreement with the Renewable Energy and Energy Efficiency Partnership (REEEP), the national Direction for Promotion of the Sub-Secretary of Electricity Energy in conjunction with Fundación Bariloche, developed a Study on the Prospective and technological, economical, financial and regulatory barriers of the Energy Resources¹³. Within the most interesting results of this study is that one of the most relevant barriers for renewable energies is the lack of integral vision of the sector (Fundación Bariloche, 2009).

3.2.2.2 Promoting the use of biofuels

The promotion of biofuels begun with the purpose of changing the energy matrix and induce substitutions in the transport sector. In the case of biodiesel, the promotion is related to the importance of diesel in the energy consumption of transport, which is the main fuel used in the transport and agricultural sectors (40% and 96%, respectively, of fuel consumption in 2009).

Argentina initially began to promote biodiesel in 2001, with the Decree 1396/2001, which states a plan for improving the competitiveness of these fuels. Nevertheless, the promotion of biofuels increased since 2004, when the Secretary of Agriculture, Livestock and Fisheries launched the National Biofuels Program (Decision No. 1156/2004). One of its main objectives was to backstop rural sectors and provide them advisory assistance in setting up biodiesel and bioethanol plants as an alternative to local soybean and soybean oil production (Flexor et al., 2012).

Since 2006 the new regulation framework for biofuels is the Law 26,093, "Regulation and Promotion of the Sustainable Production and Use of Biofuels", which established a mandatory target of 5% of biodiesel in gas oil and bioethanol in gasoline by 2010 (this percentage has been

¹² From 2004 on the Argentinean energy sector has come throughout a supply problem, particularly related to the availability of natural gas.

¹³ Available at: <u>http://www.energia.gov.ar/contenidos/verpagina.php?idpagina=3374</u>

later increased to 7% and 10%). This regulation combines the use of quota (target) and price incentives.

3.2.3 Energy Efficiency

Although energy efficiency has been promoted by different programs, it has no shown a clear continuity. Among the most relevant programs implemented there are different programs on rational and efficient use of energy, the program on energy save in public buildings, and the energy labeling.

Even though energy intensity reduced 26% during the 2004-2010 period (energy intensity in the industrial sector reduced 16%), the lack of specific indicators, difficult the evaluation of the results of these measures. In some extent this may be due to the fact that most of these programs have the characteristic of a stop and go process and the lack of continuity reduces the effectiveness of the programs.

It is important to highlight that price policies of the last decade, when energy tariff have not reflected the real supply cost, have had a negative effect and have counterbalanced efficiency measures. Regarding the relevance of this topic, it will be addressed on the next section.

3.2.4 Stimulation of Economic development (contrary results)

After the 2001/2002 crisis the Argentinean economy suffered a strong devaluation that derived on increasing government intervention on markets through electricity and gas tariff regulations, subsidies for energy companies, and frozen upstream prices (Haselip and Potter, 2010). The legally established revisions for public services prices (particularly electricity and natural gas) were postponed, deriving in an increasing distortion between energy prices and energy costs. The use of subsidies policy along the past 10 years has become one of the most relevant energy policies of the country with negative impacts over the efficient use of energy.

The disequilibrium between costs and revenues in the electricity sector does not guarantee the long term sustainability, even though the tariffs and prices of the contracts for the consumers of electricity and the national government (subsidies¹⁴) cover the operational costs. On the one side, as a result of the underbalance between tariffs and costs the majority of utilities and power generators regarded highly indebted, which induced them to underinvest in the system. On the other side, the existence of a decreasing steps tariff scheme stimulated electricity consumption. Electricity and natural gas demand increased in some periods (2003-2007) more than 6% annual (in households sector the rate of growth was 8.1%). The growths in supply requirements were mainly addressed by increasing power thermal generation capacity.

¹⁴ The subsidies from the National State include: imports from Brazil, payments to CAMMESA by supply contracts, governmental contributions for indebtedness with generators, payments for the expansion of power capacity, nuclear purchases and its expansion, payments to small thermal generators connected to the Transport and distribution networks in the framework of the Program of Distributed Energy, and Fuel Imports.

Therefore, the relevance of fossil fuels in the primary energy mix and the electricity mix augmented, from 52% in 2003 to 66% in 2012.

The same situation applies to the oil sector, deepening the declination of oil hydrocarbons reserves, the reduction in oil production and productivity per well, at the time that the percentage of heavy oils in national production increased and also increased the proportion of low pressure wells of natural gas (Montamat, 2013).

As a result of this situation energy imports increased, particularly natural gas, liquefied natural gas (LNG), and oil derivatives (Fuel oil and Gas oil), which in 2013 could represent 10% of energy consumption (and nearly U\$S 12,000 millions) with the consequent negative impact on the balance of payments. The higher the prices of imports of energy, the higher the subsidy requirements and the bigger negative impact over the national budget balance. Even though a recomposition in energy prices is extremely necessary (social tariff included), it seems to be very complicated, particularly in a context of wage inflation.

In order to reduce the negative impacts of this situation, the Secretary of Energy and the Ministry of Federal Planning, Public Investment and Services, developed different measures: energy shutdowns for industries, with a counterbalancing impact of the objective of economic development; natural gas and oil (and electricity) incremental prices for industries; electricity and natural gas rational use programmes (PUREE and PURE); re-nationalization of the 51% of the company YPF and intervention of the company's administration; and the signing of a partnership agreement with Chevron in order to invest and produce shale oil and shale gas in the Vaca Muerta field¹⁵.

3.3 Review of national plans or actions and measures

3.3.1 Change the energy matrix structure

3.3.1.1 Renewable portfolio, price and fiscal incentives in renewable electricity generation.

The national regulation for promoting RE dates from 1998 and combines price-based instruments, quota-based instruments and fiscal incentives. Several specific measures were implemented to promote the use of these sources, for instance the Law for promoting the use of Hydrogen, Law N^o 26123, which states *that the development of the hydrogen technology, as well as the production, use and applications of hydrogen as fuel and energy vector, are of national interest*; and creates the National Fund for Hydrogen Fostering (FONHIDRO).

The Law Nº 26,190 National Regimen for the Promotion of Renewable Sources for Power Generation establishes a set of policy instruments in order to incentive private investors to

¹⁵ For more information see: Di Sbroiavacca (2013)

reach quota of 8%. The regimen sets a fixed over-price production payment of U\$S 0.003 by kWh for every RETs, except for solar PV whose fee is U\$S 0.18 by kWh. Then the renewable producers receive the wholesale market price (according to the short-term marginal cost), plus a fixed fee for the renewable energy generated. Additionally some provinces enacted provincial laws with additional tariff payments, tax exemptions and subsidies to complement the national regulation¹⁶.

However, the use of the over price scheme in conjunction with the low frozen energy prices has not been enough to incentive private investment, as usually investors claim for a more certain context for their investments, which is clear from the evaluations of the renewable energy investments after the establishment of the law.

3.3.1.2 Renewable energy tenders

In 2010 the Ministry of Federal Planning, Public Investment and Services launched the first edition of the Renewable Energy Generation Program (GENREN) (Tender N°EE01/2009), initially for 1,000 MW of electricity produced by renewable technologies (wind power: 500 MW; biofuels. 150 MW; solid waste: 120 MW; biomass: 200MW; small hydro: 60 MW; geothermal: 30 Mw; PV: 20 MW; biogas: 20MW). The project consisted on bidding at auctions implemented by the state-owned company ENARSA (Energía Argentina S.A.), which signs Power Purchase Agreements for a fifteen-year period, at a fixed purchase price calculated on a project-to-project basis, to guarantee a fair return on investment. Therefore, the projects are benefitted by a feed-in-tariff scheme, or a fixed price scheme. The evaluation of the proposals based on technical, institutional and environmental characteristics, considering specially the share of national investment out of total, the prices and the installation timetable.

The total capacity contracted for the GENREN was around 895 MW¹⁷ for wind power, PV, small hydro and biofuels (Table 3.1). In order to complement the areas that were not awarded, a second tender was implemented in 2010 for the cases of geothermal (25MW), thermal solar (25MW), biogas (20MW) and solid waste (120MW), but only 15 MW of biogas were assigned. By the end of 2010 the authorities launched the GENREN II for 1200 MW (PV; solid waste; geothermal; biogas) and which received offers from 26 different projects with a total of 1208 MW which were supposed to be awarded by middle 2012. Nevertheless, According to Mattio (2011) the GENREN II contracts cannot be conferred until the original schedule of the GENREN is successfully fulfilled.

¹⁶ For instance: Cordoba (Law 8810/1999); Buenos Aires (Law 12603 in 2001), Chubut (Law 4389/89 and Decree 235/98), La Pampa (Law 2380/2007), Mendoza (Law 7822/2007), Misiones (Law 4439/2008), Rio Negro (Law 3930/2004), Santa Cruz (Law 2796/2005), Santa Fe (Law 12503/2005) (reeep/SE/FB, 2009)

¹⁷ According to recent information from the Secretary of Energy in August 2013 this value is 910 MW.

The final prices of these GENREN projects have been reduced by 20% with respect to the original values presented by the bidders. Therefore, the final prices by MWh of energy delivered at the connection point (which will remain fixed during the 15 years contract except for thermal biofuels plants) are: Wind Power: 121-134 U\$S/MWh, Biofuels: 258-297 U\$S/MWh, Small Hydro: 150-180 U\$S/MWh; and PV: 547-598 U\$S/MWh. These final prices seem to be significantly higher than in other countries of the region, particularly for the case of wind energy that in Brazil and Uruguay resulted in 80USD/MWh and 60USD/MWh, respectively.

Source Nº Projects		Capacity Contracted (MW)	(% MW)	
Wind Power	17	754	84.25%	
Small Hydro	5	10.6	1.19%	
PV	6	20	2.23%	
Biofuels	4	110.4	12.33%	
Total	32	895	100	

 Table 3.1: Projected Capacity Contracted by GENREN (1st Stage)

By mid-2013 only six of the 32 total projects approved are in operation: two for wind power (Rawson I and Rawson II), two for PV (Cañada Honda I and II) and two for biomass plants (San Martin Norte). The main barriers confronted for these projects, particularly in the case of wind farms, are related to financing due to institutional problems (Perez Wirszke and Zazzini, 2013).

Then even though the projected installed capacity for renewable energies is promising, the current installed capacity of energy does not represent more than 1.5% of total installed capacity, which means that in order to achieve the target of Law 26,190, the investments should increase more than four times along the next three years.

Additionally, in order to increase total electricity capacity the Compañía Administradora del Mercado Mayorista Eléctrico (CAMMESA) signed several contracts with private generators. For instance, the National and International Tender 01/2010 for biogas in 2010 enables the installation of two power plants, the Central San Martín Norte III-A (5 MW) and the Central San Miguel Norte III-C (10MW) which stated on May and October 2012 respectively; the National and International Tender ENARSA N° EE 02/2010 for the "Provision on Electricity from Solid Waste"; the National and International Tender ENARSA N° EE 02/2010 for the "Provision on Electricity from Solid Waste"; the National and International Tender Concourse on Prices ENARSA N° 01/2010 for the "Provision of Electricity from Wind energy"; "; the Private Concourse on Prices ENARSA N° 03/2011 for the "Provision of Electricity from Biomass" (Biomass II); the National Public Tender ENARSA N° EE 04/2011 "Environmental center for energy reconstruction (CARE)- First Stage"; 43

National Public Tender ENARSA N^o EE 06/2011 "Amplification and Increase of the transport capacity of the Transfor Station Puerto Madryn"; National and International Public Tender ENARSA N^o EE 11/2011 "Electricity Generation from Solid Waste from the Matanza-Riachuelo basin" (50MW); National and International Public Tender ENARSA N^o EE 01/2012 "Electricity Generation from Solid Waste from the Matanza-Riachuelo basin" (100MW).¹⁸

3.3.1.3 Mandatory target in fuels

As it has been previously mentioned, the Law 26,093 (Decree 109/2007) states the legal framework for biofuels. The most important instrument provided by this law is the establishment of a minimum mandatory mix in fuels of 5% (for both petrofuel and diesel) by 2010, which was increased to 7% (Decree 554/2010), and to 8% in August 2013 (Res. 449/2013 and Res. 450/2013) for the case of biodiesel.

Within the most important economic and financial incentives of this regulation there is the advance refunds of value added tax (VAT) and the accelerated depreciation of assets and infrastructure for income tax purposes (see table 3.2). One important aspect to be mentioned of this regulation is the fact that none of the incentives provided to biofuel production can be applied to biofuels exports, as the law is oriented to domestic market. Furthermore, as mentioned by Flexor et al (2012) the article 13 of the regulation delineates the eligibility requirements for the promotional benefits, which can be met by industrial ventures located in the country that produce biofuels for the domestic market as their sole business activity —i.e., firms in which the State has a majority interest or agricultural producers (which have to prove that at least 50% of their assets are located in Argentina). Additionally to the law, there are quality standards for biofuels, and then companies must have the necessary equipment in their plants to compliance with those quality standards.

¹⁸ Information available at the web page of ENARSA: <u>http://www.enarsa.com.ar/index.php/es/resultados</u>

	Т	Type of tool			
Quantitative requirements			Financial incentives		
Quotas	VAT	Profits tax	Liquid fuels tax	Infrastructure tax	Tax on transfers or imports of petrodiesel
5%	Rebate of the percentage corresponding to capital goods and/or infrastructure works	Accelerated amortization	Exemption for the percentage of biofuel in the mix	Exemption for the percentage of biofuel in the mix	Exemption for the percentage of biofuel in the mix
7%					
	Qualita	tive requiremen	ts		
Quality specifications for biofuels to be blended with X percentage of petrodiesel.					
Public tender to power market. Guaranteed 15-	o cover 150 MW of biofuel- year purchase contracts at	-fired thermal ge pre-set price.	eneration for energy fo	or sale on the wholes:	ale electrical
	Quantitative requirements Quotas 5% 7% Quality specific Public tender to power market. Guaranteed 15-	Quantitative requirements T Quotas VAT \$\frac{2}{3}\text{iso} Rebate of the percentage corresponding to capital goods and/or infrastructure works \$\frac{7\circ}{3}\text{iso} Qualita \$\frac{2}{3}\text{iso} Qualita Quality specifications for biofuels to be block Qualita Public tender to cover 150 MW of biofuel power market. Guaranteed 15-year purchase contracts at	Quantitative requirements Type of tool Quotas VAT Profits tax 5% Rebate of the percentage corresponding to capital goods and/or infrastructure works Accelerated amortization 7% Qualitative requirement Qualitative requirement Qualitative requirement Quality specifications for biofuels to be blended with X perpower market. Guaranteed 15-year purchase contracts at pre-set price.	Type of tool Quantitative requirements Financial incentives Quotas VAT Profits tax Liquid fuels tax 5% Rebate of the percentage corresponding to capital goods and/or infrastructure works Accelerated amortization capital goods and/or Exemption for the percentage of biofuel in the mix 7% Qualitative requirements Exemption for the percentage of petrodiess 9% Public tender to cover 150 MW of biofuel-fired thermal generation for energy for power market. Guaranteed 15-year purchase contracts at pre-set price.	Quantitative requirements Type of tool Quantitative requirements Financial incentives Quotas VAT Profits tax Liquid fuels tax Infrastructure tax 5% Rebate of the percentage corresponding to capital goods and/or infrastructure works Accelerated amortization Exemption for the percentage of biofuel in the mix Exemption for the percentage of biofuel in the mix 7% Qualitative requirements Exemption for the percentage of biofuel in the mix Exemption for the percentage of biofuel in the mix Quality specifications for biofuels to be blended with X percentage of petrodiesel. Public tender to cover 150 MW of biofuel-fired thermal generation for energy for sale on the wholesa power market. Quanteed 15-year purchase contracts at pre-set price. Set price. Set price.

Figure 3.2: Biofuels promotional pricing tools

Source: Flexor et al (2012)

n response to the national and provincial policies and the international demand (such as from the EU) the Argentine production of biodiesel increased since 2006. Biodiesel exports in 2010 reached 1.4 million tonnes, positioning Argentina as the fourth largest producer in the world, yielding incomes totaling more than 1,000 million US dollars. The Government levies taxes of 32% on soybean exports but only 20% on biofuel sales, with the consequent positive effect on the production of biofuels (Nadal et al, 2013). As shown in Figure 3.3, in year 2011 values for installed capacity, production and export are 2.9 million tonnes, 2.4 million tonnes, and 1.7 million tonnes respectively.



Source: Nadal et al. (2013)

With regards to bioethanol, in 2011 Argentina produced 1.5% of the mix for the transport sector, approximately 170 thousands m³, with a supposed 5% for 2020 and a production about 544 thousands m³. In this case, the main input is sugarcane, Corn, Sorghum, and Sugar beet under study.

The possible impact of the increasing biofuels production over the requirements of raw materials is of special interest. Most of the Argentinean biodiesel comes from soybean. Nevertheless, in order to reduce the potential impact over the expansion of the agricultural frontier, the exploration of alternative raw material becomes crucial. Some of these alternatives are under study (such as rapeseed, safflower, spurge, and algae). However, this evaluation requires performing different scenarios about the raw materials to be used and their productivity on the production of biofuels per unit of area. The analysis must include (besides the domestic demand of biodiesel for transport, industry and power generation) the perspectives for biodiesel exports.

Concerning the future of biofuels three crucial aspects must be taken into account: the commercial development of second generation biofuels; the sustainability of prices of grains, oil and sugar; and the requirements (and restrictions) imposed by importing countries. For instance, in May 29 2013 by regalement 490/2013, the UE established an additional "preventive" tax of 100 euros per ton of biodiesel (nearly 10% of the total value). As stated by the EU authorities, this tax was implemented with researching purposes, in the framework of a supposed dumping from Argentina and the existence of a direct or indirect State subsidy¹⁹. Due to the fact that UE is the most important destiny for the biofuel exports (90%), the persistence of this duty may imply a reduction of 50% of exports (nearly 800 million of U\$S) with the consequent impact over the balance of payments.

Finally, the challenges for the Argentinean biofuels markets seem to be: infrastructure of supply, production, technologies, and costs (highly dependent on the agricultural sector). Freights have been very significant on costs, and therefore, most of the capacity installed has been installed next to ports.

¹⁹ The average cost of production of the Argentinean biodiesel is 0.50-0.7 US dollars per litter, while the cost of production I Germany or France is 0.71-0.88 US dollars per litter and the Spanish cost is 1.28-2.50 US dollars per litter (Perez de Lema, 2013)

3.3.1.4 PROBIOMASA

In 2012 the Secretary of Energy launched the PROBIOMASA framework programme²⁰ with the objective to increase the production of energy from biomass in order to replace fossil fuels in electricity generation, and therefore reducing nearly 9.5 million of tons of CO₂ equivalent in both the agro and the energy sector. It will also contribute to supply modern energy to at least 30 communities. This programme works on three main directions:

- Line up national and provincial bioenergetics strategies.
- Establish different bioenergetics sustainable projects
- To inform and aware population on the benefits of the use of biomass

In the framework of the PROBIOMASA programme, a group of experts from the Ministry of Agriculture, Livestock and Fisheries and Ministry of Federal Planning, Public Investment and Services through the Secretary of Agriculture, Livestock and Fisheries and the Secretary of Energy, with the technical support of the United Nations Organization for Food and Agriculture (FAO), are currently developing a project to be presented as a Nationally Appropriate Mitigation Action (NAMA). The aim of this NAMA is boost production, management and sustainable use of biomass for energy purposes with the aim to generate a total of 200 electric MW and 200 thermal MW by 2016. Additionally, this NAMA is expected to generate other benefits such as: annual savings by replacing imported fossil fuels; creation of a significant number of new jobs; generation of new capabilities focused on renewable energy management; Energy security improvement in isolated areas (30 communities in total); and reduction of local pollution of soil and water as well as fire reduction. One important aspect to be remarked is that within the prospective of the working group on the global PROBIOMASA framework there are projection to increase the installed capacity to 2650 MW (50% thermal and 50% electric) by 2030 as a result of the multiplicative effect of the initial investments and projects.

3.3.1.5 Other decisions for installing capacity

In the last 6 years, the installed power capacity has increased in more than 6000 MW, primarily Combined Cycles (CC) (38%), turbogas (33%) and diesel equipment (16%). Therefore, for the period 2006-2012 the share of fossil fuels technologies in total power generation capacity increased from 62% to 69%. Within the most important projects included in this period there are: the CC Gral. San Martín and Gral. Belgrano (800 MW financed with the FONIVEMEM), hydroplant Caracoles (120 MW) and the elevation of the cota of Yacyretá.

In august 2006 the government launched the "Plan for the reactivation of Nuclear activity in Argentina", including: the finalization of Atucha II (745 MW), extension of the life of the nuclear power plant Central Nuclear Embalse (CNE), and the feasibility studies for a fourth and fifth power plants in 2010 and 2025.

²⁰ For more information please visit: <u>http://www.probiomasa.gob.ar/</u>

In 2009, the Resolution 762 of the Secretariat launched the National Plan on Hydroelectric Projects, with the purpose of encouraging hydro plants. In the framework of this plan there have been studies and projects for more than 10.000 MW.

According to the Secretary of Energy the power capacity is projected to increase in 8,400MW to 2020: 2700 MW of nuclear capacity and 4700 MW of hydropower. This includes the reactivation of two hydro projects in the province of Santa Cruz for 1740 MW: the hydropower Nestor Kirchner (ex- Condor Cliff) and the hydropower Jorge Cepernic (ex- la Barrascosa).

3.3.2 Energy Efficiency

3.3.2.1 National Program on Rational and Efficient Use of Energy (PRONUREE)

This program was initiated in 2007 with the objective of promoting the rational and efficient use of energy, particularly considering that the majority of this energy comes from nonrenewable energies. The Decree 140/2007 includes different short/medium and long term policies such as: Information and educative plans, replacement of the incandescent lamps by low consumption lamps, energy efficient labeling, rational and efficient use of energy in Public Administration Buildings, and energy efficiency in Industries.

The Annex I of the decree, clearly states the different policies to be implemented in each one of the sectors: industries, households, public buildings, cogeneration, energy labeling, regulation of energy efficiency through energy tariffs, transport, etc. It also mentions the relevance of the use of the Clean Development Mechanisms to finance the energy efficiency projects, and encourages public institutions to capacitate and advertise about its use.



Figure 3.4: Sector set-up

Source: Secretary of Energy

Replacement of incandescent lamps

Within the project of replacing lamps at household's level, the Secretary of Energy established a schedule with the replacement and saving targets. Additionally, in order to reinforce this policy, in 2009 the Law 26.473 (Decree 2060/2010) prohibited imports and commerce of incandescent lamps for households users form January 2011. The potential results on energy savings are shown in Figure 3.5.



Figure 3.5: Comparative projected trends of electricity consumption in households between trend and policy scenarios (GWh).

Source: Secretary of Energy

PRONUREE for Public Lighting

The PRONUREE for Public Lighting (Resolution № 7/08) promotes the efficient use of energy by replacing incandescent and mercury lamps by sodium lamps in public lighting and traffic lights at provincial and municipal scale, and also includes the installation of new lighting and power attenuators. The aim of the program is to replace 1 million of lamps with the consequent energy savings of 30%. By August 2012 there were 241 projects approved and the program has been signed by 38 municipalities of the Great Buenos Aires and 10 from the interior of the country.

Program on the Rational and Efficient Use of Energy in Public Buildings (PROUREE)

This program was initially known as Program for saving and Energy Efficiency in Public Buildings (PAyEEEP), and was created by the National Promotion Direction of the Secretary of Energy (DNPRM) aims at develop: methodologies for the study of energy efficiency, specific regulations and specific technologies for each region of the country considering their particular climatic characteristics, for the public buildings.

The Annex II of the Decree 140/2007 states a group of short, medium and long term measures to be implemented by public building such as the regulating the temperature of refrigeration appliances no lower than 24°C, replacing incandescent lamps with CFLs, turning of lighting at 00 AM, ending all administrative activities at 18 PM, among others.

Energy Labeling – Program on energy appliances quality (PROCAE)

This program was initiated in 2004 with the aim of reducing the electricity consumption throughout the use of more efficient appliances. The program, propelled by the DNPROM of the Secretary of Energy, consists on a mandatory Energy Efficiency Labeling for electrical appliances complying quality conditions established by the Energy Efficiency Sub-Committee of the Argentinean Normalization Institute (IRAM).

The legal framework settled to support this program is given by three different norms: Disposition 761/2010 (Labeling for washing machines); resolutions 1542/2010 and 198/2011 from the Secretary of Energy established the minimum of energy efficiency in Air Conditioners and households freezers.

According to the last information from the Secretary of Energy, in 2012 thirteen labeling rules were emitted, but only five of them are mandatory (Domestic refrigeration appliances, Incandescent lamps for general lighting, fluorescent lamps for general lighting, Air Conditioners, and Washing machines), while two labeling rules for natural gas appliances are currently under study (Gas appliances instantaneous production of hot water for home use, and Energy efficiency labeling in appliances to gas)²¹.



Figure 3.6: Total energy estimated savings from Energy Labeling and Replacement and prohibition of incandescent lamps

Source: Secretary of Energy

New Plan of Energy Efficiency in Industries

This program is been implemented in the frame of the PRONUREE with the objective of reducing energy intensity in small and medium industries. In its first "Pilot" stage the project included 25 industries from different sectors: plastic, metallurgical, fridges, textile, brick maker and ceramic,

²¹ The other emitted labeling rules for electricity appliances are: Energy label for buildings heating, Fluorescent lamps, and Measuring energy consumption in standby mode (stand by), Energy efficiency labeling for centrifugal pumps, Energy efficiency labeling for electrical water heaters, and Energy efficiency labeling in television receivers on mode.

biological laboratories; from four provinces (Buenos Aires, Catamarca, Entre Rios and Santa Fe) and the Autonomous City of Buenos Aires. In the second stage it is projected to extend it to 300 industries (incorporating 60 in 2013; 75 in 2014; 90 in 2015 and 90 in 2016).

The strategy includes the investment in new and more efficient technologies, replacing, for instance, thermal heating plants by solar thermal. The initiative is implemented by funds from the World Bank.

According to information from the Secretary of Energy, the results have been successful, as the planned 4% of increase in energy efficiency for 2016 has reached in 2012, and it is projected to increase to 10% in 2030 (in relation to energy consumption in 2007).

3.3.2.2 Program in Energy Efficiency in the Republica Argentina – GEF

Currently the Secretary of Energy is developing this program which is financed by the Global Environmental Facility (GEF) with the main objective of increasing energy efficiency to reduce energy costs, increase sustainability in the long term, and specially to reduce GHG emissions. The main contribution of this program is financing resources for other efficiency programs, for example the industrial efficiency plan (3.2.4).

The project begun in 2008 and has three different components:

- Development of the Argentinean Fund for Energy Efficiency (FAEE)
- Development of Energy Efficiency program in electricity utilities
- Development of management capacities. This stage includes the elaboration of different fiscal and financing plans and policies to support EE activities; the strengthening of the labeling program; and capacitating and informative activities.

3.3.2.3 PURE and PUREE

In 2004 the government launched a Programme on Rational Use of Electricity Energy (PUREE) (Res. 931/2005) to encourage users to reduce their electricity consumption. However, the results of this program may have been eroded by the situation of the prices mentioned in section 2.4.Frozen tariffs and the devaluated prices of electrical appliances, may have led to increasing electricity consumption, contrary to the main objectives of the PUREE. The lack of an appropriate publicity of the program can be one of the main reasons for this failure. Still, as already mentioned, the main problem seem to have been energy prices, which have remain practically frozen during the period, not accurately reflecting the real cost of energy. Similar observations can me made about the PURE (Res. SE. 415/2004), a program developed to induce the rational and efficient use of natural gas that, according to the General National Audit (AGN) also led to very poor results²².

²² For more details of the AGN report see: <u>http://www.agn.gov.ar/informes/fichas/f 94 11 02 08.pdf</u>

3.4 Review of the national strategy on climate change

3.4.1 Argentinean institutional arrangements and actors around Climate Change

In 2002, the decree N^o 2213/2002 established that the Secretary of Environment and Development (SAyDS) is the authority for the application of the Law N^o 24,295, Law of ratification of the United Nations Framework Convention on Climate Change. In 2003 the resolution N 56/2003 created the Climate Change Unit, in order to implement the Climate Change policies of the SAyDS, which in 2007 was absorbed by the Climate Change Direction (Resolution 58/2007). The main objectives of the Climate Change Direction are:

- To prepare and propose policy guidelines on climate change, identification of priority sectoral areas for mitigation actions, identification of national goals for reducing emissions, and the definition of strategies and guidelines for mitigation actions by sector to be approved by the National Direction of Sustainable Development Management.
- To coordinate the preparation of National Communications.
- To technically and administratively assist the Argentinean Clean Development Mechanism Office (CDM).

The Argentinean CDM office develops in the context of Climate Change Direction. This office evaluates the contribution to Sustainable Development of the CDM projects to be implemented (see 5.1.4). It is formed by an Executive Committee, a permanent Secretary and an Adviser Committee. The Executive Committee is chaired by the Secretary of Environment and Sustainable Development and integrated by other governmental institutions related to CDM projects.

The Argentinean Carbon Fund, was created by the Decree N 1070/2005 in the SAyDS with the aim of promote, facilitate and incentivize CDM projects, and to promote investment in new technologies, with the purpose of maximizing Argentinean projects in international carbon markets and to promote financial instruments to finance CDM projects.



Figure 4.1: Institutional organization of the Argentinean Climate Change Institutions Source: Secretary of Environment and Development

3.4.2 National Climate Change Strategy

In December 2009 the National Government created the Governmental Committee on Climate Change. One of the main purposes of this committee is to promote the National Climate Change Strategy and Action Plan. This committee is comprised of representatives of different governmental institutions such as:

- Secretary of Environment and Development
- Secretary of Industry and Commerce
- Ministry of Science, Technology and Productive Innovation
- National Commission on Special Issues
- Environmental Federal Committee
- Ministry of Foreign Affairs, International Trade and Worship
- National Institute of Water
- National institute of agricultural technology
- Secretary of Transport
- Ministry of Labor
- Undersecretary of Territorial Planning and Public Investment
- National program on Risk Reduction and Territorial Development
- Secretary of Economic Policy
- National Institute of Industrial Technology
- Secretary of Energy
- National Meteorological Service

The "*National Strategy on Climate Change: Structure, Background, Overall Goals and Means*" was adopted by the members of the Committee in October 2010 and ratified by the hierarchical authority, on 28th November 2010.

The National Strategy on Climate Change states two main objectives:

- Identify, promote and implement adaptation measures to climate change, including the impacts of climate variability, especially on particularly vulnerable populations, productive activities, and ecosystems.
- Develop policies, measures and actions aimed at limiting the growth of emissions of greenhouse gases without compromising the country's sustainable development.

And thirteen main lines of action:

- I. Incorporate considerations of integrated risk management of disasters and climate change adaptation to territorial planning processes.
- II. Strengthen livestock farming systems and food security, in order to reduce vulnerability to climate change.
- III. Strengthen management processes of health impacts from climate change.
- IV. Strengthen the management of natural resources under scenarios of climate change and climate variability.
- V. Strengthen monitoring systems, measurement and modeling of environmental and socioeconomic variables.
- VI. Incorporate considerations of adaptation to climate change in production systems, including infrastructure planning.
- VII. Promote rational and efficient use of energy.
- VIII. Promote clean energy sources in the energy matrix.
- IX. Promote efficient practices along the production process of the industrial sector in order to limit GHG emissions.
- X. Promote environmental planning.
- XI. Promote the development and implementation of sustainable agricultural and forestry practices.
- XII. Increase energy efficiency in the transport sector.
- XIII. Promote changes in lifestyle of the population

Additionally, the strategy mentions some of the barriers that should be overcome in order to achieve the overall objectives:

- Institutional strengthening
- Financial Resource generation
- Dissemination and Capacity building
- Regulatory framework

3.4.3 Existing Studies at government level to identify mitigation and adaptation options

Argentina performed two National Communications on Climate Change, (1997 and 2007) and is currently at the initial stage of the selection of the consultants to develop the third one. There is an additional document from the Secretary of Environment and Sustainable Development, Climate Change in Argentina, which resumes the recent evolution of GHG, the vulnerable areas and the proposed mitigation and adaptation policies.

According to the 2nd National Communication on Climate Change and the document Climate Change in Argentina, the most vulnerable areas of the country are:

- Coastal zones
- The Pampeana region (vulnerability of agricultural production)
- Hydro resources in the region Litoral-Mesopotamia
- The regions of Patagonia and Cuyo

The most probable impacts of Climate Change to 2040 in these regions, are: reductions of flows of the rivers of the Plata Basin; increase water stress throughout northern and western region of the country; reductions in precipitation in the Andes and probably water stress in Mendoza, San Juan and reduced hydroelectric generation in the Comahue; higher frequency of heavy precipitations and flooding; retreat of glaciers; loss of shore in coastline, particularly from the Rio de la Plata.

Regarding the core mitigation policies, some of them are related to the promotion of biofuels (Law N^o 26,093); the protection of native forests (Law N^o 26,331); and the promotion of the forestations to reduce GHG emissions and CO₂ capture (Law N^o 25,080), among others.

3.4.4 Plans, programs and other actions.

3.4.4.1 CDM activities. Projects approved and implemented

By June 2013²³, 57 of the 65 CDM projects presented were locally approved, one rejected, 5 suspended, and two are currently under evaluation. Figure 4.2 shows the projected evolution of total tons of CO_2 eq saved by the CDM projects approved up to February 2009. Most of these projects belong to industrial and landfill initiatives.²⁴

²³ <u>http://www.ambiente.gov.ar/?idarticulo=1766</u>

²⁴ <u>http://cdm.unfccc.int/Projects/MapApp/index.html</u>





Source: Climate Change Division (2010)

3.4.4.2 Educative initiatives

The Climate Change Direction develops different activities directly related to Climate Change, Mitigation and Adaptation for public and private institutions. In this framework, the Climate Change Division and the National Institute of Technology (INTI) developed the "Carbon Emission Neutralization Project" to promote the knowledge about Climate Change and Carbon Footprint in educative institutions²⁵.

3.4.4.3 Mitigation options mentioned in the "Climate Change Actions Towards 2020 in the Context of Sustainable Development" presented at COP in Cancún 2010²⁶

During a Side Event of the *XVI Conference of the Parties* developed in Cancún in 2010, the Governmental Committee on Climate Change presented a group of mitigation actions to be implemented in the framework of Climate Change.

According to this presentation, 16 projects are being evaluated to be implemented in the sectors of transport, forest, waste and energy. These actions are projected to be implemented (or are currently implemented) at national, provincial or local level²⁷.

²⁵ See: <u>www.inti.gob.ar/campus_virtual/educacion_ambiental.htm</u>

²⁶ For more information on the announced measures at the COP, please see: <u>http://www.ambiente.gov.ar/default.asp?IdArticulo=9753</u>

²⁷ The list of projects presented by the committee includes:

Argentina's National Strategy for the Integral Management for the Municipal Solid Waste (ENGIRSU)

This is a joint program of the Secretary of Environment and Sustainable Development and provincial and municipal governments, mentioned in the COP 2010. Some of the highlighted aspects of this project are:

- Provide financial and technical support to provincial and municipal governments to elaborate and implement urban solid waste management (SWM) plans.
- SWM plans prioritize the eradication of open dumps and the design and construction of sanitary landfills in a regionalized fashion involving two or more cities or towns.
- Capture and use of landfill gas in a second phase of implementation.
- Waste recycling plants are also integrated in the SWM plans as well as domiciliary recycling programs.

The projected impacts of the programme include the reductions of 2.81 Million of Tons $CO_2eq/year$ by 2020, improvements in public health in the communities currently affected by open dumps, local environmental benefits in relation to the odor control, underground water quality and positive economic impacts for the use of landfill gas for energy purposes.

3.4.4.4 Transport sector

The objective of this programme is to improve the efficiency and sustainability of the transport system, and to contribute to mitigation and adaptation to climate change.

Some of the actions to be implemented include the innovation and improvement in the efficiency of the system of cargo transportation; improvement in the interconnection and efficiency of public transport; upgrading of existing and development of new rail system; promotion of non-motorized transport.

Waste: Argentina's national strategy for the integral management of municipal solid waste; integral management of municipal solid waste program

Transport: Argentina's national strategy for sustainable transport; Railway - Belgrano cargas project. Improvement of railway infrastructure in cargo sector; Railway - bioceanic corridor "Aconcagua". Improvement of railway infrastructure in cargo sector; Railway- Belgrano North railway. Infrastructure recovery and electrification; Railway - Belgrano South railway. Infrastructure recovery and electrification; Railway - Belgrano South railway. Infrastructure recovery and electrification; Railway - Belgrano South railway. Infrastructure recovery and electrification; Railway - Belgrano South railway. Infrastructure recovery and electrification; Railway - Belgrano South railway. Infrastructure recovery and electrification; Railway - Belgrano South railway. Infrastructure recovery and electrification; Railway - Belgrano South railway. Infrastructure recovery and electrification; Railway - Belgrano South railway. Infrastructure recovery and electrification; Railway - Belgrano South railway. Infrastructure recovery and electrification; Railway - Belgrano South railway. Infrastructure recovery and electrification; Railway - Belgrano South railway. Infrastructure recovery and electrification; Railway - Belgrano South railway. Infrastructure recovery and electrification; Hybrid bus project in Buenos Aires city

Renewable Energy and Energy Efficiency: "Punta negra" hydroelectric plant and dm. San juan province; electricity generation from renewable resources (GENREN); wind power at Buenos Aires province; photovoltaic solar energy generation pilot plant. San juan province; project for the promotion of biomass energy production (PROBIOMASA); project propellets plan replacing pilots of water heating equipment and gas heaters for new electronic devices; efficient boilers project best practices in the operation of steam generators and hot water; combined heat and power (CHP) generation in the industry sector at Buenos Aires province; project solar thermal energy in social housing; national program to reduce GHG emissions from building in residential, commercial, and public sectors; energy efficiency in publics' buildings at Buenos Aires Province

Other programs: Strengthening of the meteorological observation system in Argentina; Reforestation of degraded lands in the area of Pulmarí Neuquén Province; aforestation in Buenos Aires Province; dairy sector in Buenos Aires Province Argentina; swine sector in Buenos Aires Province; poultry sector in Buenos Aires Province Argentina.

The projects included in this programme are:

- GEF Project for Urban Transportation in the cities of Mendoza, Posadas, Rosario, Tucumán.
- Improvement in the rail system: Upgrading of the railroad Belgrano Cargas.
- Restoration of passenger rail services.
- Construction of the bi-oceanic corridor.
- General Sarmiento Underground Railroad.
- Improvement of port terminals.
- Public transport integration in the metropolitan area of Buenos Aires

3.4.5 Industry sector

Some of the future actions mentioned for this sector are:

- Identification most pollutant subsectors.
- Evaluation of projects in each subsector to reduce GHG emissions.
- Capacity building to improve industrial practices and processes.
- Promotion of best practices and more efficient use of energy in the production processes.

3.4.6 Native Forests

The Law N^o 26,331 states land management processes according to three conservation categories at the provincial level. The main objectives of this regulation are the promotion of the conservation of native forests regulating the expansion of the agricultural frontier and other changes in land use; the implementation of measures to control the decrease in area of native forests; the improvement and maintenance of ecological and cultural processes in native forests.

3.4.7 Review of strategies and policies for access to modern energy sources (main aspects, defining priorities, measures and actions, progress and planned).

3.4.7.1 General Issues

Argentina is one of the nations in the world with the highest participation of natural gas in its energy matrix. A high proportion of the population have access to natural gas, of a total of 12,171,675 homes 6,834,327 have access to natural gas (52%) (Census 2010). The rate of electrification is over 98%, with 100% in urban areas and more than 70% in rural ones. The nearly 30% without access to electricity is in very isolated areas.

A cross-subsidy policy has been implemented in an attempt to make the energy system feasible while avoiding negative macroeconomic effects. However the complexity of the Argentine energy context in the wake of privatizations, deregulation and subsequent regulation changes, has had the result of privileging household users connected to the grid above all other user categories.

Fragmentary policies like prepayment meters or "social" gas cylinders have been partially successful since they provide solutions to energy access to an important share of urban poor.

However a more integrated perspective is needed to have a more broader and extended impacts and results.

The implementation of social programs, like subsidies for un-employment or other social activities, combined with increases in income from growth in informal activities (in turn a result of a favourable macroeconomic environment) has improved satisfaction in energy services. Nevertheless, the improvement of income enabling the acquisition of new electricity appliances needs to be accompanied by an increase in the electricity supply infrastructure, to avoid shortages of power and a decrease in the quality of the service.

3.4.7.2 Energy Policies and Programs

Program for electricity supply

Since September 2002, there is an agreement known as the "New Framework Agreement"²⁸ between the National Government, Buenos Aires Province and GBA electricity utilities. The main objective of the deal is to "regularize" the large number of users with illegal connections, as well as those cases of low-income households with important delays in payment of their electricity bill.

Common meters were installed in slums, identifying the number of users consuming from each measuring point and establishing a limit in the supplied power for each point according to the number of connected households. The utilities must ensure supply continuity up to the point of collective supply. Downstream of such point, the electricity companies do not take any responsibility regarding grids, installation security nor service quality, thus leaving any desired extension in the hands of the local authorities and slum inhabitants.

The tariffs to be applied to the users within this regime do not have any explicit subsidy nor is there any social tariff for electricity in the area. Despite the context of a generalized price increase, tariffs in the GBA area have experienced very few adjustments since the year 2002, which implied a generalized subsidy on electricity tariffs for all household users regardless of their income levels.

A special fund was created as a joint action of the National Government, the Buenos Aires Province and the local town councils, to cover the deficit of user payments.

According to information supplied by the distribution companies, a major reduction in illegal consumption has been achieved, partly as a result of this program and partly by the initiative of the slum inhabitants since having an electricity bill in their name brings several advantages: identification of their household, possibility of access to other services such as water grids or landline phones, access to credit, etc.

²⁸ The First Framework Agreement, at national level, was developed during the nineties, after the privatization of the power system, with the same objectives.

Price of LPG

In Argentina natural gas is widely used in all sectors and, in particular, in the household sector. The price paid for natural gas/kilocalorie is 80% lower than the price paid for the LPG kilocalorie, which is the main alternative fuel for households. LPG is used in cities that are away from gas pipelines, in rural homes and in most low-income households, which, though located in urban and periurban areas with access to natural gas, have no distribution grids inside the neighbourhoods or slums.

In 2003, the National Government signed an agreement, with companies in charge of LPG fractioning and distribution providing price stability for 10kg gas cylinders in order to maintain a differential, more economic price. In 2004, Buenos Aires City Government creates the Social Gas Cylinder Plan with the aim of subsidizing the price of 10kg LPG gas cylinders for low-income households with no access to natural gas grids. Beneficiaries were those households with social plans and incomes below the poverty line.

By the end of 2008 the National Program on Household Consumption of Bottled Liquefied Petroleum Gas ["Programa Nacional de Consumo Residencial de Gas Licuado de Petróleo Envasado"] is created, with the main purpose of amending gas price asymmetries between households with access to the natural gas grid and those without it. It establishes a maximum price for 10, 12 and 15 kg cylinders of \$16 (USD4.00), \$20 (USD5.00) and \$25 (USD6.25) respectively, applicable in the entire country. But even with these subsidized prices LPG is still 3 times more expensive than the natural gas equivalent.

A fiduciary fund has been created with money from the National Government and natural gas production companies in order to meet subsidies of the LPG price²⁹. This Program, in principle, is addressed to slum dwellers.

Rural electrification: the PERMER Program

The PERMER Program was implemented in the context of a highly mature energy system with a high electrification rate, but with a significant proportion of its rural isolated population lacking electrical services.

PERMER aims at supplying 1.4 million inhabitants (300,000 domestic users) and approximately 6,000 public services units, including health services, schools, police stations and drinking water services. The low population density and distance to the electric grid mean that traditional grid extension would be prohibitively expensive to the area where the program is located.

²⁹ Article 45 of the Law 26020 (2005) and amendment, law 26314 (2007)

The program is socially motivated and aims at improving quality of life for isolated rural communities and creates enabling conditions for the development of productive activities that could increase family income.

The program aims are:

- Providing basic electricity services to cover the social lighting and communication needs of the distributed rural population.
- Attaining significant coverage of the potential market in the short term
- Creating job opportunities in the private sector
- Attaining an electricity supply system that includes sustainable renewable resources.
- Ensuring that the private company covers all the services, attaining good economic performance at a minimum subsidy cost and a good quality service for the population serviced

The options identified for the provision of residential electricity services and for the possibility of developing small productive undertakings in small communities. The installation of PV systems in rural schools that currently lack electricity contributes to the improvement of education through the provision of a basic lighting and communication service, approximately 1,800 schools were in this situation in different provinces. The Project was implemented in eleven provinces.

The delivery model is a public-private partnership involving significant government funding to install the generating equipment and to subsidize user tariffs, along with the award of exclusive contracts to concessionaries in the private sector, public sector and co-operatives, to run and maintain the service. Financing comes from a mixture of international loans and grants from the World Bank and the GEF, with funds from the education and energy sectors, provincial budgets, user fees and, at least in its first phase, corporate investments.

The program distinguishes clearly between the concentrated electricity market and the distributed electricity market.

The key findings are:

- The biggest positive impacts are in schools, which benefit from additional power, appliances and new solar thermal installations.
- Residential users value the better quality light but many would like more power for domestic and productive uses, especially refrigeration and irrigation.
- The target population has a range of additional energy needs, in particular: water pumping; food refrigeration; cooking; welding and the use of other machine tools; water pumps and dryers for washing and drying agricultural products, which could then be sold; use of electric shearers and wool classification machines to help produce more wool and achieve a higher individual price in the market

Pilot experiences

The objective of these experiences is, if successful, to become programs of wider scope as part of an energy policy for the poor.

With regards to electricity supply, the distribution company EDENOR implemented the Prepayment Meter Project in the areas of Escobar and Merlo during years 2002 and 2003 respectively. Each user purchases a certain amount of kWh that he wishes to consume and can pay for. He can fraction the purchase in small amounts too, so that the payment scheme is affordable to him. Once this quantity has been consumed, he recharges.

The tariff applied in this system is not subsidized. The fixed charge is prorated in the first 150 kWh consumed per month and the variable charge per kWh that is bought is the same as the one for the common Household tariff.

Around 5,000 prepayment meters were installed (this is 1% of slum households in GBA), with wide acceptance among the system users (96%). Electricity consumption was reduced by 35% in relation to users under the same socioeconomic conditions, partly due to a more rational use of energy and partly due to unsatisfied needs.

In relation to natural gas supply, a pilot experience was carried out in the neighbourhood *Cuartel V* in Moreno, initiating in September 2003. The project was the result of joint actions by Natural Gas distribution company BAN (now *"Gas Natural Fenosa"*), community organizations and neighbours. Around 4,300 families were connected to the natural gas grid.

In order to finance the works, funds were supplied by the distribution company itself, as well as by the Buenos Aires Province administration, the World Bank, IDB-FOMIN and Supervielle Bank to connect 7.000 families to the natural gas grid. A fiduciary fund was created with money from the neighbourhood dwellers that would be the project beneficiaries. Among the factors leading to the project's success, the participation of the neighbours and of two community organizations (locally well-known) should be highlighted.

This project entailed other additional benefits, such as the workshops on health, nutrition and natural gas usage. In order to execute the household installations, the neighbours themselves were trained and certified as registered installers, which not only reduced costs but also equipped them with an important work field.

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4. Policy Review: Brazil

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4.1 Energy Policy Objectives and their link to Climate Change

4.1.1 Brazilian Energy Sector Stakeholders and Main Competences

The Brazilian Energy Sector has a complex and robust structure as the **Figure 18** shows. At the top of the organogram, directly related to the energy policy making process in Brazil, the **Casa Civil** (or the State Office, actually lead by the President Dilma Rouseff) is highlighted, the **Congress**, the National Council for Energy Policy (CNPE) and the Ministry of Mines and Energy (MME).

The **National Council for Energy Policy** (CNPE) is an entity for advising to the President of the Republic. It aims at formulating energy policies and guidelines for energy sector including: 1) Promoting the **rational use of energy resources** by:

a) taking care of national **strategic interests**; b)promoting **sustainable development**, **expansion of labour market** and **valorisation of energy resources**; c) taking care of **consumers interests**; d) taking care of **environment and energy conservation**; e) ensuring **energy security** related to appropriate supply of oil and natural gas, as well as exploitation of **renewable energy sources**; f) promoting market competition; g) attracting investments in energy production; and, i) improving the competitiveness of Brazil in the international market (MME, 2013a).

2) **Ensuring the supply of modern energy carriers** for all the inhabitants, including regions characterized by difficult access. To achieve this purpose the CNPE suggests the implementation of subsidies, programs and policies among other sort of actions.

3) Analysing the energy matrix of each State in order to **innovate energy conversion technologies**;

4) Establishing guidelines for imports and exports, in order to cover the specific requirements of oil products and natural gas, as well as taking care of an **appropriate operation of the** National System of Fuels Storage and the fulfilment of the Yearly Plan of Strategic Storage of Fuels (1991).

The **Ministry of Mines and Energy** (MME) performs energy policy formulation and represents the interest of the Country related to the energy sector. The fields of action of MME are: a) Geology, mineral and energy resources; b) Use of hydraulic energy; c) Mining and metallurgy; and, d) Oil, fuels and electricity, including nuclear energy. Other important tasks of MME are

related to energizing rural areas and developing agro-energy (MME, 2013a). In order to achieve its mission, the MME is supported by specific studies and advice from the Energy Research Company (*Empresa de Pesquisa Energética* - EPE).



Figure 18. Brazilian Energy Sector Structure.

Source: Own elaboration based on MME, 2013.

4.1.2 Energy Planning and Institutional Framework

Aiming at strengthening the planning tasks on the Brazilian electric energy sector, Laws 10,847 and 10,848 were implemented in 2004 in order to allow the creation of the **Energy Research Company** (EPE) and establish a **new framework of rules for the electricity market**, respectively (EPE - MME, 2007; MME, 2013a). Law 10,848 also created the Monitoring Committee for the Electric Power Sector (CMSE).

This new **institutional framework** of the **electric power sector** should ensure:

a) Security on the electricity supply, in order to enable economic development of the country.

b) Low tariffs, with the objective of fostering the competitiveness of the economy and the social inclusion of the whole population by improving the access to this public service.

c) Stability of the regulatory framework, aiming at attracting investments for the electric sector expansion.

The **Figure 19** shows the institutional framework of the Brazilian electric power sector. Institutions at the top of the figure (Casa Civil, Congress and CNPE) are associated with the energy policy making. The regulatory functions are exerted mainly by the National Agency for Electric Energy (ANEEL). Important entities coordinating and regulating the different market players are the National Operator of the Electric System (ONS) and the Trading Camera of Electricity Energy (CCEE). Other important players are the Brazilian Electricity Utilities (ELETROBRAS), the National Development Bank (BNDES), the Monitoring Committee for the Electric Power Sector (CMSE) and the Steering Committee for Electricity Efficiency Indicator (CGIEE) (MME, 2013a).



Figure 19. Brazil's Electric Power Sector Structure.

Source: Own elaboration based on ONS, (2013), MME (2013), EPE (2007).

Regarding the **planning of other energy sectors** (oil, natural gas, coal, biofuels, etc.) specific studies used to be developed by interested companies. For example, in the oil sector, planning usually followed Petrobras' point of view. Yet, this has changed and, since 2005, EPE participates actively on the oil and natural gas planning (EPE-MME, 2013).

The **energy planning**, through EPE, aims at: a) performing studies and projections of the Brazilian Energy Matrix; b) deploying and maintaining the National System of Energy Information; c) preparing and publishing the National Energy Balance (BEN); d) identifying and quantifying the potential of energy resources; e) studying the real possibility for using hydraulic resources; f) promoting actions to get environmental licences related to hydro power units or electricity transmission projects; g) developing the Expansion Plan³⁰ for generation and transmission of electricity, oil, natural gas and other fuels in the short, medium and long term; h) fostering market studies aiming at defining scenarios of supply and demand of oil and its products; i) elaborating the Master Plan for the development of oil and gas industry in Brazil; j) developing specific studies for increasing the use of renewable fuels; and k) generating academic production in order to subsidise plans and programs for sustainable development (EPE, 2013).

The **Ten-Year Energy Expansion Plan** ("*Plano Decenal de Energia*" - PDE) is a key reference for energy planning by agents in Brazil's energy sector, which incorporates an integrated vision of demand and supply expansion including different energy sources. It is published yearly since 2011 and the last one (PDE 2021) encompasses the 2012-2021 period, was launched in 2012 and was approved by the Minister of Energy in March 25, 2013 (MME, 2013b). It synthesizes the results of investments already in implementation and sets a framework for new investments thereafter. In particular, it provides a context for defining the auctions for the grid's new capacity of supply (POOLE, 2011). PDE is a bridge between nearer-term operational planning and longer term plans, such as the **National Energy Plan 2030** ("*Plano Nacional de Energia 2030*" – *PNE 2030*), published in 2007 (EPE - MME, 2007; EPE-MME, 2013).

4.1.3 Electric Sector and Auctions as Tool for Power Expansion.

Since 2004, Brazil's electric power expansion is based on **auctions**, which consider power plant facilities to operate 5, 3 or 1 year after the auction (known as A-5, A-3 and A-1 auctions) (ANEEL, 2011a; MME, 2007). Hence, electric power generation expansion is based on a competitive bidding mechanism, where energy blocks are sold from lower to higher prices until the total capacity stipulated for every single round is reached. Auctions can either include all options, or focus on specific big plants (such as several of the Amazonian dams), or on specific power options (e.g. renewable electricity generation options, such as wind, biomass and small hydro). In general, the bidding mechanism does not deny specific sources, but for several reasons the regulatory body can define a more restricted round —as occurred for alternative energy sources. For instance, in 2007 and 2008, in the specific alternative energy sources auctions only small-hydro and biomass won shares of requested capacity. In 2009, the first exclusive wind power round was accomplished, and from there on forward the source

³⁰ Since 2007 the Expansion Plan considers not only generation and transmission of electricity but also a wider vision about the increase on the demand and supply for other fuels; The PDE 2021 considers electricity, oil, natural gas, oil products, biofuels, nuclear (operation start of *Angra* III) and energy efficiency measures.

demonstrated its competitiveness in renewable-exclusive rounds (2010 and 2011). Nowadays, wind competes in ordinary rounds —opened to any source.

4.1.4 Incentives for Renewables in the Electric Sector

Aiming at fostering electricity generation from renewable energy sources, Brazil implemented in the last years several incentive programs, as well as attractive financial lines provided by the National Development Bank (BNDES).

In 1998 the Brazilian Government implemented the Law 9,648 that allowed the use of the **Fuel Consumption Account**³¹ **(CCC) for alternative energy sources in isolated systems** (DUTRA, 2007). This was a financial incentive program which consisted in creating a cross-subsidy for renewable energy power projects at isolated systems. In 2001 the Emergency Program of Wind Power- **PROEÓLICA** was implemented aiming at providing special conditions for contracting wind power projects (DUTRA, 2007).

Nevertheless, according to SCHAEFFER *et al.*, (2012) the incentive for alternative sources provided by the above mentioned programs had not got the success of both PROINFA and renewable energy auctions.

The Program for Alternative Energy Sources - **PROINFA**, coordinated by the Ministry of Mines and Energy, was launched in 2002. It had the objective of increasing the share of electric energy produced from wind energy, solar energy, small hydroelectric plants (PCHs)³² and biomass in the Interconnected National System (SIN). PROINFA was supposed to be executed according to two stages. The first stage had to add 3,300 MW of installed capacity to the SIN equally distributed between wind power, biomass and PCHs, through long term contracts (20 years) (SCHAEFFER *et al.*, 2012). The objective of the second stage of PROINFA was to achieve until 2026 a 10% share of the total national electricity production with renewable energy sources. However, PROINFA's second stage was never regulated (SCHAEFFER *et al.*, 2012). The Table 6 shows a detail of installed capacity under PROINFA's first stage.

³¹ The Fuel Consumption Account (CCC) was created in 1973. It is a charge of the Brazilian electric sector, levied in the "distribution tariffs" and the "usage fees" of electrical distribution and transmission systems (called TUSD and TUST respectively). This is paid by all utility companies for distribution and transmission of electricity to cover thermoelectric electricity generation yearly costs, mainly in the Northern region, in areas not interconnected to the National Interconnected System (SIN) called isolated systems (DUTRA, 2007).

From 1973, the CCC was initially implemented in Southern, South-eastern and Midwestern regions, later; the CCC was also extended to the interconnected system of the Northern and North-eastern regions, aiming to ensure the fuels supply for power generation plants that delivered electricity to distribution systems. In 1991 the CCC was applied, at national level, among all distribution companies that, in turn, passed that charge to all consumers by CCC Isolated Systems.

³² PCHs is an abbreviation for small hydro power plants. In Brazil a hydro power plant of nominal capacity between 1 MW and until 30 MW and upstream flooded area until 3 km² is considered a PCH (ANEEL, 2003).

	Number	Installed	(% MW)
	of	Capacity	
	projects	(MW)	
Small Hydro (PCH)	63	1,191	36%
Wind Power	54	1,423	43%
Biomass	27	685	21%
Total	144	3,299	100%

Table 6. Installed capacity contracted by PROINFA (1st stage).

Source: MME (2010a) apud SCHAEFFER et al (2012). Translated to English.

Actually, in the case of Brazil, since 2003 the main policy for promoting renewable electricity generation options, especially wind, biomass and small scale hydro, is based on specific auctions (ANEEL, 2011b; MALAGUETA et al., 2013; NOGUEIRA, 2011). In this case, the electricity distribution companies of the National Interconnected System must contract new power capacity in order to supply their market through auctions (CCEE, 2011; MME, 2007). Under Regulated Contracting Environment (ACR) the auctions could be "A minus 5"," A minus 3" and "A minus 1" when electricity supply is contracted with 5, 3 and 1 year in advance respectively to the start of operation of the power plant facility. Under ACR there is also the adjustment auction, which aims at complementing the amount of energy that a Distributor Company would need to match its consumers' demand, until 1% of the total market of each Distributor (MME, 2013c). There are also three especial auctions: a) Structuring project auction, used for strategic electric power projects of public interest; b) alternative energy sources auctions (LFA), aimed at diversifying electric power matrix; c) reserve energy auctions (LER), aimed at increasing energy security related to electricity supply to SIN with power units specially contracted for achieving this purpose (MME, 2013c). Error! Reference source not found. shows the energy sources share volution in terms of average power contracted in auctions under ACR.



LEN = New Energy Auction

LFA = Alternative Energy Sources Auction

LER = Reserve Energy Auction

A -3 : energy contracted in advance of 3 years to the beginning of supply

A - 5: energy contracted in advance of 5 years to the beginning of supply

Figure 20. Energy sources share evolution contracted in auctions under Regulated Contracting Environment (ACR) in the period 2005 – 2011.

Source: REGO, (2012), traduced from Portuguese.

The power contracting model based on auctions led to the success of wind power deployment at a large scale in Brazil (CHADE RICOSTI; SAUER, 2013; MORENO *et al.*, 2010; NOGUEIRA, 2011; REGO; PARENTE, 2013). Figure 21 shows the power, from different energy sources, registered³³ to compete between them in the auctions³⁴ until 2011, besides the public call of PROINFA. This figure shows how small hydropower plants (PCHs) have lost competitiveness against wind power in the last years. Table 7 shows the contracted capacity and prices of wind power auctions. "The prices at these auctions show that wind energy is claiming its place without subsidies, particularly in North-eastern and Southern Brazil" (CHADE RICOSTI; SAUER, 2013).

³³ "Registered power" includes all the inscribed licensed projects to compete in auctions. It is not still contracted power.

³⁴ Reserve energy auction in 2008 was only for biomass and reserve energy auction in 2009 was only for wind power.



LER 2010 = Alternative sources auction in 2007 LER 2010 = Reserve energy auction in 2010 FA 2010 = Alternative sources auction in 2010

Source: EPE and CCEE (2012).

Source: REGO, (2012), traduced from Portuguese.

Therefore, Brazil does not adopt the feed-in tariff as a major policy to foster renewable energy, as oppose to happen in the United States and Spain. Instead, Brazil adopts an auction-based incentive policy (MALAGUETA *et al.*, 2013).

Year	Contracted capacity (MW)	Price (R\$/MWh)	Price (US\$/MWh)	Number of projects
2009	1805.70	148.39	85.81	71
2010	2047.80	130.86	74.47	70
2011	861.10	99.54	61.97	34
2011	1067.60	99.58	62.91	44
2011	976.50	105.12	56.80	39

Table 7. Contracted	l capacity and	prices of wind	power	auctions in	Brazil
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Source: CHADE RICOSTI; SAUER, (2013)

4.1.5 Electricity Efficiency

The Brazilian government has been promoting energy efficiency by means of a series of laws and official programs. In the mid-1980's the **National Program for Electric Energy Conservation** – **PROCEL** was created with the purpose of promoting energy efficiency in the industry, the development of more energy efficient products and processes and stimulating the substitution of imported energy sources.

Figure 21. Share of wind power, small hydropower plants (PCH) and biomass in the specific auctions contracted under Regulated Contracting Environment (ACR).
In 2001, the Law Nº10,295 established the **National Policy for Conservation and Rational Use of Energy** aiming at the efficient use of energy sources and environmental conservation by establishing the levels of maximum specific energy consumption or minimum energy efficiency of machines and appliances fabricated or commercialized in the country. The law also establishes the mechanism for **energy efficiency in the construction sector**.

4.1.6 Oil Products, Natural Gas and Biofuels

Reduction of imported oil and gas dependency was a strategic energy policy position adopted in the 1970s that tried to reduce the Country's foreign dependence. This policy has not been abandoned, not even when the international oil prices decreased in the mid-eighties.

The Brazilian government has been promoting the use of renewable energy by means of a series of laws and official programs. The **PROALCOOL Program** created in 1975 aimed at producing ethanol from sugarcane, manioc or any other input to be used as automotive fuel. In this sense, the Law N°10,464 of 2002 established a minimum share between 20% and 25% of anhydrous ethanol in gasoline. After thirty years the Program is now experiencing a new expansion so that it can supply this fuel at large scale.

After the second world oil price shock, the government of Brazil launched a petroleum fuel conservation programme known as CONSERVE. The programme promoted more efficient fuel use and fuel substitution in industries through a range of mechanisms including sectoral protocols, industrial audits, low-interest loans, technological demonstration and promotion, and education and training (SZKLO and GELLER, 2006). According to SZKLO and GELLER (2006), "This programme was relatively successful, in part owing to the high fuel prices that were prevalent during the early 1980s. By 1985, the industrial sector as a whole cut its use of fuel oil to 59% of the level in 1979. The reduction in fuel oil use was especially large in the cement, steel, and pulp and paper industries, the three sectors that entered into protocols with the government". "The national development bank (BNDES) financed 80 projects for CONSERVE, but most of the projects were aimed at fuel substitution rather than fuel conservation or efficiency improvement" OLIVEIRA, (1998) apud SZKLO and GELLER (2006). The same authors mentioned that "The CONSERVE programme was not a complete success, however. Most of the funds dedicated to the programme were not utilized, and the impact on small and medium-sized industries was relatively limited. In addition, the programme did not develop very systematic monitoring and evaluation procedures" SZKLO and GELLER (2006).

In 1991, the National Program for the Rational Use of Petroleum and Natural Gas – CONPET was initiated to promote more efficient and rational use of petroleum products and natural gas. CONPET is housed in Petrobras and has actively promoted energy conservation within the diverse operations of the national petroleum company. "Cumulative energy savings within Petrobras from 1992 to 2000 include 230 GWh of electricity, 610 million m³ of natural gas and over 700 million m³ of oil products" ELETROBRAS, (2002) *apud* SZKLO and GELLER (2006). According to SZKLO and GELLER (2006) "CONPET programme has had limited success in

stimulating efficiency improvements and conservation outside of Petrobras" SZKLO and GELLER (2006).

One initiative, known as *Siga Bem*, is aimed at **improving the fuel efficiency of heavy trucks** through simple diagnostic tests and education of truck drivers at over 100 service stations along major highways. "It is estimated that fuel savings were on the order of 12–15% per vehicle attended, with 120 000 trucks serviced by the programme per year as of 2001" ELETROBRAS, (2002) *apud* SZKLO and GELLER (2006). Another initiative, known as *Economizar*, features similar services through a **mobile testing facility** that visits truck and bus depots. "There were 41 mobile facilities operating throughout Brazil as of 2001, resulting in approximately 114 million litres of fuel savings that year" ELETROBRAS, (2002) *apud* SZKLO and GELLER (2006).

Regarding the residential and commercial sectors, CONPET helped initiate an **efficiency testing** and **labelling programme** for **residential stoves** that consume liquefied propane gas (LPG). "This initiative prompted appliance manufacturers to improve the efficiency of their products, with estimated fuel savings of 13% on average between the 1999 and 2001 stove models" ELETROBRAS, (2002) *apud* SZKLO and GELLER (2006). If a new national energy efficiency agency is established (see Section 9.4.1), it could take over and expand on the efforts of the CONPET programme.

In 1995 the Brazilian government established the **National Program for the Production and Use of Biodiesel** (PNPB), which was initially launched with a compulsory addition of 2% in volume to diesel oil (B2). Since 2008, the PNPB has made it mandatory to add a fixed percentage of biodiesel to mineral diesel, which is currently 5% in volume.

In 2008, Brazil launched the Vehicle Labeling Program aiming at improving the energy efficiency of light vehicles, and introducing new technologies. This Program had the objective of changing the Brazilian baseline scenario related to the use of large and inefficient light duty vehicles. "In the last years, the profile of vehicles sold in Brazil has converged towards larger and less-efficient vehicles" (BASTIN *et al.*, 2010). According to BASTIN *et al* (2010) "despite its virtuous intentions the Vehicle Labeling Program will not control the tendency of rising fuel consumption of passenger cars sold in Brazil. Therefore, other policies are needed to boost innovations in Brazil's automotive industry".

The Brazilian oil and gas reserves currently experience a new investment profile aiming at attending internal demand and the **perspective of Brazil becoming a medium size oil exporter** in the next decades.

4.1.7 Brazilian Energy Sector and Climate Change

Although Brazil, as a developing country, does **not have legally binding commitments** to reduce or limit its anthropogenic emissions of GHGs, it has **some programs** to **reduce GHG emissions** and contribute to the ultimate objective of the UNFCCC. "Some of the programs and measures that Brazil has undertaken over the past two or three decades in order to mitigate economic or 74 environmental problems also had positive effects on the reduction of the country's carbon dioxide emissions" (SZKLO *et al.*, 2005). This is the case of the abovementioned **PROALCOOL Program** and **National Program for the Production and Use of Biodiesel** that today are largely supported by Brazilian Government as they understand that it also contributes to reduce GHG emissions in the transport sector by avoiding the use of oil products (gasoline, diesel and vehicular natural gas).

Energy sector is one of the most important sectors considered on the **National Plan for Climate Change.** Some of the proposed actions are: improvements in **Energy efficiency**, increase the use of **bio-fuels**, increase the energy supply by **hydroelectric power** plants, increase the use of **alternative energy sources** and, finally, increase in the use of **charcoal from planted forests** in the iron & steel industry (CIM/MMA, 2008). The National Plan for Climate Change was developed taking into account the **National Policy on Climate Change**. This policy fosters explicitly a rational and more efficiently use of energy, as well as to reduce GHG emissions in electricity supply (CASA CIVIL, 2009).

4.2 Review of National Plans or Actions and Measures

4.2.1 Energy Efficiency Standards and Building Codes

Brazil has initiated a national energy efficiency labeling program for appliances. The Brazilian National Program of Electric Energy Conservation and the Voluntary Labeling Program (PROCEL) started in 1985 and 1993 respectively. Labeling Program aims at distinguishing the efficiency of products such as refrigerators, freezers, washing machines, air conditioners, computer monitors, DVDs, and TVs. PROCEL is shifting towards a more mandatory participation scheme, particularly since the validity of the Energy Efficiency Law # 10,295 (Oct 17th, 2001). For example, since July 2008, all televisions sold in Brazil must have the PROCEL standby efficiency label (MIHLMESTE et al. 2010).

One of the outcomes of this action plan, compliant with Law N° 10,295 was the drafting of the Energy Efficiency Rating Technical Quality Regulations for Commercial, Service and Public Buildings (RTQ-C) and supplementary documents. These technical regulations were approved through Edict No 53 promulgated on February 27, 2009 by the National Institute of Metrology, Standardization and Industrial Quality (INMETRO). It ushered in a new set of dynamics for guiding the quest for architectural solutions and supplementary lighting and air-conditioning projects in order to upgrade the thermal and energy performances of buildings designed (BATISTA et al, 2011).

4.2.2 Integrated Resource Planning (IRP)

Brazil's utilities are not obliged to conduct IRP. However, there is special emphasis on efficiency. The national regulatory agency *"Agência Nacional de Energia Elétrica"* (ANEEL) has allocated 1% of the utilities' net annual operational revenue to energy efficiency and R&D. As part of its

concession contract, the distribution company presents to ANEEL a set of actions within the Annual Program against Electrical Energy Waste (D'SA, 2011).

The National Integrated Resource Planning for the Energy Sector is carried out by the Energy Research Company –EPE (*Empresa de Pesquisa Energética*), from which several studies are performed aiming at providing input for energy sector planning as a whole.

4.2.3 Energy Savings Targets

There are neither binding targets for energy saving in Brazil, for final-energy users nor for utilities companies.

4.2.4 Voluntary Agreements

The National Climate Change Policy approved by the Congress, Federal Law No 12,187 included voluntary goals for limiting the country's GHG emissions. Voluntary goals were established as a reduction between 36.1% and 38.9% of the country's GHG emissions projected to 2020 within the base line.

On 9 December 2010, during COP16 in Cancun, the Brazilian government published the Federal Decree N° 7,390 regulating the articles of Law N° 12187. For the energy sector, the decree considered the 10-year energy plan (PDE) made by EPE as a mitigation scenario, as it includes measures to increase the role of renewable energy, nuclear energy and energy efficiency in the energy policy (LA ROVERE, 2011).

4.2.5 Energy Pricing Policies

Since the 1990s, the energy sector in Brazil has been subject of a variety of reform initiatives aiming at changing the market structure and the energy price levels. These reforms were triggered by the implementation of the *Plano Real* and some liberal policies in the Brazilian economy. In the electric power sector, these reforms led to a new industrial organization and a new tariff policy implemented through a price-cap regime by the Brazilian Electric Power Regulatory Agency (ANEEL). During the implementation of these reforms, the spatial evolution of tariffs presented a trend of spatial convergence. However, after the consolidation of the tariff policy, the spatial evolution of tariffs has shown that the richest regions are experiencing lower tariffs than the poorest regions (SANTOS et al, 2013). Nevertheless, there is a Social Energy Tariff applied to the households classified as Low Income, in order to provide discounts on the base tariff.

Fuel prices in Brazil have not been directly determined by administrative decisions of the government since 2002, since when oil products prices are supposed to float according to the international oil market prices. However, as the state-controlled Petrobras oil company keeps its dominant position in the domestic market, this oil company is a price-setter and usually follows the government's instructions for setting ex-refinery prices. Hence, for setting the ex-refinery prices, Petrobras considers not only the relevant international parity, but also their impacts on

the socioeconomic side due to the oil products prices variation within the Brazilian market (its major and target market) (CAVALCANTI et al, 2012). Petrobras clearly indicates this fact by stating that "Although Petrobras's oil products prices are based on the international prices, during periods of high international prices or sharp devaluation of the Real, Petrobras may not be able to adjust sufficiently its prices in Reais to maintain parity with international prices" (PETROBRAS, 2002).

While oil products prices are supposed to be deregulated in Brazil since 2001, meaning that there is no subsidies in ex-refinery prices, since 2004 the Brazilian government controlled ex-refinery prices evolution, through its major share in Petrobras (a State-controlled oil company), in order to curb inflation. In addition, in order to keep petroleum prices constant for final consumers the government has been lowering taxes on gasoline and diesel (since 2004) and removed taxes on LPG and fuel oil. As a consequence of the lower levy rate and narrower coverage, the total amount of petroleum taxes has not increased despite growing consumption (IMF, 2013). Hence, as refinery margins are constrained by ex-refinery prices and liquid fuels demand increases given low tax levels, Petrobras goes on operational losses at its downstream business.

4.3 Review of the National Strategy on Climate Change

4.3.1 Brazilian Actors around Climate Change

A number of Government institutions are involved in the development of policies, programs and projects related with climate change issues.

The national coordination for implementing the UNFCCC in Brazil is a responsibility of the **Ministry of Science and Technology and Innovation** (MCTI), according to the Presidential Decree N° 1,160 of June 21, 1994.

The Inter-ministerial Commission on Global Climate Change (*Comissão Interministerial de Mudança Global do Clima* - CIMGC) was established by the federal Government in 1999, with the purpose of articulating governmental actions resulting from the UNFCCC and its subsidiary instruments in which Brazil takes part (MCT, 2013). The CIMGC was instituted by Decree of July 7, 1999, and as amended by Decree of January 10, 2006 (GOVERNO DO BRASIL, 2006). The Presidency of the CIMGC corresponds to the head of the Ministry of Science, Technology and Innovation (MCTI), and the Vice Presidency is for the head of the Ministry of Environment (MMA). The **Figure 22** show how is it formed. The Commission holds the following competences:

a) to provide a statement, whenever requested, on proposals for sectorial policies, legal instruments and norms that contain a relevant component for the mitigation of global climate change and the country's adaptation to its impacts;

b) to provide inputs on the Government's positions in the negotiations under the UNFCCC and subsidiary instruments in which Brazil takes part;

c) to define eligibility criteria additional to those considered by the bodies of the Convention in charge of the Clean Development Mechanism (CDM), as provided for in Article 12 of the Kyoto Protocol to the United UNFCCC, pursuant to national sustainable development strategies;

d) to analyse statements on projects that result in emission reduction and that are considered eligible to the CDM, and approve them, when appropriate;

e) to establish agreements with representative entities of the civil society in order to promote actions by governmental and private bodies with a view of meeting the commitments accepted by Brazil under the UNFCCC and subsidiary instruments of which Brazil is part;



f) to approve its rules of procedure.

Figure 22. Members of the Brazilian Inter-ministerial Commission on Global Climate Change Source: Own elaboration, based on MCTI, (2013).

The **Brazilian Forum on Climate Change** (FBMC) was created by Decree no. 3,515, of June 20, 2000, with the purpose of raising the awareness of society and mobilizing it for discussion and decision-making on problems resulting from climate change, thus promoting stakeholder dialogue. It promotes the institutional interface between Government and Civil Society. The Forum shall be permanently integrated with the Inter-ministerial Commission on Global Climate Change, aiming at the adoption of necessary measures for the implementation of the decisions reached at the Forum.

In November 2007, Presidential Decree no. 6.263/2007 was issued creating the Inter-Ministerial Committee on Climate Change (*Comitê Interministerial sobre Mudança do Clima* – CIM). The Committee shall direct the elaboration, implementation, monitoring, evaluation and proposal of periodic review of the National Plan on Climate Change. It is coordinated by the Executive Office of the President and composed of seventeen federal bodies, having the Brazilian Forum on Climate Change (FBMC) as an invitee. Its Executive Group, a subsidiary body, has the mission to elaborate, implement, monitor and evaluate the National Plan, being composed of eight Ministries and the FBMC and coordinated by the Ministry of Environment. The Figure 23 shows how it is formed.



Figure 23. Members of the Inter-Ministerial Committee on Climate Change (CIM) and its Executive Group.

MCTI bodies develop key actions regarding climate change, especially through the **General Coordination for Global Climate Change (CGMC)**, which is under the **Secretariat for Research and Development Policies and Programs (SEPED)**. The CGMC is the technical focal point of the UNFCCC in Brazil; its work covers the coordination and publication of studies and scientific research on global climate change, especially with regard to the Intergovernmental Panel on Climate Change (IPCC). Other programs under the CGMC mandate include the **National Climate Change Program** and the **Brazilian Research Network on Global Climate Change (Rede Clima)**. The Brazilian Research Network on Global Climate Change (Rede Clima). The Brazilian Research Network on Global Climate change in three subnetworks: Oceans, Environmental Services of Ecosystems and Natural Disasters. The Secretariat

Source: Own elaboration, based on MCTI, (2013) and CASA CIVIL, (2007).

also promotes liaison with research and development agencies and other public and private entities involved in implementing the **National Policy on Global Climate Change**. These activities ensure that the CGMC is an essential pillar in support of the Research and Development activities conceived under the **National Plan on Climate Change**. Finally, the CGMC is responsible for preparing **National Communications** to the UNFCCC and for providing the Executive Secretariat of the Inter-ministerial Commission on Global Climate Change.

The Secretariat of Strategic Affairs (SAE) has as its main objective to propose, together with other organisms and entities of the federal public administration, the elaboration of long term strategic actions and projects. The Executive Office of the President is responsible for the Action Plans for Preservation and Control of Deforestation of the Amazon and the *Cerrado* with the participation of Inter-ministerial groups. EMBRAPA (Brazilian Agricultural Research Corporation) is a public institution linked to MAPA in charge of research, development and innovation for the sustainability of agriculture and animal husbandry. The abovementioned Energy Research Company – EPE has the objective to perform services in research and studies aiming at subsidize the energy planning sector in the areas of electric energy, oil, natural gas, mineral carbon, renewable sources and energy efficiency, among others.

Regarding academic and research institutions, the main network is the **Brazilian Research Network on Global Climate Change (***Rede Clima***), which is linked to the Ministry of Science and Technology and based in INPE. Being financed by the Ministry, it was established in 2007 with the mission to generate and disseminate knowledge about the causes and effects of global climate change; it produces information for the formulation and follow up of public policies on climate change and to support the Brazilian negotiations under the UNFCCC. The Network involves 13 thematic sub-networks: Agriculture, Biodiversity and Ecosystems, Cities, Natural Disasters, Regional Development, Economy, Renewable Energy, Modeling, Oceans, Water resources, Health, Environmental Services and Coastal Zones.**

4.3.2 Plans, Programs and Other Actions

The **National Policy on Climate Change** was proposed by the Executive branch to the Congress in 2008. Although an agreed outcome was not reached at COP 15 in Copenhagen, the Government of Brazil indicated voluntary mitigation actions leading to an expected reduction of 36.1% to 38.9% to the projected GHG emissions of Brazil by 2020 (See **Figure 24**). This reduction target was established in the National Policy on Climate Change (Federal Law No. 12,187 of December 29, 2009). The policy provides for the elaboration of **sectorial plans for mitigating and adapting** to climate change, with a view to consolidate **a low carbon economy** and meeting the **national voluntary commitments** announced under this policy. **Figure 25** shows the main relations between entities linked to climate change and policies, plans and other actions.



Figure 24. Brazilian voluntary commitments for GHG emission reductions.

The **National Plan on Climate Change** was based on the general directives of the National Policy on Climate Change, The National Plan on Climate Change was approved in December 2008. It has four general themes: (I) mitigation; (II) vulnerability, impact and adaptation, (III) research and development; and (IV) enhancement of skills and dissemination. Its main objectives are: (i) to stimulate efficiency increase in a constant search for better practices in the economic sectors; (ii) to keep the **high share of renewable energy in the electric matrix**, preserving the important position Brazil has always held in the international scenario; (iii) to encourage the **sustainable increase in the share of biofuels in the national transport matrix** and work towards the structuring of an **international market of sustainable biofuels**; (iv) to seek for sustained reduction deforestation rates, in all Brazilian biomass, in order to reach zero illegal deforestation; (v) to eliminate the net loss of forest coverage in Brazil by 2015; (vi) to strengthen inter-sector actions concerned with the reduction of the vulnerabilities of populations; (vii) to identify environmental impacts resulting from climate change and stimulate scientific research that can trace out a strategy to minimize the socio-economic costs of adaptation in the country.

The National Policy on Climate Change also provides financial mechanisms aimed at supporting the implementation of the planned initiatives. The **Amazon Fund** (*Fundo Amazônia*), launched in August 2008, is a private financial instrument aimed at raising private grants in Brazil and abroad to reduce GHG emissions from deforestation in Amazonia.

The **Climate Change National Fund** (Law 12,114 - December 2009; regulated by the Decree 7,343 - October 2010) was established to secure resources to support projects and studies and to finance projects aimed at climate change mitigation and adaptation. Around 60% of the Fund's income derives from crude oil production and sales. This is the first fund of its kind in the world, with a projected initial budget of R\$ 226 million (US\$ 131,395,348). Of this total, R\$ 200 million, earmarked by BNDES for the production sector, will be released as loans and other 81

forms of credit. The remaining R\$26 million will be managed and invested by the Ministry of Environment, and could be transferred to States and Municipalities on the basis of cooperation agreements and conditions. Another financial instrument is the **ABC Fund** - low carbon emission in agriculture - with a budget of R\$2 billion (US\$ 1,162,790,697) in 2011.





Source: Own elaboration based on (CASA CIVIL, 2007, 2009; CIM/MMA, 2008; MCTI, 2013)

The Ministry of Science, Technology and Innovation also fosters studies on climate change mitigation through public selections and specific orders to research institutions. Many studies on energy efficiency and renewable energies are currently being financed. Grants are provided by the National Fund for Scientific and Technological Development (FNDCT)³⁵, which goal is to give financial support to priority projects and programs for scientific and technological development. Revenues come from specific taxes charged by the federal government. The National Fund is subdivided into the so-called *Fundos Setoriais* (Sector Funds), in which a portion of incoming resources from a given sector is used for generating and aggregating knowledge in the same sector.

³⁵ FNDCT: In Portuguese means: *Fundo Nacional para o Desenvolvimento Científico e Tecnológico*.

4.3.3 Baseline Scenario

In order to achieve the voluntary national greenhouse gas relative reduction target of between 36,1% and 38,9% set by the Brazilian National Plan on Climate Change the following actions are considered:

Land Use, Land Change and Forestry and Agriculture

- 80% reduction in annual deforestation rates in the Legal Amazon (range of estimated reduction: 564 million tons of CO₂ eq. in 2020);
- 40% reduction in annual deforestation rates in Cerrado biome (range of estimated reduction: 104 million tons of CO₂ eq. in 2020);
- Restoration of 15 million ha of grazing land (range of estimated reduction: 83 to 104 million tons of CO₂ eq. in 2020);
- Integration of 4 million ha to crop-livestock systems (range of estimated reduction: 18 to 22 million tons of CO₂ eq. in 2020)³⁶;
- Integration of 8 million ha to No-till farming systems³⁷ (range of estimated reduction: 16 to 20 million tons of CO₂ eq. in 2020);
- Biological N₂ fixation expansion in 5.5 million ha in substitution for N fertilization (range of estimated reduction: 16 to 20 million tons of CO₂ eq. in 2020)

Energy, Transportation and Industry

- Improvements in Energy efficiency (range of estimated reduction: 12 to 15 million tons of CO₂ eq. in 2020);
- Increased use of bio-fuels (range of estimated reduction: 48 to 60 million tons of CO₂ eq. in 2020);
- Increased energy supply by hydroelectric power plants (range of estimated reduction: 79 to 99 million tons of CO₂ eq);
- Increased use of alternative energy sources (range of estimated reduction: 26 to 33 million tons of CO₂ eq. in 2020);
- Increased use of charcoal from planted forests in the iron & steel industry (range of estimated reduction: 8 to 10 million tons of CO₂ eq in 2020).

The **energy baseline** emission should also consider, besides the PNMC, two of the major efforts of the Brazilian government to evaluate the country's overall energy system evolution in the medium term: the abovementioned 25 and 10-year Energy Plan (PNE 2030 and PDE 2020) published by the Energy Research Company (EPE).

³⁶ Plan for Low Carbon Agriculture (ABC).

³⁷ No-till farming system is an agro technique to plant the seed of sugar cane in the land when it is still covered by the straw from last harvest. It increases the organic matter and nutrients in the soil. This goal for emission reduction is considered in ABC Plan.

For the **industrial sector**, the only specific plan available to be used in order to determine the industry baseline emission is the **Plan for Reduction of Emissions of the Steel Industry**, which considers the replacement of non-renewable charcoal (from deforestation) by renewable forests planted for charcoal production for the iron and steel industry.

Another important plan that should be considered to analyse the **energy baseline emission** is the **National Plan for Logistics and Transport** (PNLT - *Plano Nacional de Logística e Transporte*), considering policies and measures for the transport sector, which was launched by the Brazilian Ministry of Transport in 2007.

Finally, regarding LULUCF, the baseline includes some measures considered by three plans: Action Plan for the Prevention and Control of Deforestation of the Legal Amazon (PPCDAm), Action Plan for the Prevention and Control of Deforestation and Fires of the Cerrado (PPCerrado) and Plan for Low Carbon Agriculture (*Plano ABC*).

4.4 Review of Strategies and Policies for Access to Modern Energy Sources

4.4.1 Rural Electrification Programs

Governments have often made of rural electrification an agenda issue. This is also the of Brazil where, in the beginning of 1960s, the possibility of financial assistance for rural electrification initiatives was discussed. This fact set the beginning of an age characterized by public sector engagement for rural electrification in Brazil.

In 2003 the Brazilian government proposed the "*Luz para Todos*" Program (LPT) (Light for All) aiming at universalizing electricity supply by 2008 (NIEZ, 2010). Targets and objectives of LPT were reformulated in order to be achieved until 2014. The original target of LPT was to supply electricity to 2 million households, equivalents to 10 million inhabitants, spread out mainly through the poor rural northeast region and the Brazilian Amazon Region. This goal was achieved in 2009. In September 2011, 2.8 million households (14.2 million inhabitants) were attended (BRASIL, 2013). According to ANEEL Normative Resolution Nº 488 of 2012, between 2012 and 2014 an additional 347 thousands households are expected to be interconnected.

Government defined the program as a "proposal for the reduction of poverty and hunger, using electricity as a vector for development" (MME, 2003). New served consumers would receive these services at affordable prices without paying additional tariffs. This underlines that rural electrification continues to be prioritized as a key element in Brazil's overall poverty alleviation strategy (GOLDEMBERG et al., 2004; ESMAP, 2005).

In fact, the Brazilian government has shown a strong interest on promoting development in poor regions in the last decade, especially the rural northeast. These approaches include social programs (old age pensions or, conditional cash transfer programs for extremely poor families through the Family Fund program, short PBF), agricultural policies (including the National

Program on Biodiesel Production and Use that focuses on the social inclusion of family farmers in the northeast), food and nutrition security or microfinance (HELFAND et al., 2009; ARAUJO and LIMA, 2009; CONSEA, 2009; OBERMAIER, 2011).

4.4.2 Natural Gas Penetration

In Brazil, natural gas has showed competitiveness in several sectors (industry, transport petrochemical and power) in comparison to other fuels.

The penetration in residential and commercial sectors depends on the availability of a distribution network, which is a direct responsibility of each geographical region concessionary. The rate of penetration is more accelerated when municipal construction codes related to the installation of natural gas in residential and commercial buildings are established. These codes encourage the dissemination of natural gas distribution networks (CATARINA, 2002).

Distribution of natural gas until 1988 was made by two concessionaries located in the states of Sao Paulo and Rio de Janeiro. For other states Petrobras supplied the industrial demand as a vertically integrated company.

Currently, there are 27 concessionaries for natural gas distribution. In most of them, Petrobras holds capital shares. Until the Law No 11.909 of 2009, the Law of Natural Gas, the transport related activities only could be done by Petrobras, the National Oil Company of Brazil. However the new law opens transport, exportation and importation of natural gas to other companies by regimes of concessions (previously auctioned) or by explicit authorization. Ministry of Energy and Mines proposed the expansion and construction of current gas pipelines.

The Ten Year Plan for Energy Expansion (PDE 2021) (EPE, 2013) expects that the natural gas consumption in Brazil, that in 2012 was estimated in 72 millions of m3/day, will rise in 67 million m^3 /day until 2021. 30% of this consumption woud be used as non-energy consumption in refineries and fertilizing plants. It is expected for 2021 that natural gas production could be close to 139 million of m^3 /day, from which 18 million of m^3 /day will be required for the operation of projected thermal plants

During 1997, was created the Project Burn Zero (*Projeto Queima Zero*) in the Campos Basin (main Brazilian oil production region), aiming at improving the use of natural gas in this region. The objective of the project was to increase the availability of natural gas, to improve the energy use and to reduce greenhouse gases emission

In 2000, considering the possibility of an energy sector crisis in Brazil, Petrobras and ANP intensified the control of gas burning in the Campos Basin, which led to the creation of Optimization Use Plan for Campos Basin's Natural Gas (POAG).

The POAG included the installation and re-design of compressors and also the construction of new offshore gas pipelines. This combination of actions allowed exporting natural gas to the continent.

4.4.3 Social Tariff in Electricity, GLP, and Natural Gas

There is an energy policy in Brazil related to a social tariff for low income consumers. The Law N° 12.212 from 2010, disposes that Social Energy Tariff, created by Law N° 10.438 from 2002, should consider discounts applied to the residential class as follows:

The first 30kWh/month of consumption receives 65% of discount. Then, the consumption band between 31 kWh/month to 100 kWh/month receives 40% of discount. Following the same principle, between 101 kWh/month and 220 kWh/month the discount will be 10%. Finally, over 220 kWh/month there will not have any discount.

The Social Energy Tariff is applied to the consumer units classified within the Low Income residential sub-category, for families registered in the Unique Registry for Social Programs of the Federal Government, with a monthly familiar income per capita lower or equal to the half of the national minimum salary or for families which have between its members a person receiving the benefits³⁸ associated to the continue provision of social assistance.

Additionally, Indigenous and quilombolas families registered in the Single Registry have a discount of 100% up to 50 kWh/month (MME, 2012).

On the other hand, for natural gas, as regulation for distribution relies on States, there are no national policies for social tariffs related to this resource. However, in the State of Rio de Janeiro, according to the Decree N° 42.884 of 2011, there is a social tariff for distributed natural gas for low income families supplied by CEG and CEG-Rio concessionaries registered in the *"Minha Casa Minha Vida"* Social Program. In the State of São Paulo, the Regulatory Agency "ARSESP", dispose a social tariff for retired people, who consumes until 7 m³/month of natural gas. This social tariff considers a 10% discount on the base value.

For LPG, there are neither subsidies nor social tariffs since 2002. In 1990 it was determined that each LPG distribution company could have their own price. Since 2001, the Government eliminated the subsidies for the product, authorizing Petrobras to practice prices according to the international parity. In December 2001, the "specific price parcel" (also known as "conta petróleo") that used to smooth the prices affected by international market was eliminated.

³⁸ Social tariff consists on a 10% discount for pensioners who consume until 7m³/month of natural gas.

4.4.4 Specific Programs for Slums and Settlements

Currently, The Second Phase of the Growth Acceleration Program (PAC), is the most important governmental program that includes an upgrade of living conditions in slums and settlements. Among the components of this program, projected from 2011-2014, there is the initiative Citizen Community, that seeks to increase the availability of State services in poorer districts with an estimated investment of R\$ 23 billion (US\$12.6 billion)

4.4.5 Urbanization Actions to Improve Access to Assets for Poorest

The Second Phase of PAC includes the "My House, My Life" initiative that seeks to reduce the housing deficit by urbanizing the informal settlements, stimulate the civil construction sector and create jobs. This initiative has an estimated investment of R\$ 278.2 billion (US\$ 152.5 billion).

4.4.6 Special Financing Programs for Energy Efficiency Appliances

The main sources of financing energy efficiency projects are the "Banco Nacional de Desenvolvimento Econômico e Social" (BNDES), a "Caixa Econômica Federal"-(CAIXA), e a "Financiadora de Estudos e Projetos" (FINEP) (MME, 2011).

Among the financing lines of BNDES, the PROESCO Program provides credits or loans to energy service companies, energy end-users and utilities. These loans and credits cover installation and related services, new equipment, information, monitoring and control, and energy audits (BNDES, 2013).

Also, Brazil adopted an utility Energy Efficiency Program in 2000 that demands utilities to spend a minimum of 0.5% of their revenues on energy efficiency programs (ACEEE, 2012).

Recently, Inter-American Development Bank (IADB) approved its Energy Efficiency Finance Facility Program (IADB, 2013), to support Latin American and Caribbean companies to make investments in energy efficiency and small-scale self-supply renewable energy projects that would reduce energy costs and greenhouse gas emissions.

4.4.7 Integral Programs to Reduce and Alleviate Poverty

There are two key programs, the first one is the "*Bolsa Família*, which is a conditional cash transfer program that increases the incomes of the poorest families while promoting health and education; the second one is the "*Brasil sem Miséria*", which is an extension of Bolsa Familia focused on people living in extreme poverty and that includes elements for social inclusion in the productive sector and access to public services. The target public of the "*Brasil sem Miséria*" Plan, launched in June 2011, is approximately 16.2 million Brazilians identified by the 2010 Census who are still in situation of extreme poverty, defined as receiving a monthly income below R\$ 70 (MDS, 2013).

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5. Policy Review: Mexico

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5.1 Identifying energy policy objectives and their link to Climate Change

5.1.1 Historical pace

In 1993, Mexico adhered and ratified the commitments made in the United Nations Framework Convention on Climate Change of 1992. Later, on June 9, 1998, Mexico signed the Kyoto Protocol and ratified it on April 29, 2000, by a unanimous vote in the Senate. Since then, Mexico has developed an active role in international forums and has attempt to meet its commitments at national level by adopting public policies on environmental and energy issues, especially to towards energy transition.

It's important to note that although Mexico had adhered to international treaties and agreements to combat Climate Change since the early 90's, it was until the year 2007 via the National Development Plan (NDP) 2007-2012 and the Energy Sector Program (ESP) 2007-2012 when for the first time was officially given a priority role to climate change and sustainable development issues.

The ESP 2007 - 2012 included sectorial objectives, goals, strategies and action plans which were mainly based on: ensuring the supply of energy as required by the economy; strengthening public sector companies in order to improve the opportunity and quality in the provision of public services, and promoting energy efficiency and renewable energies to reduce the environmental impact derived from fossil fuel use.

However, the turning point was the legal and institutional energy reform process experienced by the country during the year 2008. As a result, the following laws were passed: the Law for the Promotion and Development of Bioenergy (LPDB), the Law for the Sustainable Use of Energy (LASE) and the Law for the Use of Renewable Energies and Financing of Energy Transition (LAERFTE).

During the former government administration (2006 - 2012) were implemented the following strategies, plans and programs, most of them limited to the year 2012:

- <u>The National Strategy for Climate Change (ENACC) of 2007</u> identified mitigation and adaptation opportunities.
- The Special Program for the Development of Renewable Energies 2009-2012 focused on public policies for renewable energy utilisation. Its overall objective was to promote the use of renewable energy by establishing goals, objectives and actions. Specific objectives were to promote the development of a renewable energy industry in Mexico, to enlarge country's energy portfolio, to increase energy security so as not rely on a single source of energy, and to increase the electricity coverage in rural communities by using renewable energies where it is neither technically nor economically feasible to connect to the network. In order to

meet these objectives, it established the following strategies and general action lines: Promotion of information, development of support mechanisms for renewable energy utilisation, electrification using renewable sources, infrastructure and regulation, and research and technology development.

- The National Program for the Sustainable Use of Energy 2009-2012 identified seven areas of cost-effective opportunities to increase energy efficiency and reduce energy consumption in the medium and long term. These areas were: transport, lighting, household equipment, cogeneration, buildings, industrial motors and water pumps. It was expected that specific action lines to each area of opportunity would have resulted in cumulative energy savings of 4,017 terawatts-hour or equivalent to about three years of final energy consumption at current rates up to the year 2030. Similarly, the estimated impact of these strategies would have reached 16,417 terawatts-hours in 2050.
- <u>The Climate Change Special Program (PECC)</u> was developed for the 2009-2012 period and outlined and developed the guidance contained in the ENACC. The PECC was a cross-cutting policy instrument of the Federal Government developed voluntarily which seek the mitigation and adaptation to climate change, with no negative impact on the economic growth. It involved agencies of the Federal Government with 105 objectives and 294 goals of mitigation and adaptation for the years 2009-2012.

Although the NDP 2007-2012 and the ESP 2007 - 2012 have completed their execution time, they laid the foundation for an energy transition in the country in the short, medium and long term, as they have been the framework for implementing new developments and promotion policies (i.e. laws, strategies, plans, programs, courses of action, etc.) for renewable energy, energy efficiency measures and climate change mitigation.

Similarly, from 2008 to the third quarter of 2012, PECC 2009-2012 achieved an accumulated emissions reduction of 129 MtCO2 eq. According to the progress reviews, by late 2012, Mexico was expected to have exceeded its PECC annual mitigation goal by 4% (52.76 MtCO2 eq. /year). The PECC was useful to establish federal government strategies against climate change in the short term and outline the medium- and long-term goals. In its long-term vision, it considers a flexible convergence towards a global average of 2.8 tons of CO2 eq. emissions per capita.

5.1.2 Current context

5.1.2.1 Mexican Energy Sector Stakeholders and Main Competences

The energy sector of the country is coordinated by the Ministry of Energy (SENER). Its mission is to lead the country's energy policy within the constitutional framework while ensuring competitive, sufficient, high quality, economically and environmentally sound energy required for the development of domestic economy. SENER is in charge of the medium and long term planning of the energy sector in the areas of fossil fuels, electricity, energy efficiency and renewable energy in the context of ensuring energy security.

Mexico's energy sector is divided into the oil and electric power sectors. It also includes other entities that are responsible, within their competence, to provide various services. The Mexican Petroleum Institute (IMP), the Electrical Research Institute (IIE) and the National Institute for Nuclear Research (ININ) develop scientific research, providing technological innovation elements for PEMEX and CFE with the aim of increasing their competitiveness while providing better products and services. They also promote the formation of specialized human resources in order to support domestic oil and electric power industries.

The Energy Regulatory Commission (CRE) regulates the gas and electricity industries. The main functions of CRE are to grant permits, authorize prices and rates, approve terms and conditions for the provision of services, issue directives, resolve disputes, request information and impose sanctions, among others. Regulated activities include: Supply and sale of electricity to public service customers; private sector generation, import and export of electricity; acquisition of electricity for public service; transmission services between agencies that provide public service and generation, export and import permit holders; first-hand sales of natural gas and LPG; transportation and storage of natural gas that is not related to exploration or production; natural gas distribution, and transportation and distribution of LPG through pipelines.

The National Hydrocarbons Commission (CNH) regulates and supervises primary exploration and extraction of hydrocarbons, which are in beds or reservoirs, whatever their physical state, including the intermediate states, and that are components of crude mineral oil, are associated with it or result from it, as well as processing activities, transportation and storage directly related to hydrocarbon exploration and production projects. The CNH ensures that the exploration and exploitation projects of PEMEX and its subsidiary companies are performed pursuant to the following bases: Increase the recovery factor and obtain the maximum volume of crude oil and natural gas in the long term, in economically viable conditions for wells, fields and abandoned reservoirs, or in process of abandonment or exploitation; the replacement of hydrocarbon reserves based on available technology and in-line with the economic viability of projects; environmental protection and sustainability of natural resources during hydrocarbon exploration; minimizing flaring and venting of gas and hydrocarbons during their extraction, among others.

The National Commission for Energy Efficiency (CONUEE) is a descentralized administrative agency of SENER, with technical and operative autonomy. It aims to promote energy efficiency and establish itself as a technical body, created from the entry into force of the Law for the Sustainable Use of Energy, published on November 28, 2008, in terms of sustainable use of energy. In terms of regulations, CONUEE's responsibilities are: Binding opinions to the agencies of the Public Federal Administration, in relation to best practices for sustainable use of energy; issue recommendations to states, municipalities and individuals in relation to best practices for sustainable Use of Energy, among others. In terms of Public Policies for Sustainable Use of Energy: Develop and issue methodologies for the quantification of greenhouse gas emissions by the exploitation, production, processing, distribution and consumption of energy as well as

emissions avoided, due to the inclusion of actions for the sustainable use of energy, among others. In terms of the Promotion and Dissemination: Prepare and publish books, catalogs, manuals, articles and technical reports on the work undertaken by the Commission; participate in the dissemination of information between government and social sectors, among others.

The National Commission on Nuclear Safety and Safeguards (CNSNS) is a semi-autonomous body under the authority of the Ministry of Energy which takes the role of regulator. CNSNS is responsible for ensuring the proper application of regulations and safeguards for nuclear and radiation safety and for physical protection of nuclear and radiological installations to ensure public safety.

The oil sector

Petroleos Mexicanos (PEMEX) is the state-owned public company which has a constitutional regime for the exploitation of energy resources (mainly oil and natural gas) and refined products in Mexico. As of year 2010 the average production of crude oil reached two million 576 thousand barrels a day. PEMEX is the fifth crude oil producer worldwide and it is of the few oil companies of the world that develops all the productive chain of the industry, from the exploration, to the distribution and commercialization of all the products. It also represents the most important source of government income and the most important company of the country. Its mission is to maximize the economic value of hydrocarbons and by-products while meeting the domestic demand of petroleum products with the required quality, in a safe, reliable, cost effective and sustainable way. PEMEX operates by the conduct of a Corporative Office and four Subsidiary entities, namely: PEMEX Exploración y Producción (Exploration and Production), PEMEX Refinación (Refining), PEMEX Gas y Petroquímica Básica (Gas and Basic Petrochemicals), PEMEX Petroquímica (Petrochemical). In addition, PEMEX and their four Subsidiary Organisms have participation shareholder in 40 companies. Out of these companies, four are of majority state participation, meaning that PEMEX or some of their Subsidiary Organisms own more of the 51 percent of their capital. The companies of majority state participation are: PMI Comercio Internacional, S.A. de C.V., Compañía Mexicana de Exploraciones, S.A. de C.V, Instalaciones Inmobiliarias para Industrias, S.A. de C.V. and III Servicios S.A. de C.V.

The electric power sector

The Federal Electricity Commission (CFE) is a state-owned utility that provide electricity in Mexico and is active in generation, transmission and distribution. CFE owns 39 GW of power capacity mainly from thermal sources and serves to 36.8 million users nationwide. CFE is by law in charge of purchasing the electricity generated by independent power producers.

5.1.2.2 Legal and regulatory framework

The Constitutional Framework that governs the energy sector in Mexico is rooted in Articles 25, 27 and 28 of the Mexican Constitution.



Figure 26. Structure of the Mexican Energy Sector

The oil sector

The Regulatory Act of the Constitutional Article 27 on Petroleum defines the oil industry and establishes the regulatory industry structure. Furthermore, this act determines the activities defined as strategic and reserved only to the government (exploration, extraction, production and "First-Hand Sales") and those activities open to private participation (construction, operation, transportation, storage, and distribution, including international and domestic commercialization).

CRE promotes and enforces the efficient development of the following regulated activities:

- Natural gas first-hand sales
- Liquefied petroleum processing
- Natural gas transportation, distribution and storage

The electric power

The Constitution establishes that generation, transmission, distribution and supply of electricity to be used as public service are exclusively federal government responsibility and shall not be considered monopolistic activity. According to law, generation, transmission, distribution and sale of electricity for public service are carried out by two government-owned electric utilities: the CFE and the Central and Light Power Company³⁹ (LFC).

Legal framework for the development of electric power generation in the Mexican sector was established by means of the Amendment to the Public Electricity Service Law of December 1992 (LSPEE). It allowed for private sector participation in cogeneration, self-supply, small power producer, independent power producer, import and export projects. However, none of these newly allowed modalities can supply electricity for public service, since this activity is constitutionally reserved to the nation through a public utility, the Federal Electricity Commission (CFE).

CRE promotes and enforces the efficient development of the following regulated activities:

- Public service electricity supply
- Electricity generation of private parties
- Exports and imports between private parties
- Electricity acquisitions for public service
- Transmission services between the supplier and private generation permit holders.

In Mexico the tariff system is set by the Ministry of Finance and Public Credit (SHCP) in coordination with SENER, the Ministry of Economy (SE), the CFE, and the CRE. The tariff system is highly subsidized and none of the consumer segments have a tariff that covers the cost of providing the service.

³⁹ CFE has taken over the activities of this former state owned company. LFC was closed by the Federal Government due to its unsustainable financial situation (represented in labor and pension costs) and the large amount of energy losses in its system (32.5 %). The closure of LFC was in line with the Federal Government's strategy to reduce public spending in order to respond to the financial crisis. LFC was responsible for the supply of electricity to the central area of the country with 6 million customers that accounted for 24 % of the total electricity consumption. The company was mainly involved in distribution and retailing of electricity and had around 1 GW of installed capacity.



Figure 27 Organization of the electric power sector in Mexico

Legal conditions schemes for renewable energy and sustainable use of energy

Mexico has started a transition towards a clean energy future in order to reduce its dependence on fossil fuels. As of year 2008, an energy reform consisting of a package of the following laws and decrees that created or modified existing laws in the areas of fossil fuels and renewable energies was approved:

- Law for the Promotion and Development of Biofuels (LPDB): This law regulates the promotion and development of biofuels with the aim of achieving energy diversification and sustainable development as well as creating adequate conditions to the Mexican rural sector. SENER is the body in charge of issuing permits for the activities of production, storage, transport, distribution and retailing of biofuels carried in pipelines.
- Law for the Use of Renewable Energies and the Financing of the Energy Transition (LAERFTE): In accordance with its first article, the goal of this law is "...to regulate the use of renewable energies and clean technologies for power generation in different purposes than those of public service; to establish a National Strategy and the instruments for financing the energy transition". This law mandates SENER to elaborate and coordinate the Special Program for the Use of Renewable Energies (PEAER) and the publication of a National Strategy for Energy Transition and the Sustainable Use of Energy. This strategy is included in

the Federal Expenditure Budget by means of a Fund for the Energy Transition and the Sustainable Use of Energy. Finally, the SENER will update this strategy every year.

- Law for the Sustainable Use of Energy (LASE): The purpose of this law is "...to favor the sustainable use of energy through its optimum use along all processes and activities, from its exploitation to its consumption. It fosters indirectly the use of ER, since the definition of energy efficiency, contained in this law, states that "it is also included... the substitution of non-renewable for renewable energy sources". This law also mandates CONUEE to present a National Program for the Sustainable Use of Energy (PRONASE) one year after the publication of the law and "...will be in force over the current federal government administration.
- <u>Environmental Protection Law</u>: This law mandates that power generation plants larger than 0.5 MW regardless of the technology, require Environmental Authorizations from SEMARNAT. In addition, small hydro power projects do not require water concession permits from the National Water Commission. Finally, at the local level, municipalities also enact land use permits for the construction, installation and operation of infrastructure.
- <u>Rent Taxation law</u>: According to this law, the entities that invest in equipment and machines for the generation of renewable energy can depreciate 100 % of the investment in the first year (tax credit scheme).
- <u>Interconnection contracts</u>: The use of renewable energy sources, such as wind, hydro, biomass, biogas, biofuels, is allowed and encouraged for private investors via specific grid connection contracts. The general conditions for generation, connection and transmission of energy generated from renewable sources include interconnection contracts that are established in three complementary regulations. The most relevant aspects of these regulations are:
 - CFE commits to receive the energy generated by renewable source at any time it is produced if this reception does not compromise the stability, security and reliability of the system.
 - The energy that is not used by a generator in a specific period can be delivered to the CFE and it has the obligation to return it when requesting for it (energy bank scheme). This exchange is an administrative procedure that does not involve a physical exchange of electricity.
 - The energy exchange is carried out in the interconnection point of the project with the National Power System and its price depends on the energy price on such an interconnection point that varies with the load of the system.
 - As a preferential condition for renewable energy projects, transmission charges are fixed for each voltage level regardless of the location of the interconnection point.

5.1.3 Limitations on the current energy pattern

Mexico's proven oil reserves have fallen from 23.5 to 13.81 billion barrels in the 2000 - 2012 period as national production stabilizes after the decline of its major oilfield, Cantarell, which as of year 2010 produced 21.7% of total production. Furthermore, national energy consumption has not yet been decreased significantly. This fact has led to a situation where Mexico's proven 99

oil reserves were estimated in only 10.2 years at current production rates and it may become an energy importer in the mid-term, which in turn would result in a trade imbalance with abroad. Recovery rates of proven oil reserves accounted for 101.1% as of January 1st, 2012.

With regard to the environmental front, the Mexican energy system emits 503 million tonnes of CO2equivalent. Out of this total, emissions from power generation account for 22.9% (115.53 million tonnes of CO2equivalent). Given this emissions level, it is very likely that the country will be subject to significant international pressure to limit its CO2 emissions.

Similarly, this energy pattern has contributed to an increased local pollution, deteriorating soils, rivers, forests and marine areas. This is due to the extensive use of hydrocarbons over all different stages —production, transport, transformation and distribution— and to the emission of local pollutants such as NOx, SOx and particulate matter, ranking the country as number 43 in the Environmental Performance Index —below other less developed economies such as Ecuador (ranked 30th) or Cuba (ranked 9th)—.

It is expected that besides international pressure to reduce greenhouse gases emissions, there will be others increasingly important factors to put pressure for change on the energy pattern such as the increasing internal demands of ecologist groups, the claims of society to offset environmental damages caused by conventional energy sources, the political agenda and the establishment of more stringent environmental regulations.

On the other hand, this energy pattern has been accompanied by the consolidation of a structure of public monopolies in the Mexican energy sector, namely: PEMEX in the field of hydrocarbons and the CFE in the electric power sector. This monopoly structure has fostered a centralized generation power system which is essentially based on large power stations. As a result, distributed power generation systems, which are smaller in size and with high potential to directly promote social, productive and regional development through the use of local or regional renewable energy resources, face important difficulties to pave the way in Mexico.

Mexico's response to this problem has been inadequate. Since early 90s the Mexican energy sector increased the use of natural gas due to its lower emissions and higher efficiency for use in combined-cycle power plants. However, this boom in the demand for gas has brought negative consequences such as the contribution to a foreign trade imbalance —as a result of increased gas imports to meet the demand— and a significant energy dependence. According with data of the Natural Gas Market Outlook, there will be a trade balance deficit in the 2011 - 2026 period and would amount to 1,699 million cubic feet per day (MMcfd) in the year 2011 and 3,816 MMcfd (29% of the gas consumed in Mexico) at the end of the study period.

The problem of such unsustainable energy pattern in Mexico makes imperative and indispensable its substitution for an energy pattern that favors and boosts the country's sustainable development. In this view, renewable energies represent the most important alternative for Mexico, since there are plenty of these resources.

Although there still too much to do in renewable energy resource assessment, and due to the fact that current data are just partial estimates, the country has an average daily insolation of 5 kWh/m2 —an enormous potential for solar energy in relation to current energy needs—. There is also a huge potential for wind energy, since the estimates for a single state, Oaxaca, indicate that it is possible to install up to 33,000 MW of power capacity. The feasible potential for geothermal has been estimated in 11,940 MW and there is still an important potential to be used, since geothermal totals 964.5 MW of the total installed power capacity so far.

As for bioenergy potential assessment, it ranges from 3,035 PJ/year to 4,550 PJ/year, which would represent between 54% and 81% of the 2002 gross domestic energy supply. With regard to hydro resource, estimates point out that there is a potential of 3,250 MW in mini-hydro projects, while there is an additional of 49,750 MW in conventional hydro projects -11, 050 MW or 22% of the total potential have been used so far -.

5.2 Review of national plans or actions and measures

5.2.1 National Energy Strategy (ENE) 2013-2027

Mexico's current energy policy is basically described in the National Energy Strategy (ENE) 2013-2027. This strategy promotes the social inclusion of the population to the benefits derived from the energy use, the long-term sustainability of the sector and the mitigation of negative impacts that energy production and consumption may have on health and the environment, including the reduction of Greenhouse Gases. Also, the ENE includes four "Policy Measures" that correspond to the major tasks to be undertaken by both the supply and demand side in order to achieve strategic objectives of the ENE. These policy measures focus on: transportation systems, storage and distribution of fuels and electricity transmission and distribution, refining, processing and generation, oil production, and energy transition.

Additionally, it sets out a legal target to increase the share of non-fossil energy in the portfolio of primary energy sources for electricity generation in at least 35% by 2024. In terms of energy transition, which includes renewable energy and efficiency in the sector, SENER proposes the following three scenarios so as to achieve 35% energy generation from non-fossil sources in 2024.

- The first scenario considers a project portfolio consisting of wind farms that contain 28% capacity backed up with gas turbine technology.
- The second scenario only considers the construction of 7 or 8 nuclear power plants, with an installed capacity of 1,400 MW each and 20,900 MW of wind power.
- The third scenario examines a hybrid scheme of nuclear power plants and wind farms, which includes two nuclear power plants with a capacity of 1,400 MW each and 20,900 MW of wind power.

5.2.2 National Development Plan 2013-2018

Current National Development Plan 2013-2018 recognizes the importance of renewable energy sources to address climate change and environmental degradation. It does not only emphasizes the uncertainty, the volatility and the negative impact that hydrocarbons impose on environment but also acknowledges the role that renewable energy based generation technologies may play in addressing the challenges of energy security and diversification.

More specifically, objective 4.6 raises the need to supply country's energy requirements with competitive prices, quality and efficiency along the productive chain. This involves increasing the capacity of the state in order to ensure the supply of crude oil, natural gas and gasoline; strengthening the rational supply of electricity; promoting the efficient use of energy and the use of renewable sources by adopting new technologies and the implementation of best practices, besides strengthening the development of science and technology as a priority issue for the energy sector.

5.2.3 Crude oil outlook 2012-2026

Under the Inertial Scenario assumptions, production is expected to average 2,808 thousand barrels of oil and 7,356 million cubic feet per day of natural gas (hydrocarbon) for the 2012 - 2026 period. This scenario foresees that first deep-water production of natural gas will take place in year 2015, while oil will begin in 2021. National refining capacity will be 1,690 thousand barrels per day up to the year 2015 and will reach 1,940 thousand barrels per day at the end of the prospective period.

As for the Inertial Scenario, the average production will reach 2,937 thousand barrels of oil and 8,061 million cubic feet of natural gas during the same period. Deep water projects will be the same as in the inertial scenario but with higher production rates. Additionally, from 2018 onwards an enhanced oil recovery program will take place.

Exports are expected to be reduced from 1,247 thousand barrels per day in 2012 to 1,164 thousand barrels per day in 2026 in the inertial scenario, while they are expected to increase to 1,690 thousand barrels per day in 2026 in the ENE scenario.

5.2.4 Electricity sector outlook 2012 - 2026

Under the inertial scenario assumptions, it is foreseen that the expansion of the electric power sector will integrate a 30.3% share of installed capacity based on non-fossil and renewable energy sources in 2026. It is estimated that installed capacity in hydropower will account for 18.0%, wind power 8.2%, nuclear 1.7% and the remaining 2.4% in geothermal, solar and biogas. On the other hand, the ENE scenario, which envisages the capacity goal outlined in the National Strategy for Energy Transition and the Sustainable Use of Energy, increases the participation of non-fossil generation sources to 35% in 2026.

Both, Inertial and ENE scenarios, considers a future demand of electricity that is estimated in 445.1 TWh in 2026, representing a growth rate of 4.7% per year for the prospective period. The sector with the highest consumption in 2026 will be the industrial, accounting for 58.4% of total sales of public service and then followed by the residential sector with 25.5%. However, the fastest growing sector will be the commercial sector with a growth rate of 6.1% per year.

5.2.5 Programs and Strategies for renewable energy and sustainable use of energy

The following list presents several support programs, strategies, and support schemes for renewable and the sustainable use of energy:

- A number of sectorial funds of the National Council for Research and Development (CONACYT): Funds like the institutional fund of regional promotion for scientific development, technology and innovation, or the Upfront Fund (Fondo Avance) have the target to finance the applied research and innovation activities of research institutes, universities and private companies by providing grants, seed capital, guarantees, and tax discounts. Accesses to these funds depend on the thematic call for proposals organized by CONACYT.
- Sectorial Fund SENER CONACYT Energy Sustainability fund: This fund is being established to finance scientific research and applied technological develop-ment in the field of sustainable energy. The project leader should be a Mexican university or research institute. Resources for this fund come from an equivalent right to 0.13% of the value of crude oil and natural gas extracted by PEMEX.
- Fund for the energy transition and the sustainable use of energy. The fund provides loan guarantees for energy efficiency and renewable energy technologies. The National Bank for Public Services and Constructions operates the fund. A technical committee has the responsibility to disburse the fund resources.
- Sustainable lighting program, with the objective of replacing 47 million incandescent light bulbs for compact fluorescent lamps. This program is the world's largest of its kind.
- Appliance modernization program, grants subsidies and loans for the purchase of new air conditioning and refrigerator units in exchange for old appliances to be scrapped.
- Green mortgages, provides additional financing for the purchase of green technologies in new households. Water and energy savings can reach 2-3% of household income. This program can grow to cover 2.7 million additional credits between 2013-2020.

5.3 Review of the national strategy on climate change

5.3.1 Institutional arrangements

Mexico places great importance on the actions that contribute to the mitigation of GHG emissions. The Inter-ministerial Commission on Climate Change (CICC) coordinates the activities of the different agencies of the Federal Public Administration (APF) regarding climate change. Federal agencies have made substantial progress on institutional arrangements to address the climate change problem.



Figure 28 Structure of the Inter-ministerial Commission on Climate Change, September 2012

Regarding the National Communications, the National Institute for Ecology and Climate Change (INECC), the former INE, and the Ministry of the Environment and Natural Resources (SEMARNAT) leads and coordinates its development. This integration is carried out with the participation of the federal, state, and municipal agencies, research centers, and public and private higher education institutions, as well as of civil and private sector organizations.

Within the scope of their powers, the different States establish local offices of Inter-ministerial Commissions on Climate Change charged with coordinating the appropriate public policies, designing or modifying their laws to include climate change issues aligned with Federal Government provisions. They also make progress on the development of the State Action Plan on Climate Change (PEACC).

Municipal governments appoint the personnel to lead and/or coordinate the activities of the municipality in the development of the Municipal Climate Action Plan (PACMUN) working with the academia and other stakeholders.

5.3.2 National policy on climate change mitigation

Mexico became the first developing country in enacting comprehensive climate change laws. The Climate Change General Act (LGCC) is an instrument of public interest enforceable in all the national territory. Its publication in June 2012 made the climate change policy legally binding, including mitigation goals such as the **30% reduction of emissions by the year 2020** in relation 104

to a baseline and the **50% reduction by 2050** in relation to the year 2000. It also sets a goal of clean energy penetration into electricity generation, which must reach **35% of total installed capacity by 2024**. LGCC also establishes provisions for mitigation in the three orders of government: federal, states and municipalities.

According to a study by the Mexican Institute for Competitiveness (IMCO) to estimate the potential of the PECC goals by 2020, it will be possible to reduce 195 MtCO2 eq. by contemplating the additional potential in certain measures, the entry into force of new standards and the substantial boost given to various programs, the implementation of the REDD+ mechanism and electricity generation using clean technologies. This study also points out that achieving the goals for 2020 and 2050 will require incorporating an additional 17 actions as well as a combination of NAMAs, which would contribute 46.5 MtCO2 eq. of mitigation in 2020.

5.3.2.1 BAU scenario and potential for GHG emissions reduction in Mexico

Using information from the 2006 National GHG Emissions Inventory, historical data and economic and population growth projections for sectors with the highest emissions, a baseline was constructed representing a BAU scenario. This baseline was constructed on the assumption of 2.3% annual GDP growth between 2006 and 2020.

GHG emissions in Mexico are expected to rise to **872 MtCO2 eq. in 2020**, and **996 MtCO2 eq. in 2030**. The sectors with the highest GHG growth and emissions will be electricity generation and transportation. For 2020, **the abatement potential identified is 261 MtCO2 eq.**, which represents a **30% reduction** of the GHG emissions baseline in regard to the BAU scenario. For 2030, **the potential is 523 MtCO2 eq.**, a **53% reduction**.



Figure 29 CO2e Mitigation Potential in Mexico, 2020 – 2030

Breaking down the abatement potential at sectorial level (See Figure 5), power generation (60 MtCO2e), forestry (58 MtCO2e) and transportation (37 MtCO2e) would account for nearly 60% of total estimated reductions for year 2020. The remaining sectors such as waste (26 MtCO2e), industry (25 MtCO2e) and agriculture (20 MtCO2e) altogether would represent 27% just followed by the oil and gas (19 MtCO2e) and buildings (17 MtCO2e) both accounting for the remaining 13%. In order of magnitude, reduction potentials as a share of total avoided emissions would remain the same for year 2030 except for waste (88 MtCO2e), transportation (79 MtCO2e), and industry (59 MtCO2e) which would increase their participation, being the most significant increase found in waste with 7 % in relation to its 2020 share. In contrast, power generation (112 MtCO2e), forestry (96 MtCO2e), agriculture (79 MtCO2e), oil and gas (23 MtCO2e) and buildings (27 MtCO2e) would slightly decrease their share in relation to that of the year 2020.

5.3.2.2 Mexico's Mitigation Portfolio 2010- 2020

On the basis of cost-effectiveness, priorities and sectorial barriers for each of the actions analyzed, a portfolio of over 150 projects has been identified with a total abatement potential estimated at 130 MtCO2 eq. annually by 2020, representing half Mexico's goal for that year. Over 100 of these projects are currently underway and represent a mitigation potential of 70 MtCO2 eq. for 2020.

This portfolio includes several types of initiatives: standards and regulatory, development and technological substitution, social programs, best practices, capacity building, etc. The projects are at various stages of design and execution. The greatest potential for reduction in these projects (92 MtCO2 eq., 70% of the total portfolio) is concentrated in the forestry, agriculture, oil and gas industries and energy efficiency sectors.



Figure 30 Sectorial distribution of CO2e Mitigation Potential in Mexico, 2020 – 2030

5.3.2.3 Financial Analysis of Mitigation Actions

Preliminary analyses suggest that achieving a reduction of 261 MtCO2 eq. by 2020 will require an investment of nearly 138 billion USD. The average annual amount is equivalent to 6% of total investment in Mexico in 2011. This analysis is sensitive to the price of crude oil (estimated at 60 USD per barrel by 2030) and the cost of capital (4%).

The following estimates are obtained from the cost curve:

- Mitigation actions with negative or zero reduction cost require an investment of 30 billion USD by 2020. These initiatives have an economic benefit estimated of 34 billion thanks to existing synergies with the process of economics development.
- Mitigation actions with positive reduction cost require an investment of 108 billion USD by 2020. This includes initiatives with co-benefits that make them attractive, although they imply cost and are capital intensive, which involves a heavy investment in infrastructure. The economic impact of the implementation of these actions is near to 40 billion USD.
- The benefits and the impacts of mitigation actions are closely related, with a difference lower than 6 billion USD. It is estimated that mitigation actions will have an impact on the economy of 30 to 40 billion USD. This is due to the incremental marginal cost of mitigation

actions and the elimination of barriers. In order to cover this impact, it is estimated that Mexico will require economic support in non-recoverable funds.

Mitigation actions with negative or zero as well as positive reduction costs would be financed via local funding and soft loans, while the incremental cost to the economy and the cost of eliminating barriers would be covered by non-reimbursable loans. The main contribution comes from private capital, representing 43% of the investment required, followed by the public sector, which contributes 31% and the end users, who absorb 25% of the expense.

5.3.2.4 Economic Analysis of Mitigation Measures

As of year 2030, following the implementation of all the reduction initiatives identified and by assuming that Mexico has access to International funds, national GDP will be 5.3% higher than the base scenario. An increase in investment levels is also expected, which will be 23.69% greater, with a 7.56% higher capital stock. On the basis of these assumptions, the incremental investment required for the implementation of the low carbon strategy will generate between 300,000 and 550,000 new jobs. The unemployment rate in the trend scenario is estimated at 12% whereas in the low carbon scenario it would be 6.7%. Finally, a low carbon strategy is extremely progressive and would encourage the distribution of wealth in the social sectors with the lowest income since the incremental cost of implementation are offset by gains in productivity, energy security, environmental quality and positive impacts on health and social inclusion.

5.3.2.5 Other initiatives to reduce GHG

Mexico has a total of 147 projects in the Clean Development Mechanism (CDM) of Kyoto Protocol out of which 60% is implemented in the energy and waste management sectors. During the 2009 – 2012 period, Emissions Reduction Certificates were received for 27 projects, accounting for a total amount of 11.30 MtCO2 eq. As of July 2012, Mexico had the fourth largest number of projects registered and the fifth largest number of certificates obtained for the expected reductions of projects registered internationally.

Mexico also promotes the design of Nationally Appropriate Mitigation Actions (NAMAs) in various productive sectors. In collaboration with various sectors, in 2011-2012 twelve NAMAs were designed and promoted in the following categories: households, transportation, domestic appliances, energy efficiency, cement, chemical industry, mining, oil industry and electricity.
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