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SUSTAINABLE ENERGY AND BIOFUEL STRATEGIES FOR COLOMBIA

CO-T1052

Preliminary Report I

Inter-American Development Bank
Ministry of Mines and Energy
Government of Colombia

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1 INTRODUCTION

The Colombian Ministry of Mines and Energy (MME) has received financing from the Inter-American Development Bank (IADB) to support the development of a solid framework of guidelines, tools, institutional strengthening activities and information that facilitate the Government of Colombia (GoC) and private investors the decision making process for investments in sustainable energy and biofuel projects. The initiative consists of five main Components - defined in the Technical Cooperation CO-T1052 - and has the technical support of both the IADB Energy Division and the Colombian Ministry of Mines and Energy (MME).

For the development of Components I and III the MME-IADB has contracted the consortium Mitsubishi Research Institute (MRI), National University of Colombia (UNC) and Numark Associates (NUMARK) under the consultancy services entitled "Sustainable Energy and Biofuel Strategies for Colombia". Overall the objective of Component I is to prepare the operative guidelines for the Sustainable and Renewable Energy Strategy for Colombia (SREC) while the purpose of Component III is to prepare a Biofuel Market Study (BMS) to promote the export of Colombian biofuels. The Energy and Hydrocarbon Divisions of the MME have the technical coordination of the SREC and BMS respectively.

MRI-UNC-NUMARK is conducting the project activities in three phases: a) diagnosis, b) development of strategies and tools, and c) dissemination of results. This report (Preliminary Report I) contains the results of the diagnosis of both the SREC and BMS and will be complemented with presentations and discussions with MME, IADB and key stakeholders of the Energy sector in Colombia during the week of December 6-10 2010.

The report is divided in three main chapters. The first two are focused on the current situation of the country concerning non-conventional sources of energy and energy efficiency. They contain the analysis of short, medium and long-term renewable energy (RE) and energy efficiency (EE) targets as well as the analysis of the main economic, market, institutional, technological and operational opportunities and barriers for RE and EE. An analysis of regulatory aspects and economic incentives in force by tax law for energy and environmental impacts is also included. Each chapter contain a Strengths, Weakness, Opportunities and Threats (SWOT) analysis, that is the basis for the construction of strategic scenarios that will be developed in the future reports. Chapter 3 contains a similar set of elements for the diagnosis of the biofuels sector plus an analysis of the international market of ethanol and biodiesel driving forces. The report is based on the review of the most relevant technical studies carried out recently in the country and a series of interviews and consultations held in Bogota during September-October 2010. (See annex A for the list of consulted institutions).

2 RENEWABLE ENERGY

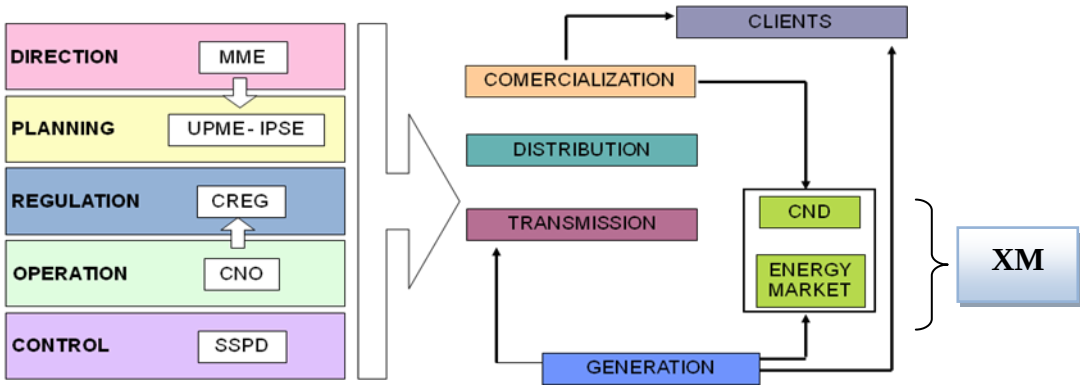
2.1 Diagnosis of energy situation and the role of RE

2.1.1 CONVENTIONAL ENERGY

The energy sector in Colombia was restructured in the early 90's. The state-owned energy supply companies were privatized in 1994 and now there are a series of private electricity generation companies, private distribution companies, and a single public-private transmission company, all of which provide Colombia's grid-connected electricity. Investments in new electricity generating capacity are made by the private generation companies. Vertical integration is prohibited.

The restructuring defined four activities in the "electricity production chain" - generation, transmission, distribution and commercialization. Each has its own characteristics, specifications, regulations. Both generation and commercialization are competitive activities that take part in the electricity market, while transmission and distribution are natural monopolies and therefore are regulated. There are also several institutions in charge of planning (UPME, IPSE), operation (CND, CNO), regulation (CREG) and supervision (SSPD) of the system, which is managed by XM, the system operator. Those are public and have their functions specified in the law 143/94 which established the whole organization of the electrical sector in Colombia. A scheme of the institutions and the activities is shown in Fig. 1

Figure 1. Electrical sector structure

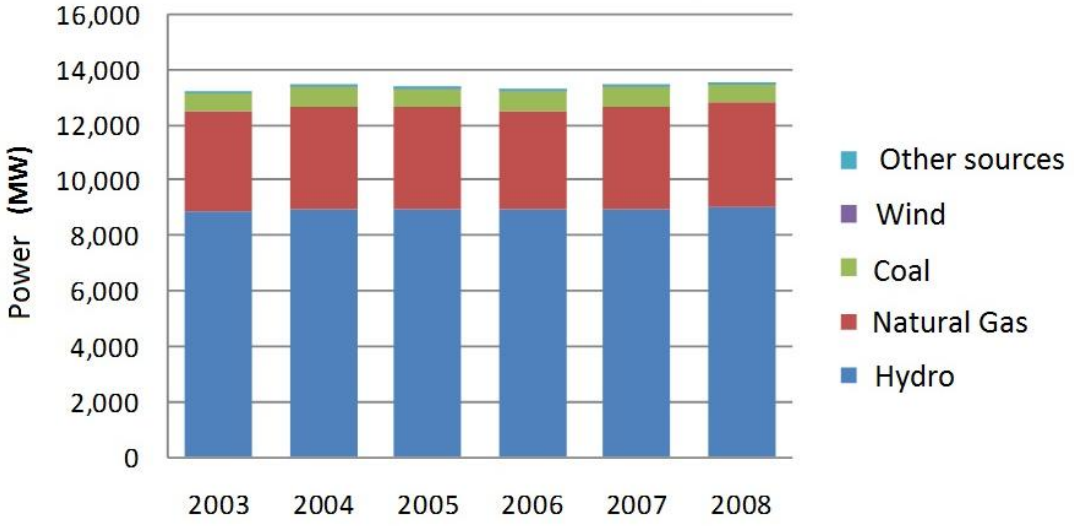


The energy sector is overseen by the Ministry of Mines and Energy (MME). Tariffs are regulated by the Electricity and Gas Regulation Commission (CREG). Capacity planning is done by the UPME, an affiliate of the MME (See Fig. 1). UPME's plans are indicative and are not mandatory.

Colombia relies largely on its roughly 9,000 MW of hydroelectric power for 66 percent of its electricity, It also has approximately 4,000 MW of fossil fuel generation, of which 80 percent is natural gas and 20% is coal. In dry years, such as during El Niño periods, the split between hydro and fossil fuel generation is about 50-50. During particularly wet years, hydro can supply 80

percent of the country's electricity needs. In response to growing demand, Colombia is planning to increase hydroelectric capacity 32 percent by 2018.

Figure 2. Power generation in Colombia



Source: UPME 2009.

Electricity from large hydro and thermal power plants is purchased directly in the electricity market by two means - either the spot market or by long term financial contracts. The buyers can be "commercializers" that are agents that buy large amounts of electricity and sell it to the users, regional distribution companies, and large industrial users. Electricity from plants smaller than 20 MW is purchased by "commercializers" who in turn sell it to users. The sale of electricity by large power plants to the distribution companies is governed by an auction process overseen by CREG and described in Section __ below. Large industrial users negotiate directly with generation companies plus pay a regulated rate for transmission and distribution. There are currently 73 retail power companies, of which 32 serve as both commerializers and distributors and serve more than 97% of the regulated market. The rest are either commercializers or generators selling large quantities of electricity and serve more than 70% of the non-regulated market, which accounts for a little moe than 3% of total consumption

An MME affiliate, the Institute of Planning and Promotion of Energy Solutions (IPSE), is charged with oversight of the remote mini-grids in the "non-interconnected zones" (NIZ). About 1.8 million people, or 4% of the country's population live in these areas, which consist of 16 political departments. The mini-grids consist of 100 MW of installed capacity (98% diesel and 2% small hydro) and are operated by different private owners, depending on the zone. On these mini-grids, it costs roughly five times more to provide electricity as on the main grid. Retail prices on the mini-grids are subsidized by the government. In addition, power suppliers receive a subsidy of one Colombian Peso (COP) for each KWH generated in the mini-grids.

IPSE's main aim is to identify, promote, develop and implement energy solutions that are economically feasible in the long term and supply the needs of the non interconnected zones while being environmentally sustainable. It is in charge of developing the expansion plan for the NIZ as

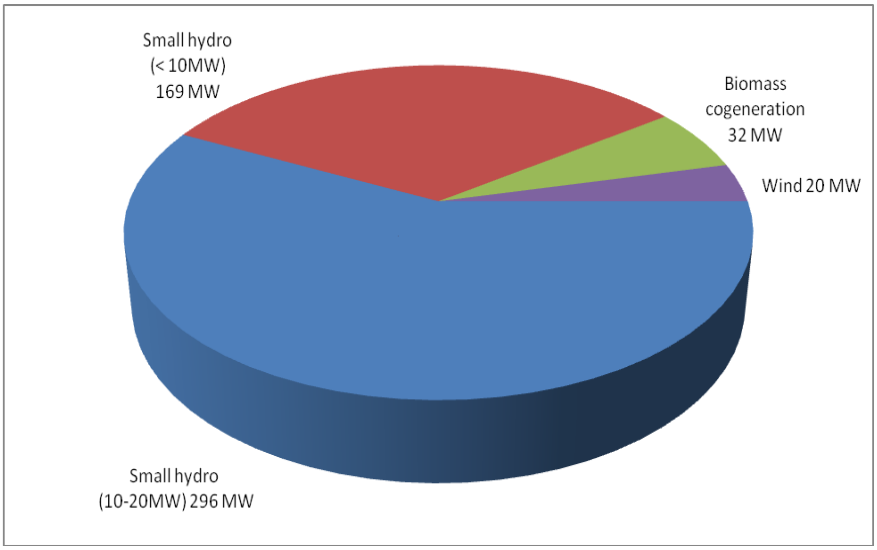
well as to give approval for projects that apply for funding from government funds such as FANZI (See Section 2.1.3).

Except for the rate negotiated by large industrial users, all retail rates are regulated by CREG. There are six residential classes based on income. The first, lowest-income clase pays a tariff set at 40% of the average cost . The second class pays 60%, the third mays 85%, and the fourth pays at the average cost. Class five and six pay 20% over average cost, as does a commercial class and an industrial class. Thus, the industrial, commercial, and top two residential classes cross subsidize the bottom three residential classes.

2.1.2 RENEWABLE ENERGY

Colombia's renewable energy power generation consist mainly of small hydro, but also biomass (sugarcane bagasse cogeneration), and wind (See Fig. 3). Currently, 515.7 MW or about 3.8 percent of Colombia's grid-connected installed capacity, comes from small plants, most of them powered by renewable energy. (See Fig. 3). Most of the plants are small hydro – less than 20 MW each, and most of those are between 10MW and 20MW (See Appendix 1 for a list of the small hydro plants). However, by law, small hydro is only considered "renewable energy" if it is under 10 MW There is thus only 169 MW of small hydro that is considered "renewable". In addition, there is 31.5 MW of sugarcane bagasse cogeneration.

Figure 3. Renewable energy generation in Colombia



Finally, a 19.5 MW wind farm has been constructed in La Guajira in the north and is operating as a research and demonstration plant. It provides its electricity to the national grid. An additional 7.5 MW wind project o will open in 2012on San Andres island, in the Caribbean Sea.

The country's goal is to increase the percentage of renewable energy on the grid to 3.5 percent by 2015 and 6.5 percent by 2020. Currently the share considered "renewable energy" -- small hydro

(<10 MW) and wind -- is 1.4%. For the remote diesel mini-grids, where conventional power generation is more expensive, the goals for renewables are 20 percent by 2015 and 30 percent by 2020. Renewable energy currently accounts for about 8% of the load in the remote areas.

Some Colombian energy institutions are currently in the process of planning for new renewable energy generation. Ecopetrol, the nation's petroleum company, is planning to build 10 MW of wind, 2 MW of solar, among other projects. Isagen, the largest electricity generation company in Colombia, is planning 50 MW of geothermal and 20 MW of wind capacity, but it's not clear how these companies will recover their costs for these investments. Isagen estimates it will need a 35 percent capital subsidy for the wind farm to be economically viable.

IPSE has supported several renewable energy projects to replace diesel fuel use on the mini-grids. It has a wind-solar hybrid pilot project, a solar-LPG pilot project, a wind project for powering a town's public lighting system, and it is building a biodiesel plant to produce fuel for the diesel power plants. In the town of Nazareth, IPSE sponsored an integrated "energy park" consisting of two diesel units (150 KW and 225 KW), a 100 KW solar system, and a 200 KW wind system.

In addition to these initiatives, the country has engaged in exercises to determine the location and quantity of non-conventional energy resources (FNCE). This has produced a multi-year average global solar radiation map; a wind energy density map; a multi-year average small hydroelectric potential map; a determination of geothermal energy resource; and an estimation of the country's biomass potential. Much of this work has been done by UPME through SI3EA, one of its information systems that contains current information and studies on energy efficiency and non conventional sources of energy. The objective of the SI3EA system is to support development of renewable energy policies and direct scientific and technological research in the fields of energy efficiency and renewable energy.

2.1.3 RENEWABLE ENERGY POLICY

Colombia 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 increased 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. Appendix 2 shows a summary of the most significant regulation made to promote the use of renewable energy in Colombia. In some cases, there are prohibitions against using combinations of incentives.

Resolution 18-0919, adopted on June 1, 2010, established the Efficient Use of Energy and Other Non Conventional Energy Sources Program (PROURE) to focus mainly on improving energy efficiency but also to take steps toward increasing renewable energy. The resolution named the MME as the responsible agency for implementing PROURE, and the SREC will establish the operating guidelines for implementing and executing it. Under the program, a five-year plan establishes goals for energy efficiency and renewable energy in the areas of increasing economic and technical information; strengthening institutional capabilities; promoting involvement of private businesses; and developing new regulations and incentives to spur investment.

The MME has received no funding from the Colombian government for the development of the PROURE program. However, the program was adopted with the hopes of attracting funds from

international donor agencies. So far, the Clean Technology Fund, managed by the World Bank, has approved US$50 million for a program to improve energy efficiency in lighting and refrigeration.

Colombia has used two domestic funds to support renewable energy projects – FAZNI and FNR. The FAZNI fund is capitalized by a surcharge on grid-connected electricity sales and is operated by MME.[1] It finances plans, programs and investment projects in the non-interconnected zones for both conventional and renewable energy. The FNR (National Fund of 'Regalias'), funded through an extraction tax on mining, is managed by the National Department of Planning (DNP) to provide development assistance mainly to regions affected by mineral extraction, but to other regions as well.[2] Both the FAZNI and FNR provide funds to cover 80 percent of project costs.

UPME has undertaken an effort to formulate a development plan for non-conventional energy sources. With assistance from CORPOEMA, the plan will recommend both policy and regulatory changes that are intended to stimulate increased investment in renewable energy projects. To date, there are not yet any recommendations from this study. But it will likely focus on some form of requirement for utilities to purchase a certain amount of electricity from renewable energy sources. The COPROEMA conclusions and recommendations will be integrated into this report when they become available.

2.1.4 ELECTRICITY AUCTION PROCESS

Colombia has adopted a national electricity auction process for conventional electricity resources that may serve as a precedent for the sale of electricity from renewable sources as well. The auction process ensures a low cost and reliable electricity supply. It also provides a market signal for developers building new generation facilities. Under the process, UPME determines how much new demand must be met; CREG adds a reserve margin and determines the overall size of the auction, which is administered by XM, the system operator (See Fig. 4).

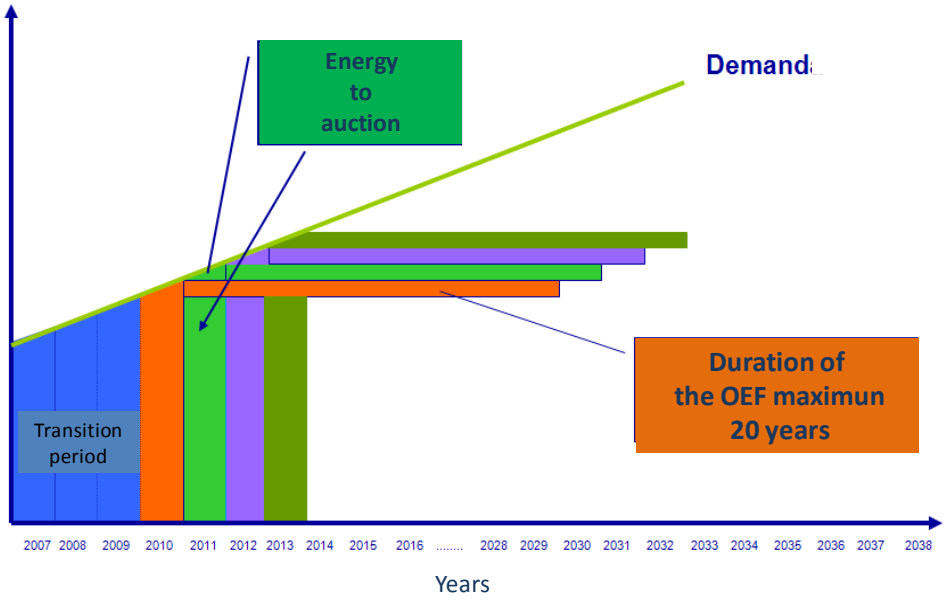
Only firm power resources participate in the auction – that is, only power sources that can assure availability at all times regardless of climatic conditions. CREG developed a mechanism called a "reliability charge" in order prevent future shortages of energy. Under this scheme there is a figure called firm energy obligation (OEF) which is the energy that the backup plants can assure, through generation assets, under critical conditions. These obligations are offered and bought by distribution utilities and large industrial consumers in auction process. For the buyers, the process provides a guaranteed certain known price for a pre-determined period of time. With this scheme when the dry season approaches and the spot price of electricity rises reaching a pre-established price called shortage price the plans with OEF assigned will have the obligation of given energy to the system, keeping the price lower.

The auction works in a dynamic way called "descending clock" in which the bidders are the generators and the investors who presented all the required information and fulfill all the requirements and the demand is represented by a function of the price and the amount of energy determined by the CREG. The auction takes place many years before the actual obligation is to be

[1] FAZNI was created by Law 693 of 2009, articles 81 to 83, and extended by law 1099 of 2006 and regulated by decrees 2884 of 2001 and 1128 of 2008.
[2] FNR was created by Law 141 of 1994. The law established the right of the state to receive income from the exploitation of non-renewable natural resources.

met in order to give time for the new projects to be developed. Finally the winners of the auction are all the bidders that presented OEF's at a lower price than the closing price of the whole auction.

Figure 4. Electricity auction diagram



Source: CREG

The main advantages of this scheme are the following:

- It gives economic signals to invest in new generation projects
- It provides for the long term stability of the electricity system
- There is legal obligation of the generators to provide the energy they are being paid for
- It increases system reliability over the long term
- Since the OEF are determined by auction, it guarantees a competitive scheme and more efficient prices

The main disadvantages of the scheme are:

- Reliability may be problem in the short term. During the last el niño phenomena, the obligation of firm energy did not work because the government intervened the market
- There is no opportunity to select which energy source to buy from
- The "shortage price" can be manipulated by agents, since only a few of them own most of the generation assets the have a dominate position in the market. In general it is not convenient to reach the Shortage Price because at that point it becomes mandatory to give the OEF and the generators prefer not to do that because they have to go to the market and buy the required energy.

- Only firm sources can participate, so that excludes intermittent renewable energy sources such as wind and solar.

The main actors in the reliability charge scheme are:

- The owners of existing generation plants
- The investors interested in developing new generation projects
- CREG (defining the amount of required energy and the rules of the auction)

The daily operation of the system is managed by XM (the power system operator), after receiving offers of power price and quantity from the generators. The hourly programmed dispatch is done the day before the actual dispatch. That process is accomplished through price sorting to fulfill the quantity of the demand which is estimated by the system operator based on historic data.

2.2 Strengths, weaknesses, opportunities & threats in renewable energy development

2.2.1 STRENGTHS

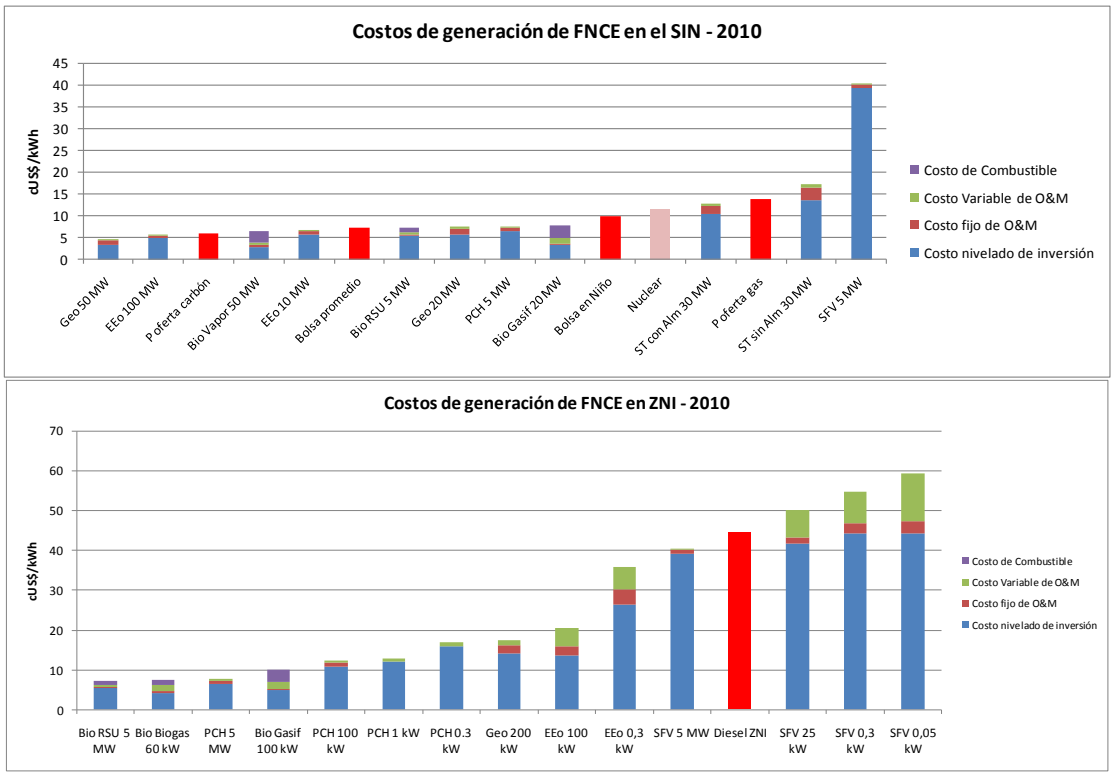
Renewable energy offers a number of advantages over conventional energy for Colombia. First, it is a reliable source of electricity during low hydro capacity El Niño periods. Second, it is a good insurance policy for the unpredictability of climate change impacts, when there may be increasing periods of insufficient hydro capacity due to lack of rainfall. Third, because there are no fuel supply costs (except with biomass), renewable energy can offer buyers long term price stability and predictability. Fourth, renewable energy can be used to replace natural gas and thus conserve Colombia's limited natural gas reserves. Fifth, some forms of renewable energy (solar and wind) are modular. That is, incremental capacity additions are nearly as easy as adding another wind turbine or solar panel, compared to the difficulty and expense of adding a new conventional dam or boiler.

Renewable energy already has some positive features. First, Colombia has a numerous renewable energy sources available for development, including solar, wind, biomass, small hydro, and geothermal. Second, there is a national desire and interest to expand renewable energy implementation in the country, accompanied by targets for renewable energy development. Third, there are already some basic policies – tax exemptions and reliability charge exemptions – that support renewable energy and can be built upon under the PROURE program to expand renewable energy investment. Fourth, Colombia already has extensive experience with small hydro, so the country has the homegrown expertise and experience to apply to new small hydro projects. Fifth, Colombia has capable institutions for both the regulation and management of electricity resources and the development of CDM projects and preparation of CDM documets.

2.2.2 WEAKNESSES

The main weakness (or barrier) to increased investment in renewable energy is price. Except in several strategic situations, renewable energy sources generally cost more than conventional energy supply (See Fig. 5). Large hydro is the main energy source in Colombia, and all renewable energy sources are more expensive than that.

Figure 5. Average price of new electricity generation in Colombia (US$/MWh)



Source: UPME-CORPOEMA, preliminary results

If the decision on whether to increase implementation of renewable energy in Colombia were made solely on the basis of upfront costs, most renewable energy projects would not be competitive. However, sugarcane bagasse cogeneration and wind power are competitive with hydro (especially the spot price) and of course natural gas, while all renewable sources except solar are competitive with the diesel fuel used on the remote mini-grids.

The second barrier is the widespread perception that additional hydro capacity is the best solution, along with some additional fossil fuel capacity for dry years. People with this perception believe expanded renewable energy implementation is unnecessary and that hydro and fossil fuels have served Colombia well and provide enough diversity in the event of El Niño or global climate change conditions.

Third, although there are defined national goals for the contribution of renewable energy, there is no clear path to achieving those goals. Specifically, there are inadequate incentives and regulatory structures for fostering widespread implementation of renewable energy.

Fourth, because of the high proportion of hydro power in the system, the CO2 emission factor for the grid is too low to generate much in the way of profit for project developers from CDM revenues. The Ministry of Environment recently (Resolution 180947/2010) defined the emission factor at 0.2849 kg CO2/kWh, which is too low compared to other countries, and that makes the CO2 reductions too low to apply for a CDM project. Fifth, self-generation projects are prohibited from selling excess electricity to the grid.

2.2.3 STRATEGIC OPPORTUNITIES FOR RE

Colombia has ample renewable resources, estimated at 25,000 MW of small hydropower, 21,000 MW of wind power potential in the Guajira region alone, and a daily average solar potential of 4.5 kWh/m².3 There is thus an opportunity to greatly expand renewable energy development, thereby contributing energy diversification, price stability, and insurance against climate change impacts to the nation's power generation system.

The major near term opportunities for renewable energy are to replace high-cost diesel generation on the remote mini-grids; to provide a power "boost" near the ends of transmission lines, particularly in Colombia's South Caribbean region and to provide power to the remaining population that has no access to electricity and to whom it would be prohibitively expensive to extend the transmission grid. These opportunities are enhanced by the fact that many renewable energy technologies are already price competitive or nearly price competitive with conventional energy sources (See section 2.2.2) and project funds are increasingly available for clean energy projects from international institutions.

Renewable energy provides an additional opportunity for distribution companies, whose purchase contracts with generation companies are only 3-4 years, meaning the distribution companies face price uncertainty over the medium and long terms. Renewable energy purchase contracts could be much longer – 10-15 years or even 20 years, because there are no fuel purchases, so the operating costs are stable and predictable.

2.2.4 THREATS

While global climate change represents an opportunity for renewable energy, it also represents a threat. Climate change could impact wind patterns, cloud coverage, and crop production, which could negatively affect wind power, solar power, and biomass production, respectively. In addition, there is price uncertainty in the global carbon market, particularly after 2012, thus increasing risks for investors seeking to benefit from carbon finance.

[3] ESMAP study, 2007. P. 24.

2.3 New policy and regulatory options/scenarios for achieving renewable energy targets

As noted, the Colombian government has expressed support for renewable energy and has established renewable energy goals. But there are few regulations or financial incentives to trigger significant investment in renewables.

Several regulatory options are available to spur grid-connected renewable energy investment in Colombia. They have been successfully implemented in other countries, particularly in Europe and the U.S. but also in China, India, Algeria, South Africa, and other developing nations. None involve financial subsidies or even tax incentives from the national government, although such subsidies, provided on a strategic and limited basis, can enhance the effectiveness of the regulatory approaches.

The main regulatory approaches are: a) Feed-in tariff; b) Renewable energy portfolio standard; c) National renewable energy auction; and d) Net metering. All four approaches are variations on the theme of requiring the electric system to allow access to renewable energy generation and paying a good price for that generation. In addition to these, renewable energy certificates (RECs) are a way to create a commodity that can be bought, sold, and traded to comply with some of these regulatory measures. Finally, there are some existing regulations that can be adjusted in order to provide an advantage to renewable energy.

A separate set of policies can be considered to spur the use of renewable energy on the remote diesel grids, at the end of transmission lines and for the remaining population that has no access to electricity. In these instances, renewable energy offers a competitive advantage but requires assistance with financing because energy users cannot afford to pay the full cost of supplying the electricity.

2.3.1 FEED-IN TARIFF

A feed-in tariff allows renewable energy access to the electric grid and pays renewable energy project owners for their electricity at a price that allows for full cost recovery and an acceptable rate of return. The grid access and purchase price are provided on a long-term basis to allow for renewable energy project developers to finance their projects, recover their costs, and earn a profit. The price is set by regulators, and it is up to the developers to operate their plants efficiently.

The design of a feed-in tariff can vary according to maximum MW project size allowed, the term of the purchase contract, and the method for determining price. The price can be based on a utility company's marginal cost of new generation; or it can be based on a certain percentage of retail electricity prices; or it can be based on the cost of generating each form of renewable electricity, which means there would be a different feed-in tariff for wind, biomass, solar, etc. as well as for projects of different sizes.

2.3.2 RENEWABLE ENERGY PORTFOLIO STANDARD

A Renewable Energy Portfolio Standard (RPS) is a government requirement that a specified amount or percentage of a distribution utility's electricity must be supplied by renewable energy sources. This is the approach adopted by a number of states in the U.S. and has been proposed at the national level as well.

The amount of renewable electricity required under an RPS usually starts out small, at around 3 – 7 percent in order to allow the utility to gain experience acquiring renewable energy sources and also to have little or no impact on the tariffs. As the utility gains experience, the percentage can increase. Some states now have RPS goals in the 20-25 percent range.

Another feature of some RPS's is a two-tier requirement whereby two sets of renewable energy resources are required. The first tier would be relatively low-cost, combustion-oriented resources like landfill methane and biomass. The second tier would be non-combustion resources like wind and solar energy. The purpose of this approach is to ensure that not only combustion-oriented resources are pursued.

One variation on the two-tier system is the "solar carve-out," which requires that a very small percentage – perhaps .5 percent - of solar electricity be acquired in order to ensure that the cleanest (but most expensive) energy source plays at least some role in the power system.

The advantage of the RPS over the national renewable energy auction approach is that it is done on a utility by utility basis, thereby allowing for consideration of the types and costs of renewable energy sources available in each service territory. This could be the approach used to fund the strategic renewable energy sources – the mini-grids, off-grid, and boosting power at ends of transmission lines.

2.3.3 NATIONAL RENEWABLE ENERGY AUCTION

Colombia's national electricity auction could be supplemented by a separate auction for renewable electricity. The auction could have two components - firm sources (geothermal, small hydro, and biomass) and non-firm sources (wind and solar) or there could be a single auction with two or more renewable energy projects presenting a firm power package. Renewable energy developers would compete to provide renewable energy to the grid and XM would manage the auction just as it manages the conventional energy auction. The auction process would manage the entry of new resources in order to avoid the boom-and-bust cycle common in other markets. That is, when there are power generation shortages, there can be a scramble to develop new projects, and a number of projects may be built around the same time. Then the development process stops because there is adequate capacity for the near and medium term. So there is no work for the developers and construction firms. The auction process allows for a more orderly and consistent development process.

Participants in the auction would be the distribution utilities that would be required to acquire a certain amount of MWh or a certain percentage of their power from the renewable energy auction or other renewable energy sources. The auction would lock in a firm price for the renewable electricity several years in advance.

2.3.4 NET METERING

Net metering is a policy that requires electric utilities to purchase excess electricity generated by customers' on-site renewable energy systems. It allows electric meters to run in both directions – one direction to measure and charge for the customer's electricity consumption, and the other direction to measure and provide payment for excess electricity generated by the customer's renewable energy system. The customer pays for the "net" amount of electricity consumed after subtracting the amount sold to the grid.

Net metering is a way to encourage renewable energy development by helping customers cover the cost of their renewable energy systems. It is mainly applicable to rooftop solar photovoltaic systems and bagasse cogeneration systems at sugar mills. At present in Colombia, only bagasse cogeneration is the only form of on-site electricity generation that is allowed to intertie with the grid, but this intertie is not considered net metering because the sugar mills are not paid at the same rate per kWh as they pay for their electricity. Under net metering, kWhs are bought and sold at the same price.

2.3.5 RENEWABLE ENERGY CERTIFICATES

Renewable energy certificates (RECs) are a means of commoditizing renewable energy generation and then buying, selling, and trading it among generators, distributors, consumers, and brokers. RECs are denominated in MWhs and are created alongside each MWh of renewable electricity that is generated. That is, if a wind farm generates 1 MWh of electricity on a specific date and sells it to a distribution company, a REC is likewise created on that date that can be sold either to the same distribution company or to a different buyer.

The REC price will be market driven but will be based on the incremental cost of supplying that MWh of wind compared to supplying a MWh of conventional electricity. Thus, if the average cost of conventional electricity is US$40/MWh and it costs US$60 to generate wind power, the wind developer will be able to sell the wind electricity for $40 and will need to sell a REC priced at $20. The buyer of the that U$20 REC would be a distribution utility that is required to comply with an renewable energy portfolio standard (RPS). Instead of building its own renewable energy generation or contracting with a developer to build a new facility, it can instead enter into a contract with the wind developer to buy RECs. Alternatively, the wind developer could sell his/her RECs to an agent or broker who would market them to a number of distribution companies to find the best price.

Another approach would be for RECs to be the commodity that is bought and sold in a renewable energy auction. Such an approach could eliminate the distinction between firm and non-firm renewable energy sources. Buyers would simply be buying RECs without regard to the source or timing of that source's electricity generation.

RECs could also be sold on a voluntary basis to firms or institutions wishing to have "green" credentials. Such an institution could buy an amount of RECs equal to, say, 50% of its annual electricity consumption and then properly claim that half of its electricity comes from renewable energy. The voluntary market for RECs will be small in comparison to the compliance market, but

voluntary purchases can have appeal to certain institutions such as environmental organizations, environmental agencies, and companies seeking a positive public image.

Basically, RECs can be the currency for buying and selling renewable energy under an RPS or a renewable energy auction, and for promoting a green image through voluntary purchases

2.3.6 REGULATORY EXCEPTIONS TO SUPPORT RENEWABLE ENERGY

The government of Colombia currently allows certain regulatory exemptions for projects under 20 MW. They do not have to participate in the country's dispatch system and they don't have to pay a reliability charge. Additional regulatory exemptions could be enacted to spur increased renewable energy investment.

a. Ownership exemption

Currently there is a restriction on joint generation-and-distribution companies being able to provide only 60 percent of their own power. This restriction could be modified so that renewable energy generation does not count toward the 60 percent. The modification would serve as an incentive for these companies to increase their renewable energy generation.

b. Self-generation wheeling exemption

Currently, self-generation is allowed in Colombia, but not if the generation plant is located off-site. An exception could be made for renewable energy sources, which often must be located in the proximity of the resource (e.g., wind, geothermal, biomass) and not where the electricity consumption takes place. A company or institution wishing to self-generate with renewable resources could be permitted to construct the generation facility off-site and pay a reasonable wheeling fee to its local distribution company for the cost of transmitting the power.

2.3.7 INTEGRATING RENEWABLE ENERGY POLICY WITH ENERGY EFFICIENCY POLICY

Whichever policy and regulatory options are selected to spur increased investment in renewable energy, they should be coordinated with an aggressive national energy efficiency policy. The reason is that renewable energy is more expensive than large hydro plants, and thus the cost of expanded renewable energy implementation could put upward pressure on tariffs. Energy efficiency, on the other hand, will lower consumers' energy bills. So while tariffs could increase in order to pay for renewable energy projects, energy efficiency programs will reduce consumption, and the net effect will be lower energy bills.

2.4 Financing renewable energy

Private developers can find needed debt and equity for new renewable energy projects. But that will only be possible if they know they'll be able to cover their costs, earn an acceptable profit, and manage the risks inherent in such an undertaking. However, because most grid-connected renewable energy projects will cost more than conventional power plants, developers and their private investors will need assurances that either the cost of their electricity will be subsidized or their higher priced electricity will be purchased by utilities and users. So the incremental cost of renewable energy will need to be addressed. While some of the incremental cost can be covered with donor funds and the sale of certified carbon emission reductions, the remaining incremental costs will have to be covered with Colombian resources provided by either the taxpayers or the ratepayers.

If the incremental costs of renewable energy projects are covered by the ratepayers, the electricity tariffs could increase slightly, depending on how much renewable energy is to be acquired over a given time period. Feed-in tariffs in Germany have resulted in some small increases for ratepayers. However, large additions of wind power have had the effect of reducing spot market prices in Spain and Denmark, with the result that feed-in tariffs in those countries have resulted in no tariff increases. Most states in the U.S. have adopted relatively small targets for their renewable energy portfolio standards with the result that the standards have caused little or no tariff increases.

If Colombia focuses mostly on the lower cost renewable resources like small hydro, wind, municipal solid waste, landfill methane, and certain kinds of biomass generation, then the acquisition of these resources could have a negligible impact on tariffs. In other countries, these renewable energy sources are often less expensive than natural gas generation.

Another way to cover the incremental costs is to allow renewable energy project developers to sell directly to energy users. This would allow them to sell their electricity at a higher price than if they sold only to distribution utilities. Such sales could initially be allowed for on-site generation. In such a case, a developer would install a renewable energy system on the site of the energy user. The energy user would enter into a long-term power purchase agreement with the developer and would allow access to his/her property for the construction and maintenance of the renewable energy system. The advantages for the developer would be the revenues from the tax incentives under Law 788, the sale of CERs, and the long-term off-taking of his/her electricity at a stable and relatively high price by the buyer. The advantage for the renewable electricity buyer would be a supply of electricity at either a long-term fixed price or a long term predictable price comparable to what he/she is currently paying for conventional electricity.

Even with the adoption of policies to allow developers to cover the incremental costs, there may be a need for an additional policy measure to support renewable energy financing. Traditional lenders may not be willing to take the risk of financing what they consider a new and unproven technology. This may especially be the case when lending to new or relatively small developers. Because of the higher perceived risk, the lenders may charge a higher interest rate, shorten the tenor, or require a large amount of collateral. There may thus be a short-term need for either loan guarantees or subordinated debt provided by a donor or international finance institution in order to lower the primary lender's risk and allow it to set loans at normal or even below-market terms.

2.5 Institutional structure to support renewable energy

The current institutional structure in Colombia's energy sector is fairly standard – a central energy ministry, a rural affiliate of the ministry, a central regulatory authority, and a series of electric and gas utilities supplying and transporting the energy resources. Increased support for renewable energy through the PROURE program can be adapted to this structure by creating special sustainable energy cell within MME. Capabilities will also need to be expanded within CREG and the distribution utilities.

The PROURE program has been assigned to the MME, which can use that authority to propose policies and regulations that will spur investment in renewable energy. It should essentially serve as focal point for renewable energy project and energy-efficiency program development and integration.

CREG will need to play an important role in renewable energy development. Just as it oversees the electricity auction process, it will need to oversee and set the rules for either a renewable energy auction, a renewable energy portfolio standard, or a feed-in tariff. It will also need to set the rules for net metering and wheeling of renewable electricity. And of course, CREG will need to adjust tariffs, if necessary, to cover the costs of renewable electricity.

If distribution utilities become subject to a regulatory requirement that they acquire renewable energy, then they will need to have the capability to evaluate the reliability and cost of various renewable energy sources, as well as the ability to appraise potential revenues from the sale of RECs or carbon emission reductions.

One option is to establish an independent government sustainable energy corporation to evaluate, certify, and possibly help finance energy-efficiency programs and renewable energy projects. Funding would come from a small surcharge on electricity sales or from the sales of electricity to Ecuador and other neighboring countries. Donors may be willing to help capitalize the fund as well. The certification function may be particularly important because many utilities and other potential buyers of renewable energy face uncertainties about the technologies and their performance, dependability and costs. A "stamp of approval" on the project and it's developer from the sustainable energy corporation would help reduce uncertainty and risk faced by the utilities and other buyers.

The corporation could also serve as a co-developer of energy efficiency programs and renewable energy projects, and be paid by utilities on a per kWh basis. Alternatively, the corporation could serve as a project preparation facility for renewable energy projects, evaluating proposals and providing funds for feasibility studies. These funds could be repaid by the project developer if the project goes forward.

Appendix 1 - Colombia's Grid-Connected small (< 20 MW) plants, 2010

PLANT	Effective Capacity (MW)	TYPE	LOCATION (1), (2)	OPERATOR
AGUA FRESCA	7.05	H	JERICO,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
AMALFI	0.81	H	AMALFI,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
AMERICA	0.41	H	MEDELLIN,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
ASNAZU	0.45	H	SUAREZ,CAU	COMPAÑÍA DE GENERACIÓN DEL CAUCA S.A. E.S.P.
AYURA	18.00	H	ENVIGADO,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
BAYONA	0.60	H	BOHEMIA,QUI	EMPRESA MULTIPROPOSITO DE CALARCÁ S.A. E.S.P.
BELLO	0.35	H	BELLO,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
BELMONTE	3.40	H	PEREIRA,RIS	EMPRESA DE ENERGÍA DE PEREIRA S.A E.S.P
CALDERAS	19.90	H	SAN CARLOS,ANT	ISAGEN S.A. E.S.P.
CALICHAL	0.20	H	BUCARAMANGA,SAN	ELECTRIFICADORA DE SANTANDER S.A. E.S.P.
CAMPESTRE (CALARCA)	0.70	H	BOHEMIA,QUI	EMPRESA MULTIPROPOSITO DE CALARCÁ S.A. E.S.P.
CAMPESTRE (EPM)	0.87	H	MEDELLIN,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
CARACOLI	2.60	H	CARACOLI,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
CARUQUIA	9.50	H	SANTA ROSA DE OSOS,ANT	PRESTADORA DE SERVICIOS PÚBLICOS LA CASCADA S.A. E.S.P.
CASCADA	3.00	H	BUCARAMANGA,SAN	ELECTRIFICADORA DE SANTANDER S.A. E.S.P.
CEMENTOS DEL NARE	4.50	H	PTO NARE (LA MAG),ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
CHARQUITO	19.40	H	SOACHA,CUN	EMGESA S.A E.S.P
CIMARRON	19.90	G	YOPAL,CAS	CENTRAL TERMOELÉCTRICA EL MORRO 1 S.A. E.S.P.
COCONUCO	4.50	H	POPAYAN,CAU	EMPRESA MUNICIPAL DE ENERGIA ELECTRICA S.A. E.S.P.
CURRUCUCUES	1.25	H	ROVIRA,TOL	ENERMONT S.A . E.S.P
DOLORES	8.30	H	ANGOSTURA,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
EL BOSQUE	2.28	H	ARMENIA,QUI	ENERGÍA RENOVABLE DE COLOMBIA S.A E.S.P.
EL LIMONAR	18.00	H	SAN ANTONIO DE TENA,CUN	EMGESA S.A E.S.P
EL MORRO I	19.90	G	YOPAL,CAS	CENTRAL TERMOELÉCTRICA EL MORRO 1 S.A. E.S.P.
EL MORRO II	19.90	G	YOPAL,CAS	CENTRAL TERMOELÉCTRICA EL MORRO 1 S.A. E.S.P.
FLORIDA	19.90	H	POPAYAN,CAU	COMPAÑÍA DE GENERACIÓN DEL CAUCA S.A. E.S.P.
GUACAICA	0.86	H	NEIRA,CAL	CENTRAL HIDROELÉCTRICA DE CALDAS S.A. E.S.P.
GUANAQUITAS	9.50	H	SANTA ROSA DE OSOS,ANT	PRESTADORA DE SERVICIOS PÚBLICOS LA CASCADA S.A. E.S.P.
INSULA	19.00	H	CHINCHINA,CAL	CENTRAL HIDROELÉCTRICA DE CALDAS S.A. E.S.P.
INTERMEDIA	0.96	H	MANIZALES,CAL	CENTRAL HIDROELÉCTRICA DE CALDAS S.A. E.S.P.
INZA	0.75	H	INZA,CAU	COMPAÑÍA DE GENERACIÓN DEL CAUCA S.A. E.S.P.
IQUIRA I	1.30	H	IQUIRA,HUI	ELECTRIFICADORA DEL HUILA S.A. E.S.P.
IQUIRA II	0.61	H	IQUIRA,HUI	ELECTRIFICADORA DEL HUILA S.A. E.S.P.
JULIO BRAVO	1.50	H	PASTO,NAR	CENTRALES ELÉCTRICAS DE NARIÑO S.A. E.S.P.
LA CASCADA – ABEJORRAL	0.45	H	ABEJORRAL,ANT	ENERVÍA S.A. E.S.P.
LA CASCADA (ANTIOQUIA)	2.30	H	SAN ROQUE,ANT	PRESTADORA DE SERVICIOS PÚBLICOS LA CASCADA S.A. E.S.P.
LA HERRADURA	19.80	H	CANASGORDAS,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
LA JUNCA	19.40	H	LA MESA,CUN	EMGESA S.A E.S.P
LA PITA	0.78	H	GARZON,HUI	ELECTRIFICADORA DEL HUILA S.A. E.S.P.
LA TINTA	19.40	H	LA MESA,CUN	EMGESA S.A E.S.P
LA VUELTA	11.60	H	CANASGORDAS,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
MANANTIALES	3.15	H	BELLO,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
MIROLINDO	2.40	H	IBAGUE,TOL	COMPAÑÍA DE GENERACIÓN DEL CAUCA S.A. E.S.P.
MONDOMO	0.75	H	SANTANDER DE Q.,CAU	COMPAÑÍA DE GENERACIÓN DEL CAUCA S.A. E.S.P.
MUNICIPAL	1.40	H	MANIZALES,CAL	CENTRAL HIDROELÉCTRICA DE CALDAS S.A. E.S.P.
NIMA	6.70	H	CALI,VAL	EMPRESA DE ENERGÍA DEL PACÍFICO S.A. E.S.P. "EPSA E.S.P."
NIQUIA	19.00	H	BELLO,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
NUEVO LIBARE	5.10	H	DOS QUEBRADAS,RIS	EMPRESA DE ENERGÍA DE PEREIRA S.A E.S.P
NUTIBARA	0.75	H	MEDELLIN,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
JEPIRACHI	18.42	E	URIBIA,GUA	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
OVEJAS	0.82	H	BUENOS AIRES,CAU	COMPAÑÍA DE GENERACIÓN DEL CAUCA S.A. E.S.P.
PAJARITO	4.90	H	YARUMAL,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.

PLANT	Effective Capacity (MW)	TYPE	LOCATION (1), (2)	OPERATOR
PALMAS SAN GIL	15.00	H	SAN GIL,SAN	ELECTRIFICADORA DE SANTANDER S.A. E.S.P.
PASTALES	0.70	H	PASTALES,TOL	COMPAÑÍA DE GENERACIÓN DEL CAUCA S.A. E.S.P.
PATICO - LA CABRERA	1.48	H	POPAYAN,CAU	GENELEC LTDA. EMPRESA DE SERVICIOS PÚBLICOS
PIEDRAS BLANCAS	5.00	H	MEDELLIN,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
PRADO IV	5.00	H	PRADO,TOL	EMPRESA DE ENERGÍA DEL PACÍFICO S.A. E.S.P. "EPSA E.S.P."
PUENTE GUILLERMO	1.00	H	PUENTE NACIONAL,SAN	ENERCO S.A. E.S.P.
REMEDIOS	0.75	H	REMEDIOS,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
RIO ABAJO	0.90	H	SAN VICENTE,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
RIO BOBO	4.00	H	SANTA ROSA,CAU	CENTRALES ELÉCTRICAS DE NARIÑO S.A. E.S.P.
RIO CALI	1.80	H	CALI,VAL	EMPRESA DE ENERGÍA DEL PACÍFICO S.A. E.S.P. "EPSA E.S.P."
RIO FRIO I	1.69	H	RIOFRIO,VAL	COMPAÑÍA DE ELECTRICIDAD DE TULUÁ S.A. E.S.P.
RIO FRIO II	10.00	H	RIOFRIO,VAL	COMPAÑÍA DE ELECTRICIDAD DE TULUÁ S.A. E.S.P.
RIO INGENIO	0.18	H	SANDONA,NAR	CENTRALES ELÉCTRICAS DE NARIÑO S.A. E.S.P.
RIO MAYO	19.80	H	SAN PABLO,NAR	CENTRALES ELÉCTRICAS DE NARIÑO S.A. E.S.P.
RIO PALO	1.44	H	CALOTO,CAU	COMPAÑÍA DE GENERACIÓN DEL CAUCA S.A. E.S.P.
RIO PIEDRAS	19.90	H	JERICO,ANT	COMPAÑÍA COLOMBIANA DE INVERSIONES S.A E.S.P
RIO RECIO	0.30	H	LERIDA,TOL	COMPAÑÍA DE GENERACIÓN DEL CAUCA S.A. E.S.P.
RIO SAPUYES	1.65	H	TUQUERRES,NAR	CENTRALES ELÉCTRICAS DE NARIÑO S.A. E.S.P.
RIOFRIO (TAMESIS)	1.20	H	TAMESIS,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
RIOGRANDE I	19.00	H	DON MATIAS,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
RIOGRANDE I (MENOR)	0.30	H	DON MATIAS,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
RIONEGRO	9.60	H	PUERTO SALGAR,CUN	EMPRESA DE ENERGÍA DE CUNDINAMARCA S.A. E.S.P.
RUMOR	2.50	H	TULUA,VAL	COMPAÑÍA DE ELECTRICIDAD DE TULUÁ S.A. E.S.P.
SAJANDI	3.20	H	PATIA (EL BORDO),CAU	COMPAÑÍA DE GENERACIÓN DEL CAUCA S.A. E.S.P.
SAN ANTONIO	19.40	H	SAN ANTONIO DE TENA,CUN	EMGESA S.A E.S.P
SAN CANCIO	2.00	H	MANIZALES,CAL	CENTRAL HIDROELÉCTRICA DE CALDAS S.A. E.S.P.
SAN JOSE	0.38	H	PENSILVANIA,CAL	GENERADORA COLOMBIANA DE ELECTRICIDAD S.C.A. E.S.P
SAN JOSE DE LA MONTAÑA	0.40	H	S. JOSE LA MONTA,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
SANTA ANA	8.00	H	UBALA,CUN	EMGESA S.A E.S.P
SANTA RITA	1.30	H	ANDES,ANT	ENERMONT S.A . E.S.P
SERVITÁ	0.65	H	BUCARAMANGA,SAN	ELECTRIFICADORA DE SANTANDER S.A. E.S.P.
SILVIA	0.38	H	SILVIA,CAU	COMPAÑÍA DE GENERACIÓN DEL CAUCA S.A. E.S.P.
SONSON	18.50	H	SONSON,ANT	EMPRESAS PÚBLICAS DE MEDELLÍN E.S.P.
SUEVA 2	6.00	H	JUNIN,CUN	EMGESA S.A E.S.P
TEQUENDAMA	19.40	H	SAN ANTONIO DE TENA,CUN	EMGESA S.A E.S.P
TERMOYOPAL I	19.90	G	YOPAL,CAS	TERMOYOPAL GENERACION 2 S.A. E.S.P.
TPIEDRAS	3.75	G	PIEDRAS,TOL	TERMOTASAJERO S.A E.S.P
UNION	0.70	H	BOHEMIA,QUI	EMPRESA MULTIPROPOSITO DE CALARCÁ S.A. E.S.P.
URRAO	1.03	H	URRAO,ANT	ENERVÍA S.A. E.S.P.
VENTANA A	2.50	H	CHICORAL,TOL	COMPAÑÍA DE GENERACIÓN DEL CAUCA S.A. E.S.P.
VENTANA B	2.50	H	CHICORAL,TOL	COMPAÑÍA DE GENERACIÓN DEL CAUCA S.A. E.S.P.
ZARAGOZA	1.30	H	BUCARAMANGA,SAN	ELECTRIFICADORA DE SANTANDER S.A. E.S.P.
TOTAL MENORES	**611.75**			

Source: XM

Appendix 2 - Legal Support for non-Conventional Energy in Colombia

NAME	SUMMARY	INCENTIVE
Law 697/2000	Rational and efficient use of energy is declared as a matter of public and social interest of national benefit, fundamental to assure a complete energy supply, economic competitiveness, and protection for the final user and the promotion of non conventional sources of energy in a sustainable way with the environment and the natural resources.	
Decree 2532/2001 3172/2003	Regulation of article numeral 4 article 424-5 158-2 of tributary statement	It was defined that equipment and machinery to be used in projects, activities or programs intended to reduce energy consumption or use clean energy technology will not qualify for VAT exemption (2532/2001) or income tax exemption (3172/2003) unless their uses are part of programs or plans developed by the ministries of environment and energy and are intended to help in achieving energy consumption reduction and clean energy goals established by those ministries. Before there were no concrete plans so there was not tax exemption. However, at present both ministries are discussing the goals and the concrete plans, so the exemption could be made in the future.
Law 788/2002	Tributary reform	Electricity sales made by generation companies are exempted from income taxes for 15 years if generated by wind, biomass and agricultural waste and if generated by a generation company. Only those energy sources are included in the law, not solar, geothermal, or small hydro,In order to accede to the exemption it is required to: ▪ "Arrange, obtain and sell CO2 emission reduction certificates according with Kyoto protocol ▪ Invest at least 50% of the money obtained with the certificates in the social development of the community influenced by the company". All imported machinery and equipment used to generate carbon emission reductions are exempt from import duties.

NAME	SUMMARY	INCENTIVE
Decree 3683/2003	Regulates Law 697/2000 giving clear responsibilities to each agent as well as the path that the legislation should follow	Makes available certain incentives and scholarships for research and development.
Resolution 181401/2004	Determines CO_2 emission factor of the grid	Fixes the emission factor in 0.471 kg CO_2/kwh for any electricity generation project under 15 MW using renewable sources such as wind, solar, hydro, wave/tidal.
Resolution 180609/2006	Creates subprograms to promote renewable energy and the efficient use of energy	Defines 10 subprograms intended to promote the energy efficiency and the use of renewable energy. These include: ▪ Culture, research and promotion of rational use of energy ▪ Promotion and development of renewable energy and energy efficiency projects ▪ Sustainable building and equipment associated with rational use of energy ▪ Energy losses control ▪ Climate change, methane market and carbon capture ▪ Incentives to technologies, products and projects in EE and ER ▪ Projects or activities of cleaner production and energy saving ▪ Promotion of EE in the following sectors: official, commercial, transport, residential, industrial and ESCO ▪ Fuel substitution, from conventional to biofuels or cleaner fuels ▪ Technological upgrading or reconversion of industrial equipment directed to EE
Law 1151/2007	National Development Plan	Promotes the use of renewable energy sources for areas that are not grid-connected and designates renewable energy shall be supported with the funds FANZI and FAER (Fund of Financial Aid for Electrification of the Interconnected Rural Areas - is capitalized by a tax on electricity transport).
Decree 180919/2010	Adoption of action plan 2010-2015 to develop the Program for Efficient Use of Energy and non Conventional Sources of Energy PROURE	It defines specific goals to achieve before 2015 regarding the participation of non conventional sources of energy. For the national level it is expected to reach 3.5%, and for the interconnected zones it is expected to reach2 0%. These are the goals defined by the Ministry of Energy (and are the same goals mentioned in the previous decrees but at that time (2001 and 2003) where not defined. The goals are now defined in 2010. Tax reductions for those equipment and machinery mentioned in 2532/2001 and 3172/2003 are in the discussion phase (as of November 2010).
Resolution 180947/2010	Determines CO_2 emission factor for the national grid, useful for CDM projects	Fixes the emission factor in 0.2849 kg CO_2/kwh for any electricity generation project connected to the national grid

3 ENERGY EFFICIENCY

3.1. Diagnosis of energy efficiency (EE) situation

3.1.1 IMPORTANCE OF EE FOR COLOMBIA

The energy consumption in Colombia is approximately 250,000 Teracalories (See Fig 1.). The consumption is dominated mainly by the transport (39%), industry (27%) and households (22%) sectors, followed by agriculture and mining (5%) and the commercial and public sectors (5%). The energy demand is supported by a energy mix comprised of oil and gas (45%), natural gas (19%), bioenergy (16%), electricity (16%) and coke (5%).

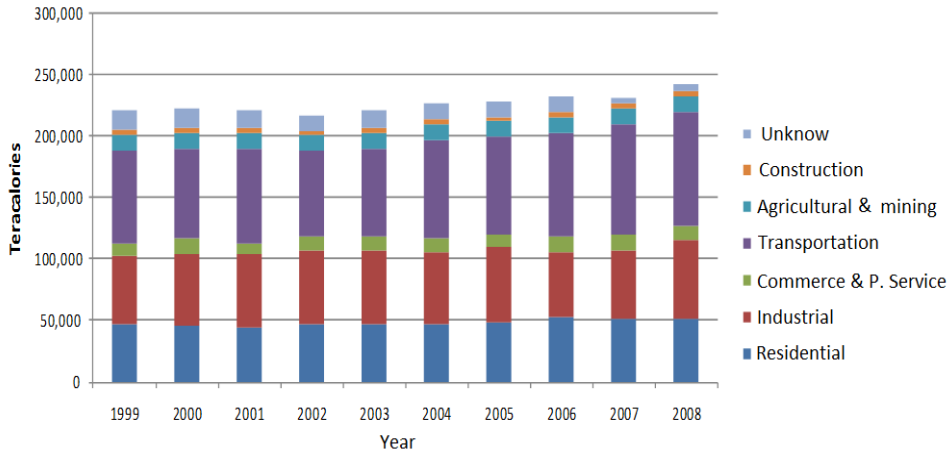
These figures suggest a significant potential for achieving energy savings along with cost and emission reductions by implementing energy efficiency programs across different sectors of the economy. Indeed, recent studies conducted by the Mining and Energy Planning Unit (UPME) argue that Colombia could potentially lower its emissions by anywhere between 12 and 67 Mt of CO2e in a 17-20 year period, depending on the aggressiveness of the energy efficiency measures. In terms of costs, the Inter-American Development Bank (IADB) estimates that a 10% reduction in energy consumption in Colombia by 2018 through the use of efficient technologies and equipment will reduce the power consumption by 6,300 GWh at a cost of approximately $730 million. This represents a savings of $1,600 million compared to the cost of building a new set of gas turbines to produce the same amount of energy. Additional benefits that have been identified include a less urgent need for subsidies and a more competitive economy.

Studies supported by the Ministry of Mines and Energy (MME) have already identified a number of energy efficiency measures. In the industry sector, these measures include improving/substituting boilers, kilns and ovens; introducing cogeneration schemes; and improving the efficiency of electrical devices, particularly motors. In the residential and commercial sectors, energy efficiency can be accomplished through the use of technologies and good practices in illumination, refrigeration and air conditioning. In the transport sector, energy efficiency can be improved through the reduction in transit redundancy; optimization and rationalization of transit routes; a higher vehicle occupation; and the introduction of new technologies such as electric vehicles. Colombia has also actively pursued policy improvements, and last June adopted the *Program of Rational and Efficient Use of Energy and other Forms of Nonconventional Energy* –PROURE, which set targets with regard to energy savings in different sectors of the economy.

3.1.2 EE INITIATIVES

A variety of energy-related studies has been conducted in the last eight years, including energy characterization studies in the residential and commercial sectors led by the Universidad Nacional de Colombia*;* studies designed to explore the potential savings and updating the energy information for different sectors as well as market potential led by the Fundación Bariloche, the Universidad Externado de Colombia and a host of nationals experts; and educational proposals and strategies for the industry led by COCENIT.

Figure 1. Final energy consumption by sectors



Source: 2009. UPME - Balances Energéticos

The last decade saw the development of a pilot project designed to change existing refrigeration equipment that contained substances harmful to ozone layer; it achieved the replacement of 1898 domestic refrigerators that contained CFCs, as well as the use of parts and residues of old equipment. The project has contributed to the diffusion of the environmental impacts; sensitization of end users in the effects of the actions and reconversions; achievement of suitable disposition of the old equipment; compilation of information and to extend the project nation-wide.

In the last five years the MME has encouraged the use of alternative sources of illumination and has developed pilot projects in different municipalities, which have led to a reduced consumption of electrical power in the commercial and residential sectors and public buildings. Through Decrees 2331 (2007) and 895 (2008) established a mandatory substitution of the low efficiency lighting sources in all public buildings. Decree 3450 established a nation-wide ban on import, commercialization and the use of low efficiency lighting bulbs (incandescent) beginning on January 1, 2011.

Additionally the government introduced a mandatory regulation governing street lighting systems that defines technical parameters of the equipment used in illumination and electrical systems. In terms of consumer protection ICONTEC and UPME developed practical standards and published a technical rule that would enforce the use energy efficiency labels in electrical equipment. The MME is completing the legal review of the decree and is expected to enter into force in 2011. The MME has also developed strategies designed to include the rational and efficient use of energy in educational programs as part of the curriculum within the PRAE (scholar environmental programs).

Multilateral institutions have also supported various initiatives. IADB and ANDESCO developed a program for energy audits in aqueducts. The Bogota Chamber of Commerce Bogotá (CCB) in alliance with the IADB developed a program that will offer market opportunities in energy services and clean energies in Bogota and Cundinamarca for the small and medium enterprises

(SME). The mains lines of action are the implementation of good practices in energy efficiency, the development of technological reconversion projects under the scheme of performance contracts and the implementation of pilot projects of clean energy in the SME. UNDP-GEF have been financing energy efficiency studies in the construction sector and also labeling programs on appliances.

ECOPETROL has defined various strategies and corporate areas for energy planning and energy demand management. This includes long term electrical energy purchase contracts as well as the identification of commercial opportunities and technological solutions on renewable energy sources. ECOPETROL is also working with COLCIENCIAS and group of Universities *i*n the implementation of a integral energy management system in strategic areas. Utilities such as ISAGEN and EPM are working with their industrial customers to implement energy audits and programs of integral management of energy seeking a major loyalty of the costumers and improvements in productivity. These companies together with research groups and technological development centers are also conducting research into new technologies and characterization studies of the renewable energy potentials.

3.1.3 EE POLICY

The energy efficiency legal framework in Colombia has been established over the last decade with the enactment of the Law 697 (2000) on the Rational and Efficient Use of Energy and Non-Conventional Sources of Energy, the Decree 3683 (2003), and the issuance of more than 50 regulations, resolutions and decrees that establish guidelines, incentives, and specific programs in various sectors and end-use technologies.

The Law 697 set the general legal framework for the development of policies and regulations by the national government. It established CIURE – the inter-institutional commission for the rational and efficient use of energy and nonconventional sources of energy – endorsing CIURE the responsibilities of developing policies and strategies, coordination between organizations; and articulation of programs and actions at national level. The Decree 3683 regulated the Law 697 giving responsibilities to each agent; later on by Resolution 180609 (2006) MME defined a subset of 11 subprograms intended to promote the energy efficiency and the use of renewable energy. More recently through Decree 180919 (2010) MME adopted PROURE (Program of Rational and Efficient Use of Energy and other Forms of Nonconventional Energy), a 2010-2015 action plan that includes indicative energy efficiency goal by sectors. The Appendix 1 summarizes the main energy efficiency related legislations.

3.1.4 EE NATIONAL TARGETS - PROURE

Strategies

PROURE establishes potentials and goals for energy savings in different sectors (transport, industry, residential, agriculture and mining, commercial and public) as well as the participation of the nonconventional sources of energy in the national energy matrix. It proposes short term scenarios, strategies and high-priority actions, which shall be implemented gradually and that must be reviewed and adjusted frequently. PROURE is also oriented towards the consolidation

of a energy saving culture, construction of the conditions to promote a market of energy goods and services, strengthening of the institutions, and the promotion of enterprises and investments. The Program identify as priority programs:

Residential Sector

- Incandescent lamp substitution
- Energy efficient use in refrigeration equipment, coolers and other electrical appliances
- Burners
- Design, construction of efficient and sustainable buildings
- Liquated Petroleum Gas - GLP in rural sector and marginal zones

Industrial Sector

- Improvement of the electrical energy use for engines
- Improvement of boilers
- Illumination efficiency
- Integral management of energy at the industry with emphasis on cleaner production
- Co-generation and self-generation
- Rational and efficient energy use at Small and Medium Enterprises
- Improvement of combustion processes
- Improvement of the cold chain

Commercial, Public and Services Sector

- Technology diffusion and good practices in illumination systems, refrigeration and coolers in the commercial, public and services sector
- Characterization, indicators management and technical assistance in the commercial, public and services sector
- Street Lighting technological updating

Transport Sector

- Technological conversion of the fleet
- Transport options
- Good practices in transport

Goals

As indicate earlier PROURE set indicative goals on energy efficiency (see Table 1). They were defined by the MME based on studies conducted by UPME in 2006 (Characterization of energy consumption in the residential sector); UPME - Fundación Bariloche and BRP Ingenieros in 2007 (*Consulting study to strategic formulation of the plan for rational use of energy and nonconventional sources of energy 2007 – 2025*), and updated information on population, households, industries and technologies penetration. This goals seem reasonable, however, it may be needed an update of the baseline of energy consumption. As part of the scope of this study the consulting team will conduct an evaluation of the current targets and provide recommendations on required adjustments.

Table 1. Colombia energy efficiency goals for 2015

Sector	Prospective savings for 2015 (%)*		Energy savings target for 2015 (%)	
Nationwide	Electricity	20.3	Electricity	14.8
			Others	2.1
Residential	Electricity	10.6	Electricity	8.66
			Others	0.55
Industrial	Electricity	5.3	Electricity	3.43
			Others	0.25
Commerce and Public service	Electricity	4.4	Electricity	2.66
Transport	Others**	0.44	Others	0.33
	Others***	1.06	Others	0.96
*Potential electricity savings expected by UPME				
**Potential savings from technology conversion (diesel to electric) of both articulate bus rapid transit system and a fraction of traditional buses (diesel to electric and hybrid) of the bus rapid transit system that serves Bogotá				
*** Potential savings from better driving practices in both bus systems and traditional buses nationwide and in the bus rapid transit system that serves Bogotá.				

Source: MME, Decree 180919

3.1.5 INSTITUTIONAL STRUCTURE TO SUPPORT EE

There are several stakeholders in the energy efficiency sector in Colombia, ranging from governmental agencies to private enterprises. Figure 2 presents a scheme of the relationships; the main roles by institutions are outlined below. Appendix 2 provides a detailed description of responsibilities by institution as defined by the law.

STRATEGIC LEVEL: Entities responsible for policy and regulatory developments

- Ministry of Mines and Energy (MME). Responsible for the promotion, organization, assurance of the development and the pursuit of the programs aimed at the rational and efficient use of energy.

- CIURE. Advise and support MME in the coordination of policies on URE and other non conventional energy forms in the national interconnected system as well as in non-interconnected areas.

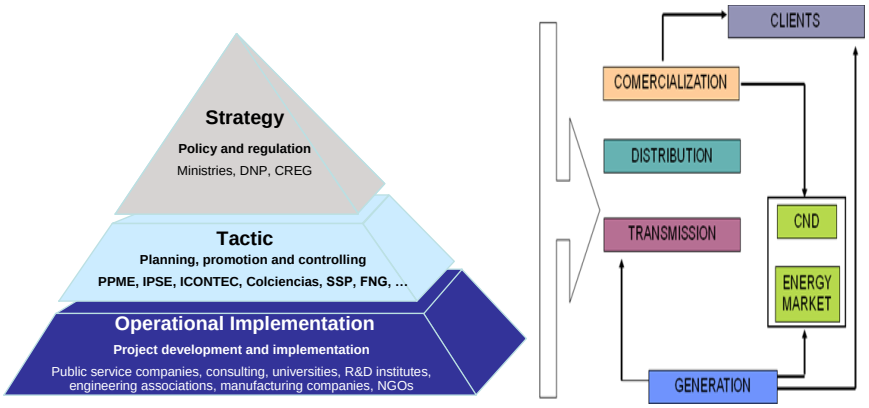
- MAVDT. Promote the formulation of plans of industrial conversion connected with the installation of environmental friendly technologies.

- Ministry of Education (ME). Increase by means of the education, the awareness for the conservation, protection and improvement of the environment, of the quality of life, of the rational use of the natural resources.

- Commission of Regulation of Energy and Gas (CREG). Assist MME in the identification and implementation of the models and financing sources for the administration and implementation of the PROURE and the projects related to URE.

- National Department of Planning (DNP). Coordinate the entities and public organizations to guarantee the proper fulfillment and execution of the policies, the programs and the projects outlined in the National Development Plan

Figure 2. Energy efficiency sector structure



Source: PROURE

TACTICAL LEVEL: Support, planning, promotion and controlling entities.

- COLCIENCIAS. Develop and support research programs and technological developments in the area of URE and/or non conventional sources of energy, in the context of pertinent National Programs of the National System of Science and Technology.

- UPME. Support MME in the identification and implementation of the models and financing sources for the administration and execution of the PROURE and the projects related to URE. Develops and maintain an inventory of conventional and non-conventional energy sources.

- ICONTEC. Contribute to establishing a technical regulation for the labeling of the equipment which becomes a Colombian technical standard and can be extended to a standard for the producers and importers with the target to inform the final users.

- Planning Institute for Energetic Solution (IPSE). Responsible for the energy supply in the non interconnected zones ZNI (mainly Orinoquia region, Amazonia, Pacific Coast).

- Bancoldex. Offers lines of credit for energy efficiency investments to the Colombian financial sector.

- BBVA Colombia and the Inter-American Investment Corporation's (IIC). IIC and BBVA are engaging SMEs with the purpose of energy efficiency audits.

OPERATIONAL LEVEL: The responsibilities of these entities are the execution of projects and the development of the market.

- ESCOs. Generate, supply and sell electric power and implement URE programs. Every three years they present information about technical and financial aspects of their activities with regard to URE to the UPME, for controlling, analysis and incorporation in the National Energy Planning.

- UTILITIES. Energy generation, construction of projects, and commercialization of energy solutions.

3.2 Strengths, weaknesses, opportunities & threats in energy efficiency development

3.2.1 STRENGTHS

There is strong governmental interest to support energy efficiency programs. Law 697, Decree 3683 and Decrees 180919 set up a legal framework that gives to Energy Efficiency and FNCE a higher status as a public interest issue; establishes responsibilities among different institutions and outline a plan of action for the period 2010-2015.

The last five years the MME has issued resolutions and decrees on lighting and lead the implementation of pilot projects for mass replacement of bulbs in different municipalities. This has contributed to raise awareness on energy efficiency and to the growth of the energy efficiency market in the residential sector.

At the present there is a plan that establishes clear goals to be achieved in the short term. This plan will help to develop an energy efficiency market and to sensitize the society on the importance of such actions intended to save energy.

There is an available talent ready to provide technical services. The main universities currently offer courses and specialization programs in energy efficiency and conduct research on this area. This research centers are in capacity in to support the plan of action of PROURE and promote qualified services to the market.

3.2.2 WEAKNESSES

Despite the general framework set by Law 697 that defines the efficient use of the energy as a subject of national interest, there is still lack of public awareness about the importance of energy efficiency.

There is an absence of incentives to promote energy efficiency programs. The current incentives are either insufficient or inadequate. Previous experiences such as lines of credits haven't had demand by the private sector.

Despite that PROURE establishes goals, its implementation may face big barriers as the action plan is not sufficiently known and the required resources are not guaranteed.

In some sectors is not possible to make an appropriate energy characterization due to the lack of information. This makes difficult the construction of energy balances and energy intensity indicators as well as the monitoring of goals and opportunities for energy saving. Similarly there is no reliable information of the efficiency of technologies that arrive to the market, neither a quality assurance program of its energy performance.

The current energy efficiency goals are focused on the commercials and residential sectors where the benefits in terms of primary energy savings and emissions reductions, although important are limited.

3.2.3 OPPORTUNITIES

Colombia has prepared a *Clean Technology Fund (CTF) Investment Plan* that covers priority actions in the transport and energy efficiency. These plans is supported by the multilateral banks under the UN climate change agreements and open a good opportunity to obtain financial resources to start the implementation of projects and programs in strategic areas identified in the PROURE.

A combination of financial schemes that consider energy efficiency and carbon credits is yet to be developed in Colombia. This seem worth to be explored as institutions such as Bancoldex has a ine of credit on CDM and BBVA is studying market opportunities created by the new regulation for SMEs.

On the international level there is an increasing interest by multilateral agencies and governments to promote and support energy efficiency policies and programs as well as the development of efficient technologies

3.2.4 THREATS

The MME remains as the responsible entity for the implementation of PROURE; however MME currently does not have the resources to develop the strategies and successful implementation of appropriate actions.

It is not clear yet the sources of funding and monitoring mechanisms to meet the PROURE targets. Without appropriate and clear financial support and without an adequate technical and monitoring and verification mechanism, the progress of the programs and its success will be hard to evaluate and sustain.

3.3 Scenarios for achieving energy efficiency targets

The adoption of the indicative plan PROURE 2010-2015 created new scenarios for the consolidation of a culture in sustainable and efficient management of natural resources and the construction of technical and economic conditions for the development of a market in these areas. This will require institutional strengthening, the promotion of business initiatives, and the creation of a new institution with specific functions and responsibilities. Two scenarios are proposed for discussion: a tendency scenario and a reference scenario.

Tendency scenario

Defined by a series of action to comply with Law 697/2000, the resolutions/decrees issued by the MME in the last three years, the diffusion of the action plan of PROURE as well as the dynamism of the international market of goods and services on clean and efficient technologies, the international pressure to reduce the emission of GHG and the current level of awareness on climate change. The basic characteristics of the scenario are:

- Entities, such as MME, UPME, CREG and all the participating institutions of CIURE, will continue to develop actions according to their capacities and resources, and will follow the previous path, but this will not be enough to achieve the goals proposed by 2015.

- The end users in all the sectors will begin to take decisions regarding replacement of equipment. The industry besides changing the technology will make energy management as a result of a) global markets and productivity requirements, and b) cost reduction and competitiveness in the industrial sector.

- The multilateral institutions (IADB, PNUD) and the international funds (GEF, CTF) continue making contributions, that are representative but that are not sufficiently embraced, unless the action plan moves forward according with the established schedule.

Reference scenario

This scenario comprises the fulfillment of the 2015 action plan goals, thanks to the participation and effective support of all the stakeholders. The main elements of the scenario are:

- The political willingness for the consolidation of the strategic subprograms defined in the action plan. Actions such as the creation of an entity to support end-users and the administration of financial funds to support to the MME in the execution of the action plan PROURE are implemented.

- There is enough support and adequate coordination between international organizations asnd local institutions towards the implementation of programs on:

    a. Energy efficiency in buildings (PNUD and GEF)
    b. Energy efficiency labeling for the Andean Community of Nations (PNUD and GEF)
    c. Energy efficiency projects (CTF, WB, IADB)
    d. Promotion of market opportunities for energy efficiency and clean energies (IADB, CCB)
    e. Energy audits for aqueducts (IADB, ANDESCO)

- The Clean Technology Fund- CTF Colombia Investment Plan received support for its implementation and it is reviewed in function of the targets and programs of the 2015 action plan.

- An integrated approach on energy efficiency and renewable energy is implemented.

Appendix 1 - Legal Support for Energy efficiency in Colombia

NAME	SUMMARY	INCENTIVE
Law 697/2000	Rational and efficient use of energy is declared as a matter of public and social interest of national benefit, fundamental to assure a complete energy supply, economic competitiveness, protection for the final user, and the promotion of non conventional sources of energy in a sustainable way with the environment and the natural resources needs editing	
Decree 2532/2001 3172/2003	Regulation of article 424-5 and 158-2 of tributary regime	It was defined that equipment and machinery to be used in projects, activities or programs intended to reduce energy consumption or use clean energy technology will not qualify for VAT exemption (2532/2001) or income tax exemption (3172/2003) unless their uses are part of programs or plans developed by the Ministry of environment or energy to achieve goals and energy consumption reduction and/or clan energy technologies. In the present the regulation of this aspect is being discussed by both ministries.
Decree 3683/2003	It regulate the Law 697/2000 giving responsibilities to each agent as well as the path that the legislation should follow	It gave some incentives regarding research and development, as well as scholarships. It creates and award to the companies that implement good operating practices in energy efficiency
Law 788/2002	Tributary reform	It is exempt of import tax all the machinery and equipment that will generate CO2 emission reduction certificates
Concept MME 508640/2005	Legal viability to implement the use of labels to identify the energy efficiency of some electric devices	
Resolution 180609/2006	Creation of subprograms to promote the efficient use of energy	It defines 11 subprograms intended to promote the energy efficiency and the use of renewable energy
Decree 2501/2007	Promotion of efficient use of energy	It promotes good practice of energy use in transmission, distribution, end use of energy, building and public lighting.
Decree 2331/2007	It declares mandatory the use of efficient lighting devices in all public building	
Decree 180919/2010	Adoption of action plan 2010-2015 to develop the Program for Efficient use of Energy and non Conventional Sources of Energy PROURE	It defines specific goals to achieve before 2015 regarding energy savings in different sectors. For the national level it is expected to reach 14.8% saving in electricity consumption and 2.1% in other energy sources

Appendix 2 – Energy efficiency responsibilities by Institution as defined by law.

INSTITUTION	ROLE	REFERENCE	ENERGY EFFICIENCY
Ministry of Mines and Energy (MME)	Entity regulator and promoter	Law 697 of 2001	Responsible of promoting, to organize, to assure the development and the one pursuit of the programs of rational and efficient use of the energy.
			To design in the Program of Rational and efficient Use of the energy and other non conventional energy ways "PROURE"
			In coordination with the public entities and private pertinent it designed strategies for the education and development of the Use Rational and Efficient of the Energy.
			It will formulate the guidelines of the policies, strategies and instruments for the development and the promotion of the sources not conventional of energy, with special importance in the not interconnected areas
		Decree 3683 of 2003	MME, its Special Administrative Units CREG and UPME, in coordination with the pertinent public entities, they will identify and they will implement the models and financing sources for the administration and execution of the Program of Rational and Efficient Use of Energy and other Forms of Non Conventional Energy, PROURE, and the applicable ones to the projects of Use Rational and Efficient of Energy, URE, and of promotion of energy non conventional.
			It in coordination with the other authorities competent, it will send the technical regulations of energy efficiency that, among other aspects, they will establish the conditions for the behavior of the label URE of the teams of final use of energy, the creation of the excellence stamp energetics and the conditions of commercialization of this teams with regard t energy efficiency, with the purpose of protecting the rights of information of the customers
Colciencias	Research	Law 697 of 2001	The National Government will incline for the creation of investigation programs in the Rational and Efficient Use of the Energy through Colciencias
		Decree 3683 of 2003	It will present to the Fund of Support Financier for the Energizing of the Not Interconnected Areas, FAZNI, plans programs and projects for the investigation and technological development of renewable sources in the Not Interconnected Areas, ZNI

			It through the National Programs of the National System of Science and Technology that are pertinent, it will develop strategies and actions together with other entities, to create research lines and technological development in the rational and efficient use of the energy and/or non conventional sources of energy
CREG	Support	Decree 3683 of 2003	MME, its Special Administrative Units CREG and UPME, in coordination with the pertinent public entities, they will identify and they will implement the models and financing sources for the administration and execution of the Program of Rational and Efficient Use of Energy and other Forms of Non Conventional Energy, PROURE, and the applicable ones to the projects of Use Rational and Efficient of Energy, URE, and of promotion of energy non conventional.
UPME	Support	Decree 3683 of 2003	The UPME will make an inventory of conventional and non conventional energy sources that will be taken as reference for the formulation and structuring of plans, programs and projects to consideration of the Committee of Administration of the FAZNI.
			MME, its Special Administrative Units CREG and UPME, in coordination with the pertinent public entities, they will identify and they will implement the models and financing sources for the administration and execution of the Program of Rational and Efficient Use of Energy and other Forms of Non Conventional Energy, PROURE, and the applicable ones to the projects of Use Rational and Efficient of Energy, URE, and of promotion of energy non conventional.

4 BIOFUELS MARKET STUDY

This chapter provides an overview of the situation of the biofuels in Colombia, analyze the short, medium and long-term national targets, review the regulatory and economic incentives for the promotion of biofuels and elaborates on the international market of ethanol and biodiesel trends and driving forces. The final sections present a SWOT analysis for positioning Colombia as a biofuel exporter and outlines strategic scenarios the consulting team proposes to the MME for consideration and further discussion.

4.1 Biofuels in Colombia

4.1.1 PRODUCTION

Colombia is one of the largest producer of biofuels in Central and South America. During 2009 Colombia produced 324,7 million litters of ethanol and 173,043 t of biodiesel. The country implemented mandatory blends for gasoline-ethanol (10%) and diesel-biodiesel (5%) in 2008. There are six bioethanol and seven biodiesel production plants in operation that use sugar cane and palm as main feedstock respectively. The total production capacity is about 1.1 million liters per day of ethanol and about 1.7 million l/day of biodiesel. It is estimated that biofuels generate 24,000 direct and 48,000 indirect jobs. Colombia has been producing sugar cane and palm oil since the early 1900. Not including coffee, each of them contributes to approximately 4% of the GDP in the agricultural sector. A key factor in the production cost of biofuels is the feedstock productivity and Colombia benefits from a high yield in sugar cane, oil palm and cassava, ranking among the top countries in the world.

A. Bioethanol

In 2009 Colombia produced 325 million liters of bioethanol and for 2010 it is expected a total production of 310 million liters, all consumed by the internal market. The country has been producing bioethanol from sugar cane since 2005. Three expansion projects are underway that upon completion by January 2011 will add 200,000 l/day to the existing capacity: Ingenio Providencia 50,000 l/day, Incauca 50,000 l/day, and Mayagüez 100,000 l/day. Two additional bioethanol plants are under construction (see Table 1). Three more are planned: two of them sugarcane based with a total capacity of 450,000 l/day and a 300,000 l/day plant sugar beet based. With these new plants the total production of bioethanol in Colombia will reach approximately 1.75 million l/day in 2011 and 2.5 million l/d in the next few years.

Table 1. Bioetanol plants in Colombia

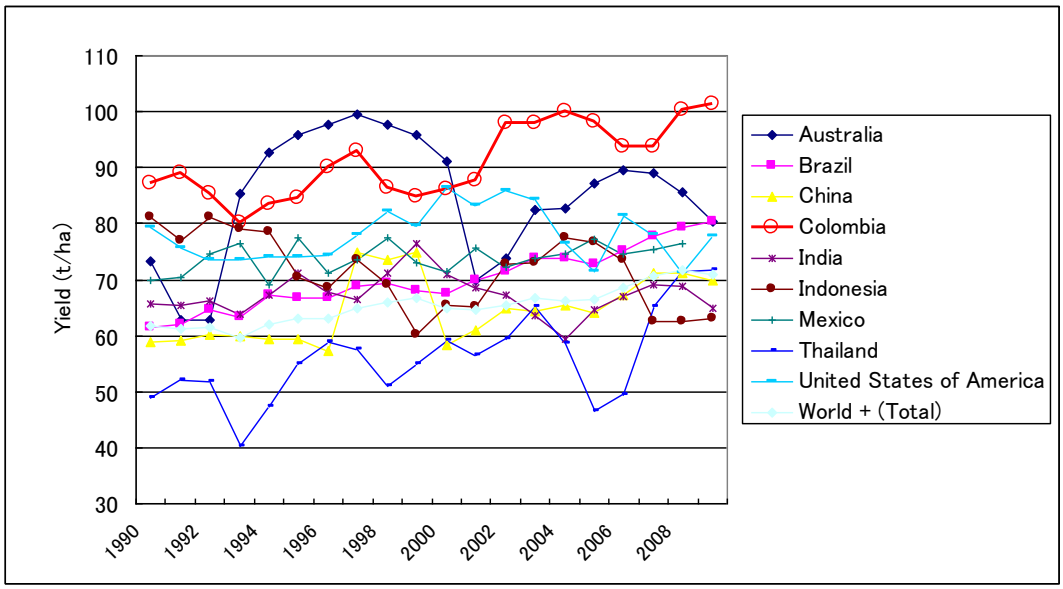
Region	Company	Capacity (l/day)	Feed stock	Cultivated area (ha)	Date of operation
Miranda/Cauca	Incauca	250,000	Sugar cane	11,942	09/2006
Palmira/Valle	Ingenio Providencia	300,000	Sugar cane	9,287	09/2006
Palmira/Valle	Manuelita	250,000	Sugar cane	8,721	03/2006
Candelaria/Valle	Mayagüez	150,000	Sugar cane	6,587	03/2006
La Virginia/ Risaralda	Ingenio Risaralda	100,000	Sugar cane	3,004	03/2006
Canta Claro/ Puerto López	GPC Etanol	25,000	Cassava	1,200	12/2009
Sub-total		1,075,000		40,741	
Puerto López/ Llanos Orientales	Bioenergy (Ecopetrol)	300,000	Sugar cane	12,000	TBD
Pivijai/Magdalena	Agrifuels	375,000	Sugar cane	10,000	TBD
Sub-total		675,000		22,000	
Total		**1,750,000**		**62,741**	

Productivity

The sugar cane production in Colombia is characterized by high productivity levels. According the FAOSTAT data, the 2004-2008 average yield in the country was 97.3 t/ha, 12% higher that Australia (86.8 t/ha) and 28% higher than Brazil (75.7 t/ha). Some studies explain these leading yields to the equatorial climate, the fertile soils of the Cauca Valley and a year round harvest cycle[4]. Cenicaña attribute this yields also the sustained investments in applied research and development in crop management and agricultural practices. In 2009 the yield reached 120 tons/ha (CENICAÑA), which combined with a standard of 75 l of bioethanol /ha lead to an average of 9,000 l of bioethanol/ha.

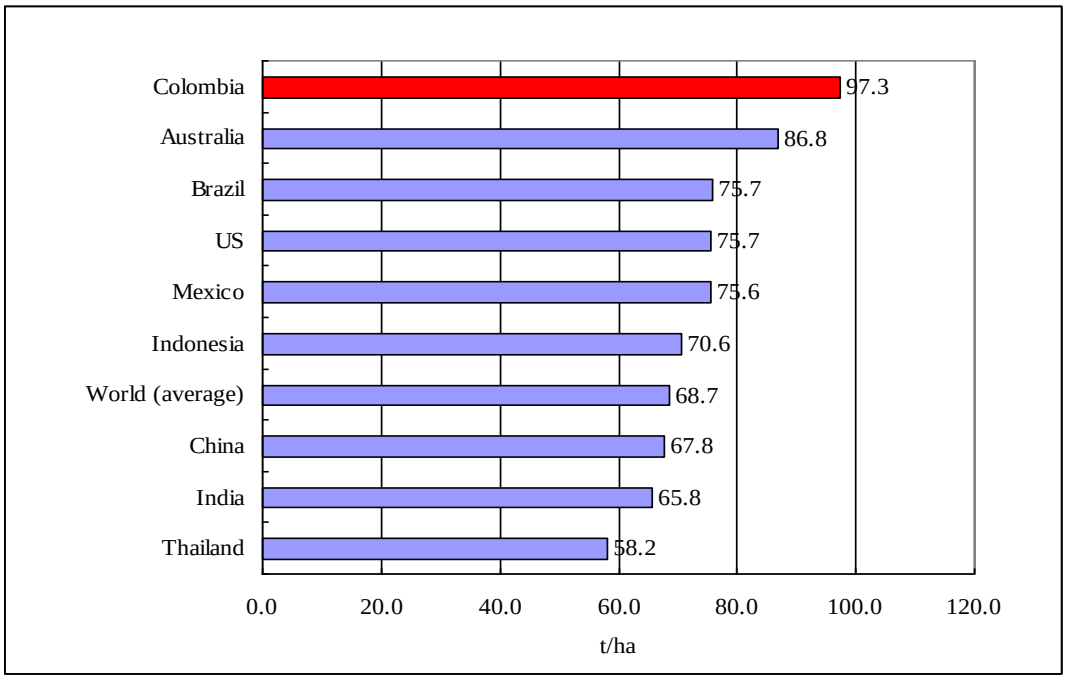
[4] http://www.kingsman.com/images/SampleRpts/Ethanol/MonthlyEthanolEditorial.pdf

Figure 1 Historical data of sugarcane yield, 1990-2009, in selected countries



Source: FAOSTAT (database updated: 02 September 2010)

Figure 2 Average yield of sugarcane production, 2004-2008 in selected countries



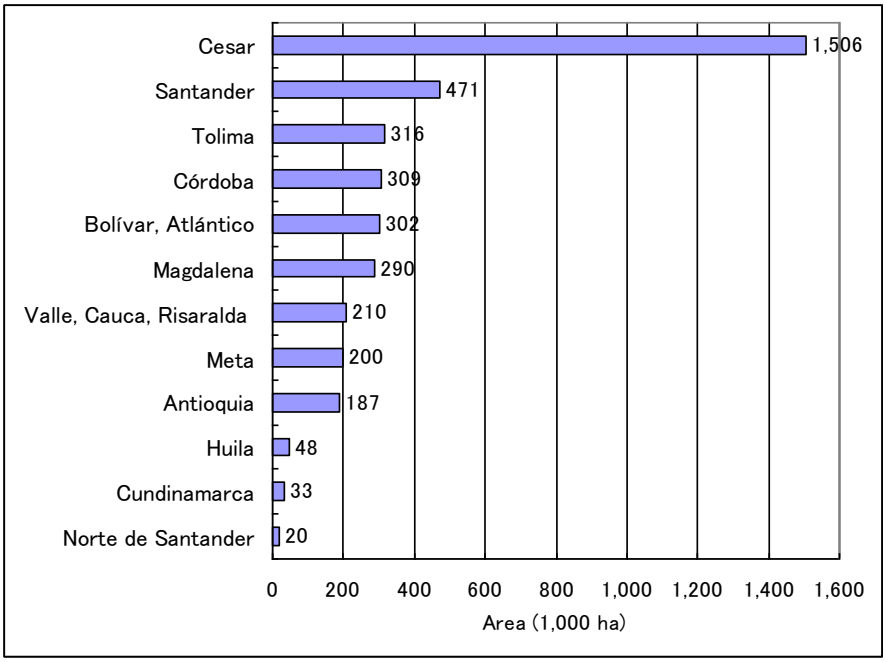
Source: FAOSTAT (database updated: 02 September 2010)

Potential of expansion

Land availability does not seem a factor to worry about when considering an increase in bioethanol production. Out of the 114 million hectares of the national territory only 40,000 ha are devoted to bioethanol production and the Ministry of Agriculture and Rural Development (MARD) estimates in 3.9 million ha the area with potential for sugarcane production.

According to CENICAÑA in the northwestern and eastern regions the yields most likely will not be as high as those in the Cauca Valley but will be high enough to make ethanol production profitable. Moreover, as the land in these regions is currently either unused or used only as low-density livestock pasture, CENICAÑA suggests that sugarcane plantations will not displace any crops and, thus, future ethanol production will not affect food security (USDA report).

Figure 3 Potential area for sugarcane production



Source: MADR, Política Nacional de Biocombustibles en Colombia
V Seminario latinoamericano y del Caribe de biocombustibles, agosto 2010.

B. Biodiesel

The installed production capacity of the 7 existing plants is 522,000 ton/year. The biodiesel production in January 2009 was around 1,039 ton and since then has been steadily increasing reaching a level of 31,849 ton in August 2010. In 2009 the total production was 169,411 ton and for 2010 it is expected a total production of 320,000 ton. The installed capacity will increase slightly with a new plant in Castilla la Nueva (Meta) that will add 10,000 ton/year. The Odin Energy and Clean Energy facilities are currently not operating. All plants are European technology (D Smet Ballestra and Bernardini).

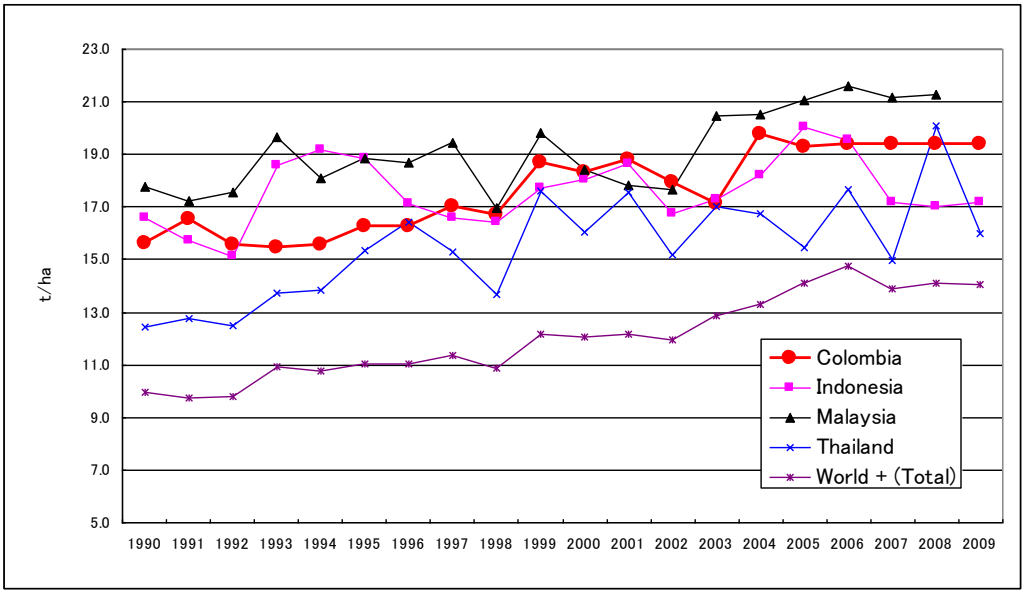
Table 1. Bodiesel plants in Colombia

Region	Company	Capacity (l / day)	Capacity (ton/year)	Cultivated area (ha)	Date of operation
Codazzi/Cesar	Oleoflores	188,275	50,000	11,111	11/2007
Santa Martha/ Magdalena	Odin Energy	112,965	36,000	8,000	05/2008
Santa Martha/ Magdalena	Biocombustibles Sostenibles del Caribe	313,391	100,000	22,222	03/2008
Facatativa/ Cundinamarca	Bio D	313,391	100,000	22,222	03/2009
Barrancabermeja	Ecodiesel de Colombia	313,391	100,000	22,222	06/2010
Barranquilla/Atlantico	Clean Energy	112,965	36,000	7,000	06/2010
San Carlos de Guaroa/ Meta	Aceites Manuelita	313,391	100,000	22,222	07/2009
Total		**1,667,769**	**522,000**	**114,999**	

Productivity

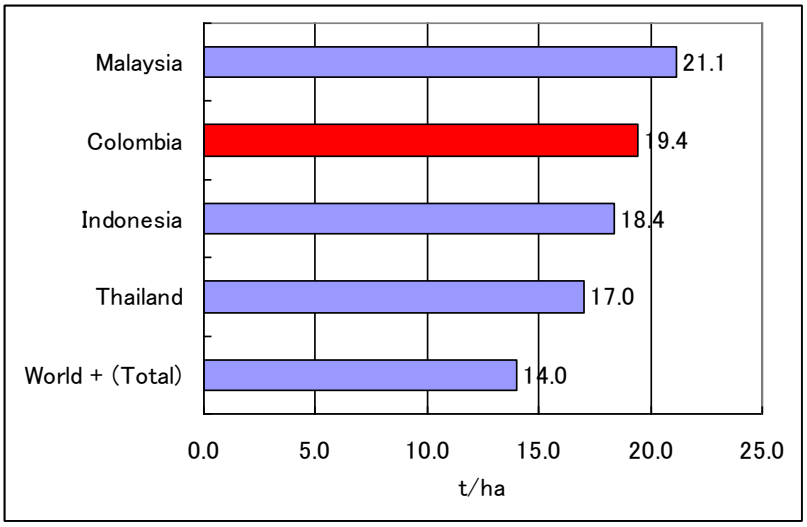
The oil palm production in Colombia is characterized by high productivity levels. The 2004-2008 average yield in the country was 19.4 t/ha, 5% higher that Indonesia (18.4 t/ha).

Figure 4 Historical data of oil palm yield, 1990-2009, in selected countries



Source: FAOSTAT (database updated: 02 September 2010)

Figure 5 Average yield of oil palm yield production, 2004-2008 in selected countries



Source: FAOSTAT (database updated: 02 September 2010)

Potential of expansion

Colombia has been conducting studies to estimate the potential areas for additional production of palm oil. The most recent effort comes from an inter-institutional project that involved several governmental agencies such as the MADR, MAVDT, IGAC,IDEAM and private organizations such as FEDEPALMA and CENIPALMA. The preliminary results indicate that the country has 600,000 ha with high to medium potential for palm production where the crop will have low impact, and around 1 million additional ha with low potential, meaning areas that will need some environmental and social management.

4.1.2 BIOFUELS POLICY

Regulations and Incentives

Colombia has initiated a strong action plan to become a biofuels producer, initially for the internal consumption but bearing in mind the growing demand in the international market. The government with support of key stakeholders has developed since 2001 a strong regulatory framework in order to promote the production of biofuels, mainly ethanol from sugar cane and biodiesel from palm oil.

The regulation has covered different aspects. On one hand some technical features have been established, such as quality of biofuels and quantity of the mixtures with gasoline and diesel; on the other hand the government has created a clear price structure for biofuels as well as incentives to promote the development of biofuels and to create a market. Most of the incentives are related with exemption of sales taxes, VAT, fuel taxes, etc. The exemptions have not only been for the fuel itself but also for the land use and for feedstocks such as palm and the sugar cane. The price of ethanol and biodiesel is also defined by a national resolution issued by the MME. The most recent one is the resolution 181232 of 2008, which is based on the document Conpes 3510.

An investor that wishes to develop a bioethanol plant has several incentives: a minimum price for the product, a market since there is a mandatory blending with gasoline (10%), tax exemptions for crops dedicates to the ethanol production and a VAT exemption for the ethanol itself. In the biodiesel case the investor also has a minimum price guaranteed; firm demand due to a mandatory mix of 5% with regular diesel; tax exemptions for crops suitable for biodiesel production; and, a VAT exemption for the biodiesel.

Through the congress the government has also developed mechanisms that can be used by the palm oil growers such as credits from the Banco Agrario (state own bank) with very low interest rates and very favorable conditions. There are also incentives supported by the MADR for irrigation districts built to increase production. This program - named Agro Ingreso Seguro - is under revision but the incentive still available.

A brief summary of the main regulation that have been developed since 2001, with special focus on the ones related to incentives is presented in table 3

Table 2 Incentive of Biofuels in Colombia

NAME	SUMMARY	INCENTIVE
Law 693/2001	The gasoline used in the urban centers > 500,000 inhabitants, should include oxygenated compounds beginning in 2005. The percentages of the mix are to be defined by the MME	Change the article 11 of the law 83/25 by which the production of alcohols was a departmental monopoly by letting it as an open activity where any private or public company can participate
Law 788/2002	Tributary reform	Exempt of VAT and other taxes such as global gasoline tax to fuel alcohol Exempt of import tax all machinery and equipment that generate CO2 emission reduction certificates
Law 863/2003	Tributary reform	Exempt fuel alcohol of sell tax
Law 939/2004	Stimulate the production and commercialization of biofuels from vegetal or animal origin to be used in diesel engines	• to exempt of income taxes the cultivations that are suitable for those fuels such as palm oil during 10 years • to allow the mix of suitable biofuels with diesel to operate the engines • to exempt of VAT and extra taxes the biofuels produced to be mixed with diesel
Law 1083/2006	Promotes the use of clean fuels in the transport sector	Propose the implementation of benefits for the vehicle that use clean fuels After January 1st , 2010 all the new vehicles for public transport should use clean fuels
Law 1151/2007	National development plan	It promotes the use of biofuels and the competence in its market. It has the goal of 26 departments with 5% mix of biodiesel
Resolution 180158/2007	Define which are the clean fuels for the country	
Conpes 3510 Resolution 181232/2008	Guideline to promote the sustainable production of biofuels in Colombia	The prices for biofuels are regulated by the MME and are defined as follows: Alcohol: The maximum income for ethanol producer is defined as the mayor value between:

		• A reference value for the opportunity cost of using the most efficient raw material in an alternative way (for Colombia it is an equivalent average price of export white refined sugar in the London market transformed into an equivalent of ethanol gallons) • A reference price that take into consideration the international prices of gasoline (adjusted by the changes in the fuel, by reduction of heating value, less sulfur, more octane number) • A minimum fixed priced by gallon (COP$ 4.497/gallon) updated by the IPP and the exchange rate Biodiesel: The maximum income for biodiesel producer is defined as the mayor value between: • An estimation of the efficient costs of producing biodiesel • The equivalent cost of importing diesel plus the cost of transformation if palm oil

Financial support

The Colombian Government has also promoted the development of the biofuels market by supporting technical studies that facilitate the decision making process as well as financing research and development projects. Among the most recent and relevant is worth to highlight:

MME-UPME

- Development of a strategic program for the biodiesel production from vegetable oils (2003)
- Development and consolidation of a biofuel market in Colombia (2007)
- Development of a regulatory framework and a price formation methodology for biofuels (2008)
- Development of a technical and economical regulatory framework for the flexfuel program in Colombia (2010)
- Sustainable Energy and Biofuel Strategies for Colombia (2010-2011) composed by a life cycle assessment of the production chain of biodiesel and bioethanol, the present study and a study in quality control assurance in laboratories

Ministry of Trade, Industry and Tourism (MTIT)

- Formulation and execution of sectorial business plans in public-private partnerships for world class sectors (oils, fats and biodiesel) (2010)

MAVDT-MADR-IDEAM

- Establishment of suitable areas for the cultivation of palm, based on social, economical and environmental criteria (2010)

COLCIENCIAS-MADR-ECOPETROL

COLCIENCIAS-MADR have sponsored 56 R&D projects (25 Colciencias and 31 MADR -5 of them in cooperation with ECOPETROL) on topics that fall into the following categories:

- Evaluation of new raw materials (higuerilla, jatropha, banana residues, sugar beet, cassava) and suitable areas for the production of biofuels.
- Evaluation of the use of biodiesel and bioethanol in internal combustion engines.
- Improvement of the production processes and development of new processes.
- Use of byproducts of the biofuels production such as the use of glycerin in animal feed.

Blending targets

In order to establish an internal market in 2008 the government set a mandatory blends for gasoline-ethanol (10%) and diesel-biodiesel (5%). The targets are expected to increase as indicated:

	2010	2011	2012	2015	2020	2025	2030
Ethanol	E8	E10	E10	E10	E12	E15	E20
				E20	E85	E85	E85
Biodiesel	B10	B10	B20	B20	B20	B20	B20

4.1.3 STAKEHOLDERS AND INSTITUTIONAL STRUCTURE

Figure 7 illustrates the structure of the institutional chain to support the biofuels business in Colombia. There are several stakeholders in this area: from governmental agencies (MME, UPME, MADR) to associations and private enterprises (ASOCAÑA, FEDEPALMA). The main institutional actors and their roles with regard to the legal framework are outlined below.

STRATEGIC LEVEL: Entities responsible for policies and regulation

- Ministry of Mines and Energy (MME). MME regulates and promotes the biofuels in Colombia. It is in charge of the regulation of prices, blending percentages and the technical requirements for biofuels.

- Ministry of Environment, Housing and Territorial Development (MAVDT). MAVDT promotes the environmentally sustainable performance. Determines the environmental criteria of quality of fuels and exercises control on the environmental impact of the biofuels.

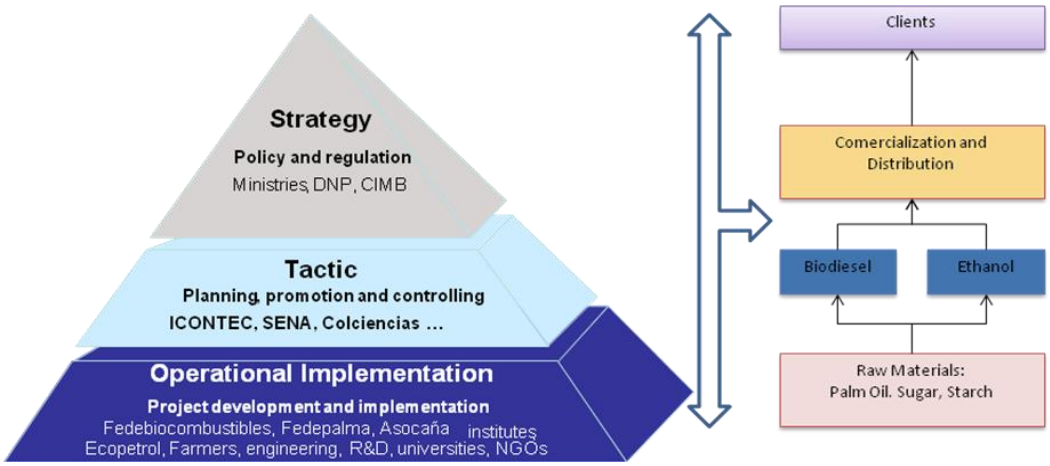
- Ministry of Agriculture and Rural Development (MADR). Acts as the Technical Secretary of the Intersectoral Commission of Biofuels (CIMB). Impels the implementation of the policy and strategies of the CONPES 3510.

- Ministry of Trade, Industry and Tourism (MCIT). Promote the trade of Biofuels. This includes contributing to positioning the country as a biofuels exporter.

- Ministry of Treasury and Public Credit (MHCP). Defines the fiscal incentives for the agroindustry of the biofuels.

- National Department of Planning (DNP). DNP coordinates the formulation of the National Plan of Development, in this the energy sector is promoted.

Figure 6 Institutional chain to support the Biofuels in Colombia.



TACTIC LEVEL: Support, planning, promotion and pursuit entities.

Colciencias. Leads the National Plan of Research and Development in Biofuels. This involves: the structuring of an integral plan of innovation, technological development and investigation (R+D+I) in biofuels.

OPERATIVE LEVEL: Execution of projects and impulse of a market.

Fedebiocombustibles, Fedepalma y Asocaña. Act as representatives of the biofuels producers. Coordinate sectoral projects and the positions of the sector in the negotiations with the government or international treaties.

Cenicaña and Cenipalma. Conduct applied research and provide support to the producers in order increase the productivity of the sector.

4.2 International Trends on Biofuels

4.2.1 THE MULTILATERAL PERSPECTIVE

The UNCTAD Biofuels Initiative indicates that the production of biofuels provides an opportunity for developing countries highlighting as main benefits:

- Use their own natural resources
- Attract foreign and domestic investment to achieve sustainable development goals.
- Provide greater energy security
- Provide improved quality of life, economic development, job creation and poverty alleviation, especially in rural areas.

A more critical perspective is provided by FAO's Bioenergy and Food Security Criteria and Indicators (BEFSCI) project, which mentions complex interrelationships between bioenergy, poverty and food security[5]. The project remarks that biofuel development may have significant implications for all four dimensions of food security (availability, access, stability and utilization). These interactions were analyzed by the FAO's Bioenergy and Food Security (BEFS) project concluding that:

- *Bioenergy developments can pose an increased threat to food security because it may compete with the same natural resources used for food production. Expanding production of fuel crops can influence national and international markets, triggering price surges and greater price volatility for staple foods. In areas where fuel crops expand, vulnerable rural communities may find it more difficult to gain access to the land or water they need to earn their livelihoods.*

- *Bioenergy development can also provide opportunities for increasing food security. It can generate employment and raise incomes in farming communities and spur rural development by providing a sustainable source of energy that is an affordable substitute for imported fossil fuels. Under the right conditions, investments in bioenergy can increase harvests for both food and fuel crops.*

4.2.2 BIOENERGY DRIVERS

Bioenergy markets are largely policy driven in most parts of the world and its key drivers have been: i) rising energy prices, in particular oil; ii) energy security; iii) climate change; iv) rural development, and v) others such as air pollution. Traditionally energy security and climate change are the most relevant factors in developed countries while rural development predominates in developing countries.

[5] http://www.fao.org/bioenergy/foodsecurity/befsci/en/

Table 3. Key drivers of bioenergy

Key drivers	Context
High Energy Prices	Soaring energy costs, especially oil prices, are motivating nations to find energy alternatives for their transport, heat and power sectors.
Energy Security	A driver of bioenergy growth is the aim of many nations to reduce their vulnerability to price increases and supply disruptions thereby increasing their energy security. Increased oil and gas prices are putting great strain on national budgets in import-dependent nations. Bioenergy is seen as a key mean of diversifying energy supplies and reducing dependency on a few exporters of oil and natural gas.
Climate Change	The factor driving bioenergy development relates to the commitments of nations to reduce their GHG emissions to mitigate global climate change. A growing group of nations are working towards GHG neutrality and many of them are incorporating bioenergy as a key element of their efforts to develop new economic models based on low-carbon emissions.
Rural Development	A fourth key driver in many contexts is the potential for rural development and especially the revitalization of agricultural sectors. Although it is still mainly unclear how resource poor farmers might participate in bioenergy schemes, biomass energy systems could contribute to maintaining employment and creating new jobs in rural areas, avoiding land abandonment and reducing in-country migration to cities. New crop types, improved farming practices and the ability to use agricultural and forestry residues provide the potential for new and diversified income streams for farmers and landowners. Local production and use of modern bioenergy could contribute to rural development and poverty alleviation, if countries promote a sustainable context.
Other Drivers	Air Pollution: Burning biomass with modern technologies or using liquid biofuels in engines may result in lower emissions of regulated air pollutants compared to the use of fossil fuels. Liquid biofuels results in minimal emissions of sulphur oxides (SOx), which in turn results in lower particulate matter (PM) emissions. Use of biofuels as liquid fuel oxygenates can reduce emissions of carbon monoxide (CO, an ozone precursor), and control pollutants contributing to photochemical smog. Biofuels also have lower emissions of heavy metals as well as a number of carcinogenic substances. Furthermore, biofuels can be used to replace lead in gasoline. Still, liquid biofuels such as ethanol may increase emissions of volatile organic compounds (VOC) if not controlled properly in car tanks, and fuelling stations. Soil Protection and Land Reclamation Growing biomass feedstocks can help restore degraded land and reclaim land through the use of energy crops for bioremediation. Residues and Waste treatment Straw, rice husk, sawdust, bark, animal wastes, black liquor, bagasse, pruning and thinning residues, municipal solid wastes and many other wastes, can be used as source of energy.

Source: A REVIEW OF THE CURRENT STATE OF BIOENERGY DEVELOPMENT IN G8 +5 COUNTRIES, FAO/GBEP, 2008.

4.2.3 POLICIES AND MEASURES TO PROMOTE BIOFUELS

In many countries the biofuels market depend on government policy to make them competitive with oil-based fuels. Examples include: blending mandates and production subsidies. Some of the most widely used polices include:

Subsidy to feedstock production

Feedstocks trend to have high share in the biofuel production cost structure. Subsidies to crop growth (if sufficient) contribute to reduce the feedstock cost leading to a lower biofuel prices. This may not have immediate impact on biofuel promotion but is very important for stable implementation in the long run. This subsidy may attract farmers to switch from food crops production, leading to lower supply and higher prices of food. As with any other subsidies, government expenses may become high in mature markets. One effective option to address this issue is limiting the subsidy to certain crops (those with high yield, low environmental pressures, etc). The subsidy to feedstock production has a direct positive impact on biofuel export, through reduction in biofuel price.

Capital investment support for biofuel production facility

Since fix cost are small compared to operational cost for conventional biofules, capital investment support for production facilities may play limited role for biofuel promotion; nevertheless, it lower the risk for biofuel producers. Investment support is more important for advanced biofuel production with higher capital costs. If cost reduction (by learning curve, larger capacity, etc) cannot be expected, investment support will be necessary forever. Similar to the subsidy to feedstock , capital investment support has direct positive impact on biofuel export.

Mandate for fuel suppliers

Mandate for fuel suppliers can stabilize the demand of biofuel, which will attract investment by private sectors. However, if the quota is set too low, it could restrict the market and disappoint industries. No revenue loss for government occurs apart from implementation and monitoring costs, thus it is easier to apply to relatively mature markets. Mandate for fuel suppliers does not have direct impact on biofuel export promotion, but can contribute indirectly since active domestic demand help develop the biofuel industries.

Consumer tax reduction

Consumer tax reduction is proven to be successful to initiate markets when combined with high fuel taxes. It is relatively easy for the government to implement this option by using existing tax schemes. Revenue loss may become high, thus many countries shift from tax reduction to mandates as market matures. Consumer tax reduction does not have direct impact on biofuel export promotion, but can contribute indirectly since active domestic demand help develop the biofuel industries.

Subsidy to adapted vehicles

Subsidy to adapted vehicles is important especially for high blends that can not be used in existing vehicles, since adapted vehicles often cost more than normal vehicles. It has proven to be an effective, yet complementary instrument in European countries such as Sweden. Subsidy to adapted vehicles does not have direct impact on biofuel export promotion, but can contribute indirectly since active domestic demand help develop the biofuel industries.

Fuel standards

Fuel standards will contribute to the promotion of efficient development of social infrastructures, as well as building trust of fuel suppliers, car manufacturers and consumers. It is essential to implement the standard at early stage to minimize social costs. Globally consistent standards will simplify biofuel trade, thus have positive impact on biofuel export.

Table 4 Classification of Types of Government Incentive for the Biofuel Sector

Classification of program	Instruments used	Examples
Support for Production of Biomass	Direct Subsidies for biomass Production	EU ECA introduced in 2003 (subsequently removed); eligibility of biomass for conservation payments
	Indirect subsidies for biomass production	Fuel, fertilizer and water subsidies; crop insurance and income subsidies to biomass producers
	Trade policies on biomass	Tariff concessions; export restrictions
Support for Biofuel Production and Distribution	Reduction of capital and infrastructure Costs	Capital grants for biofuel plants; concessional loans for ethanol producers in U.S. under ESA (1980); "enhanced capital allowances" under the tax code
	Reduction of production costs	Income tax credit (U.S. Energy Policy Act (2005)
	Direct subsidies for production of biofuels	Subsidies per unit of production
	Guaranteed prices paid by distributor	Minimum price for biofuels; "feed-in tariff"; "green bonus" for biofuels
	Trade policies on biofuels	Tariffs on imported biofuels
	Reduction of distribution costs	Fuel excise tax credit to blenders as in U.S.; direct subsidies for distribution (Sweden)
	Quantitative promotion	Quota obligation schemes and infrastructure (e.g. fuel pump) mandates; subsidies for infrastructure
Support for Consumption of Biofuels	Price reductions for biofuels	Excise tax exemption, VAT exemption; income tax credit
	Quantitative requirements for Blending	Quota obligation schemes; blending requirements
Support for R&D	Support for research into biofue	Development of second and third generation biofuels

Source: Biofuel and Biomass Subsidies in the U.S., EU and Brazil: Towards a Transparent System of Notification, IPC Position Paper, September 2010.

Table 5. Synthesis of major policies and measures for supporting biofuel

Process chain	Measures	Direct cost by	Direct impact to	Features, prospects
Supply: feedstock	Subsidy to feedstock production	Government	Agricultural sector (incentive)	- Indirect impact to biofuel increase due to reduction of production cost. - May have negative impact on food supply/cost. - Government expense may become high in mature markets.
Supply: biofuel production	Capital investment support for biofuel production facility	Government	Biofuel producer (incentive)	- Important for advanced biofuel production with higher capital costs. - Lower risk to producers compared to other incentives. - Government expense may become high in mature markets.
Demand: fuel suppliers	Mandate for fuel suppliers	Fuel suppliers (Fuel consumers if adequately imputed)	Fuel supplier (obligation)	- Stabilize market share, attracting investment - No revenue loss for government apart from implementation and monitoring costs, thus easier to apply to relatively mature markets. - Could restrict the market if quota is set too low.
Demand: end user	Consumer tax reduction (excise tax, fuel tax, etc.)	Government	Consumer (incentive)	- Proven to be successful to initiate markets when combined with high fuel taxes. - Relatively easy to implement by using existing tax schemes. - Revenue loss may become high in mature markets.
Demand: end user	Subsidy to adapted vehicles	Government	Consumer (incentive)	- Important especially for high blends that require adapted vehicles. - Government expense may become high in mature markets.
Supply and demand	Fuel standards	Government /industry	Biofuel producer/ Fuel supplier (obligation)	- Crucial for ensuring market penetration. - Early introduction can lower social costs. - Limited cost for government (only technical studies if necessary) - Global consistency necessary for export promotion.

Table 6 Major policies and measures in each country/region

Process chain	Measures	Brazil	EU	US
Supply: feedstock	Subsidy to feedstock production	■: 1975 PROALCOOL (credit guarantees and low-interest loans for feedstock production)	●:2003 Common Agricultural Policy (45€/ha subsidy, deregulation)	●: 2002 US Farm Bill
Supply: biofuel production	Capital investment support for biofuel production facility	■: 1975 PROALCOOL (credit guarantees and low-interest loans for biofuel production)		
Demand: fuel suppliers	Mandate for fuel suppliers	●:started in 1931 (5% blend), currently 20~25% blend (Law No. 8.723/1993)	●: Directive 2003/30/EC	●:Renewable Fuel Standard (2007 RFS2)
Demand: end user	Consumer tax reduction (excise tax, fuel tax, etc.)	■: 1975 PROALCOOL (retail price guarantee)	●: Directive 2003/96/EC	●: 2004 Ethanol Excise Tax Credit (VEETC)
Demand: end user	Subsidy to adapted vehicles			
Supply and demand	Fuel standards	●: Technical Regulation DNC - 01/91	●: Directive 85/536/ECC	●: ASTM Standard (D4806-98, D5798-98a)

●: existing policies, ■: policies which used to be in place

Figure 7 Current government support measures for biofuels in selected countries

	Targets/mandates*	Support measures
Argentina	E5 (2010) B7 (2010)	Blending mandate; tax exemption Blending mandate; tax exemption
Australia (New South Wales)	E6 (2011) B2	Blending mandate; tax reduction
Brazil	B5 (2010); E20-25	Blending mandate; tax reduction
Canada	E5 (2010) B2 (2012)	Blending mandate Blending mandate
China (nine provinces)	E10	Biofuel mandate (50 Mt/y); fixed subsidy
Colombia	E10; B10 (2010); B20 (2012)	
France	7% by energy content	Obligation for fuel suppliers, under a tax for not complying with biofuel incorporation (Taxe Generale sur les Activites Polluantes)
Germany	6.75% by energy content (2010)	Blending mandate; tax reduction
India	E10; B5 (2012); 20% biofuels (2017)	
Italy	B3.5 (2010)	Tax reduction
Japan	500 million litres by 2010	
Korea	B2.5 (2011); B3 (2012)	Blending mandate
Paraguay	E24; B5	
Peru	E7.8 (2010); B5 (2010)	Blending mandate
South Africa	E2**; B2	Blending mandate; tax exemption
Spain	5.83% by energy content (2010)	Blending mandate; tax reduction
Sweden	5.75% by energy content (2010)	
Thailand	B2; B5 (2012)	
United Kingdom	3.6% (2010); 4.2% (2011); 4.7% (2012); 5.3% (thereafter)	Blending target; tax reduction
United States	49 billion litres (2010, of which 0.02 cellulosic ethanol); 78 billion litres (2015, of which 11.4 cellulosic); 136 billion litres (2022, of which 60 cellulosic)	Loan guarantees, production tax credit for cellulosic biofuels, VTEEC blending tax credit; blending target
Zambia	E5 (2011); B10 (2011)	Blending target

* Share of biofuels in total road-fuel consumption by volume (unless otherwise specified); E = Ethanol, and E5 represents a 5% share of ethanol in the final product fuel mix, similarly B = Biodiesel, and B7 represents a 7% share of biodiesel. Policies written in blue are mandatory.

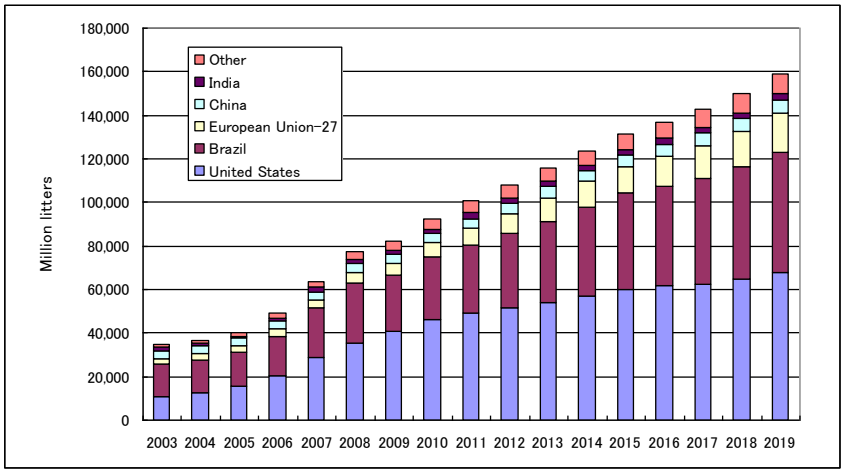
** Use of corn as a feedstock is prohibited.

Source: World Energy Outlook 2010, IEA (original source: IEA databases and analysis.)

4.2.4 PRODUCTION, TRADE BALANCE

Currently the global production of ethanol is approximately 82 billion liters (2009). According the OECD-FAO Agriculture Outlook 2010-2019, this level is projected to increase to 159 million liters by 2019.

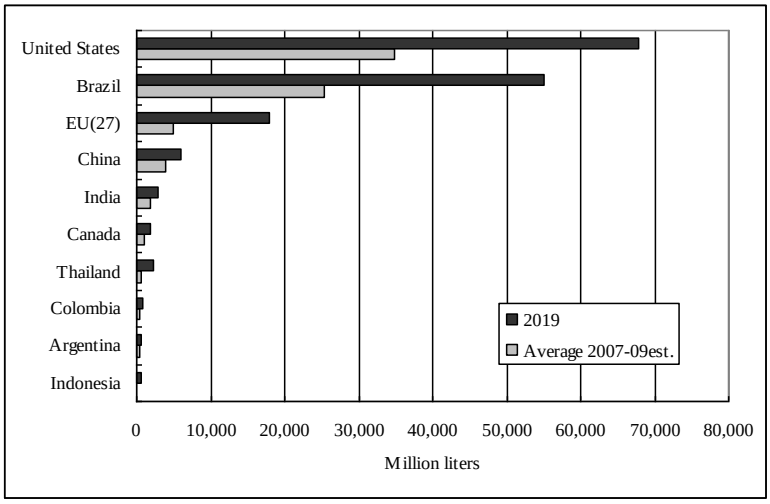
Figure 8 Global ethanol production



Source: OECD-FAO Agricultural Outlook 2010-2019

The ethanol market is currently dominated by the US and Brazil. In the period 2007-2009 they produced an annual average of 34,888 million liters and 25,308 million liters respectively. The US accounts 47% of the global production of ethanol and Brazil 34%. The EU production share in the global market is only 7% (4,890 million liters). According to OECD-FAO estimates, the US and Brazil are expected to remain the largest ethanol producers over the next decade.

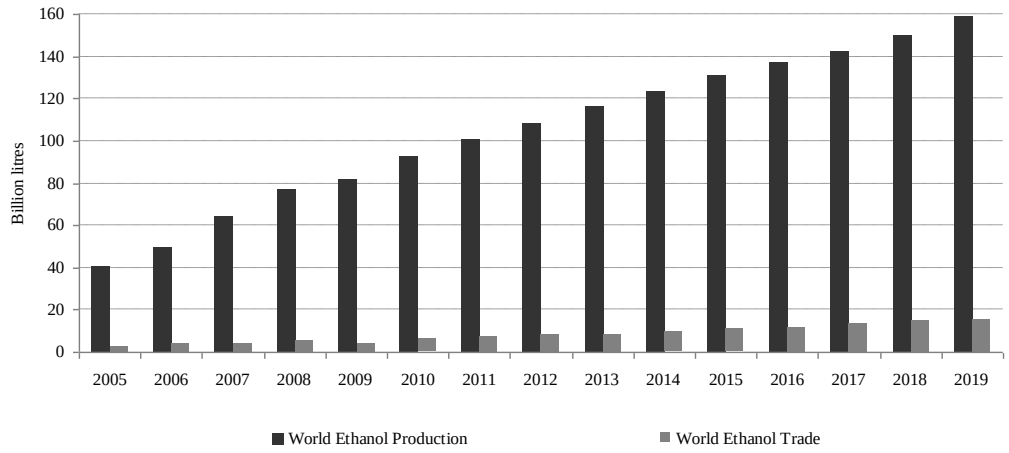
Figure 9 Ethanol production by major countries



Source: OECD-FAO Agricultural Outlook 2010-2019

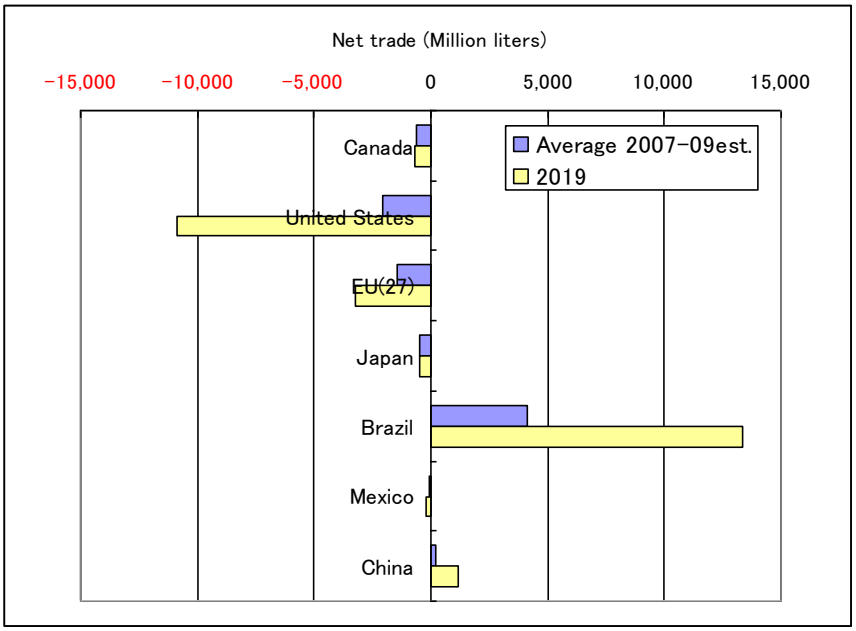
Data of the average production during 2007-2009 indicate a total net trade exports of ethanol of 4,465 million liters (6% of global production) during that period. Brazil is the main exporter with a net trade of 4,127 million liters (92% of the total net trade) and is expected to keep that role at least until 2019.

Figure 10 Global ethanol trade



Source: OECD-FAO Agricultural Outlook 2010-2019

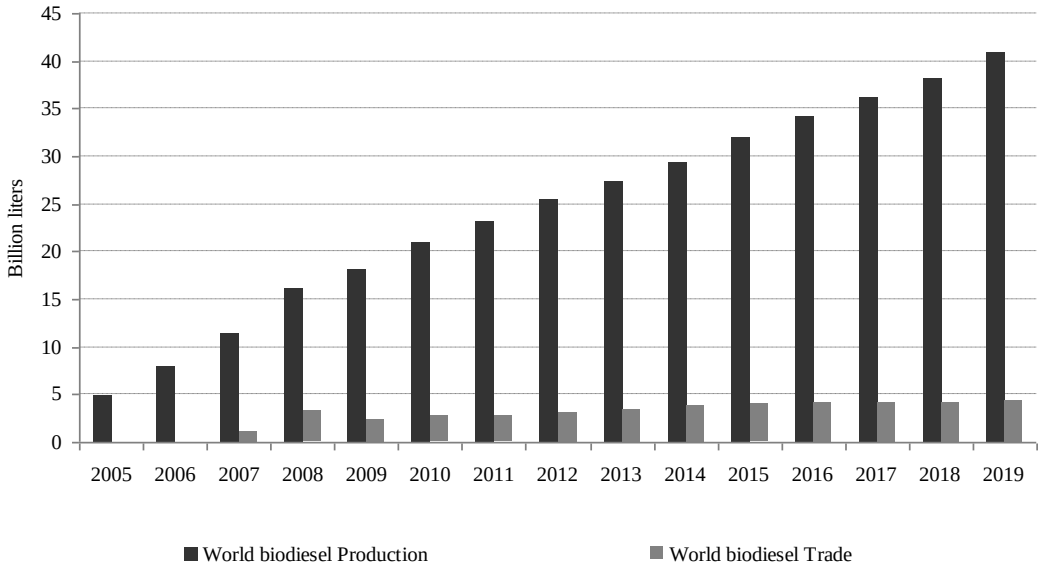
Table 7 Net trade exports of ethanol by countries



Source: OECD-FAO Agricultural Outlook 2010-2019

In the case of biodiesel the global production is expected to increase from around 21 billion liters in 2010 to almost 41 billion liters by 2019. The biodiesel net trade is also less than 10% of the total production, but the main exporter is Argentina.

Figure 11 Global biodiesel production



Source: OECD-FAO Agricultural Outlook 2010-2019

4.2.5 PRICE TRENDS AND PRODUCTION COSTS

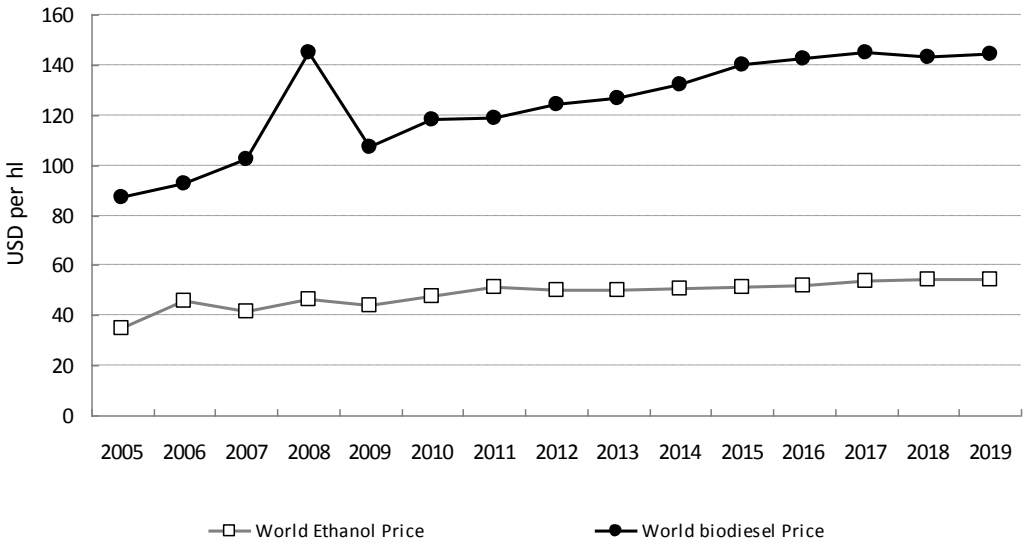
Price Trends

Price of biofuel is highly influenced by crude oil and raw material prices. According the OECD-FAO Agricultural Outlook 2010-2019, the world ethanol price will increase due to the strong and rising crude oil prices6. The report forecast:

- A price around USD 54.4 per hl in 2019 due to a strong demand in a) the United States to meet the RFS2 standards and b) in Brazil due to the development of the flexi-fuel industry.
- An increase of the biodiesel price until 2017 and then to remain stable around USD 144 per hl. This is considering that second generation biodiesel will become more available in the EU after that period, reducing the pressure on global supply.
- Crude oil prices will be strong and rising throughout the projection period, reaching almost USD 97/barrel by 2019.

[6] Chapter 4 biofuels, OECD-FAO Agricultural Outlook 2010, June 2010

Figure 12 Biofuels price trend



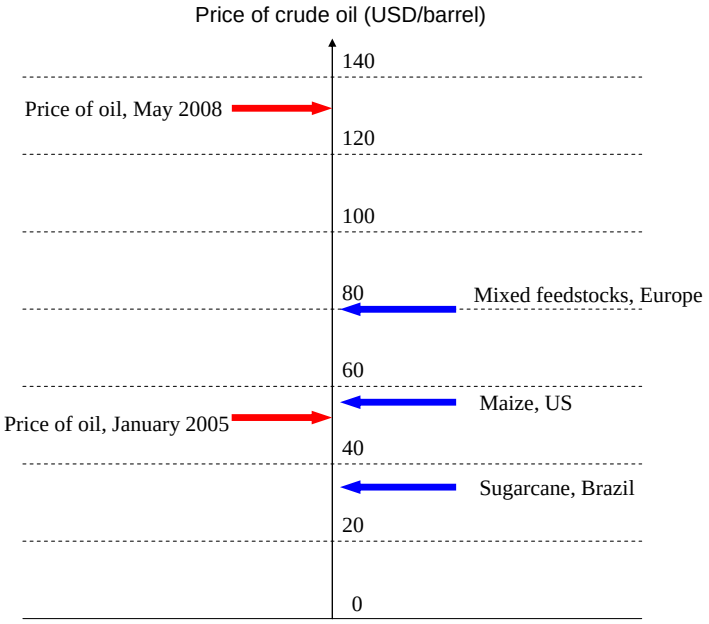
Source: OECD-FAO Agricultural Outlook 2010-2019
Ethanol price: Brazil, Sao Paulo (ex-distillery).
Biodiesel price: Producer price Germany net of biodiesel tariff.

Another study conducted by FAO[7] that analyzes breakeven prices for crude oil and selected feedstocks concludes.

- Brazilian sugar cane is competitive at much lower crude oil prices than other feedstocks and production locations.
- Based on maize prices prior to 2006, United States maize ethanol is competitive at crude oil prices of around US$58/barrel.
- The breakeven point change as feedstock prices change. Indeed, sharp rises in maize prices (partly due to demand for biofuels) and reductions in sugar prices suggest a widen competitive advantage of Brazilian sugar-cane ethanol over United States maize ethanol.

[7] The state of food and agriculture, FAO, 2008

Figure 13 Breakeven prices for crude oil and selected feedstocks in 2005



(Based on data from "FAO. 2006. Impact of an increased biomass use on agricultural markets, prices and food security: a longer-term perspective, by J. Schmidhuber. Rome").

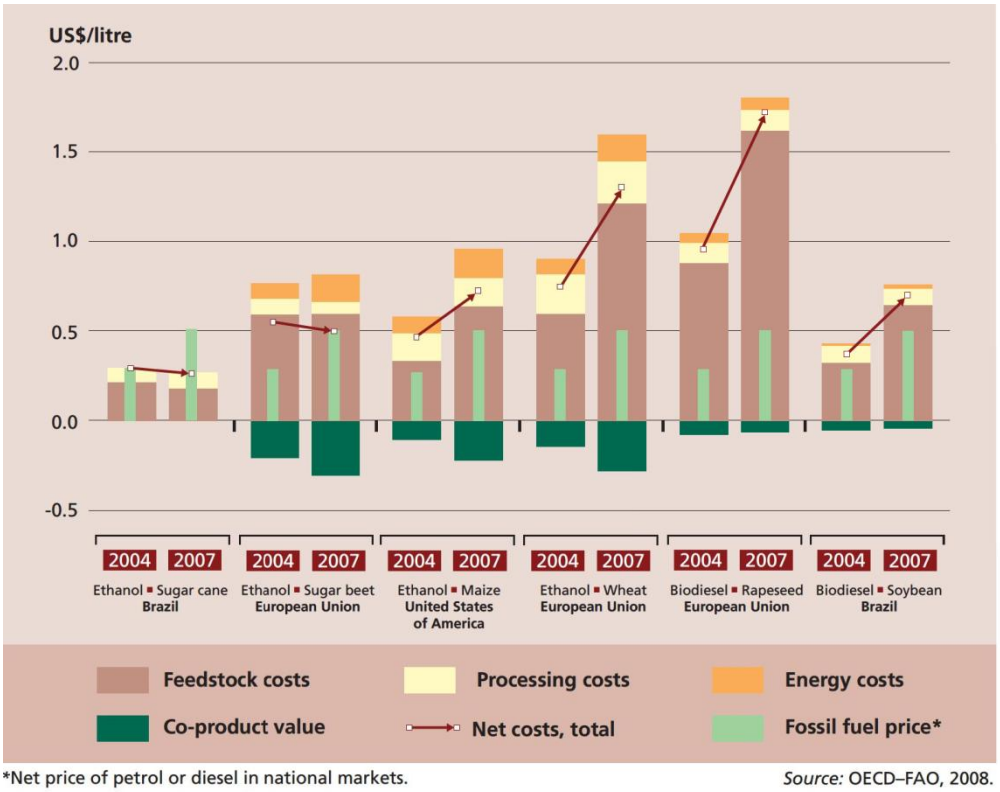
Source: The state of food and agriculture, FAO, 2008

Production cost

The 2008 FAO also analyze the production costs of biofuels in selected countries broking down by feedstock, processing and energy costs and deducting the value of co-products. The overall conclusions are:

- In general, the lowest total cost is Brazilian sugar-cane ethanol.
- Commodity feedstocks accounts for the largest share of total costs.
- Energy costs for ethanol production in Brazil are negligible because bagasse, the major co-product of sugarcane processing, is burned for fuel.
- European and United States processors typically pay for fuel, but sell co-products from the ethanol and biodiesel production processes, usually for animal feed.

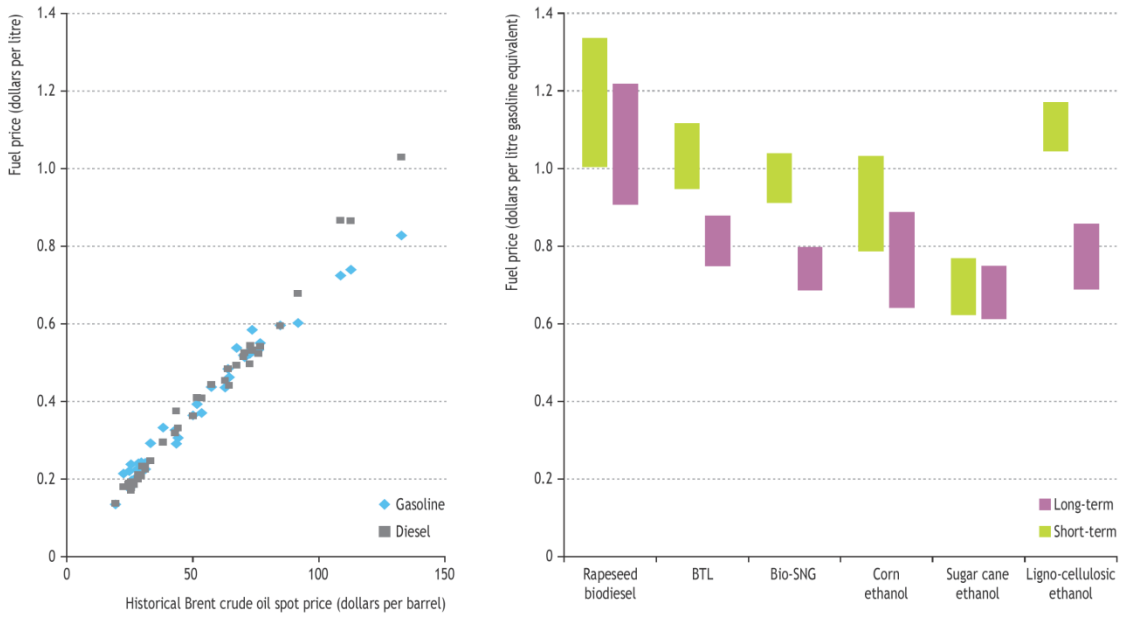
Figure 14 Biofuel production costs in selected countries, 2004 and 2007



Source: The state of food and agriculture, FAO, 2008

Other relevant aspect to consider are the fact that a) outside of Brazil, biofuels generally cost much more to produce than conventional gasoline or diesel; b) the cost of Brazilian sugarcane ethanol is lower than that of corn ethanol; and c) advanced biofuels, like BTL biodiesel or ligno-cellulosic ethanol, are currently not competitive with conventional fuels.

Figure 15 Indicative cost ranges of selected biofuels versus gasoline and diesel prices



Source: World Energy Outlook 2010, IEA (Adapted from the Mobility Model of the IEA.)
Note: Gasoline and diesel prices are quarterly from January 2000 to April 2010. Costs exclude subsidies. Feedstock costs are averages and can vary significantly by region.

4.2.6 SUSTAINIBILITY

The potential risks of biofuel production for food security, biodiversity and the environment are hotly debated at the international level and therefore became an important issue to consider when planning global trade of biofuels. One important measure to promote the positive and reduce the negative impacts is the development of sustainability criteria, standards and certification schemes fro biofules production. Currently the most relevant international initiatives and regulations on sustainability are:

Global Bioenergy Partnership (GBEP) [8]

The purpose of the Global Bioenergy Partnership is to provide a mechanism for partners to organize, coordinate and implement targeted international research, development, demonstration and commercial activities related to production, delivery, conversion and use of biomass for energy, with a focus on developing countries.

GBEP's main functions are to:

- promote global high-level policy dialogue on bioenergy and facilitate international cooperation;

[8] http://www.globalbioenergy.org/aboutgbep/

- support national and regional bioenergy policy-making and market development;
- favour the transformation of biomass use towards more efficient and sustainable practices;
- foster exchange of information, skills and technologies through bilateral and multilateral collaboration;
- facilitate bioenergy integration into energy markets by tackling specific barriers in the supply chain;
- act as a cross-cutting initiative, working in synergy with other relevant activities, avoiding duplications.

The Roundtable on Sustainable Biofuels (RSB)[9]

The Roundtable on Sustainable Biofuels (RSB) is an international initiative coordinated by the Energy Center at EPFL in Lausanne that brings together farmers, companies, non-governmental organizations, experts, governments, and inter-governmental agencies concerned with ensuring the sustainability of biofuels production and processing. The RSB has developed a third-party certification system for biofuels sustainability standards, encompassing environmental, social and economic principles and criteria through an open, transparent, and multi-stakeholder process. Participation in the RSB is open to any organization working in a field relevant to biofuels sustainability.

Renewable Fuels Standard (RFS2) in USA[10]

The RFS program was created under the Energy Policy Act (EPAct) of 2005, and established the first renewable fuel volume mandate in the United States. As required under EPAct, the original RFS program (RFS1) required 7.5 billion gallons of renewable fuel to be blended into gasoline by 2012. Under the Energy Independence and Security Act (EISA) of 2007, the RFS program was expanded in several key ways:

- EISA expanded the RFS program to include diesel, in addition to gasoline;
- EISA increased the volume of renewable fuel required to be blended into transportation fuel from 9 billion gallons in 2008 to 36 billion gallons by 2022;
- EISA established new categories of renewable fuel, and set separate volume requirements for each one.
- EISA required EPA to apply lifecycle greenhouse gas performance threshold standards to ensure that each category of renewable fuel emits fewer greenhouse gases than the petroleum fuel it replaces.

The most relevant issue on sustainability of the RFS2 is that impose restrictions on the level of GHG emissions for biofuels production: conventional renewable fuels must reduce GHG by 20% when compared to gasoline, advanced biomass-based diesel and non-cellulosic advanced biofuels by 50% and cellulosic biofuels by 60%.

Conventional biofuel	Conventional biofuel is ethanol derived from corn starch. Conventional ethanol facilities that commence construction

[9] http://rsb.epfl.ch/
[10] http://www.epa.gov/otaq/fuels/renewablefuels/index.htm

	after the date of enactment must achieve a 20 percent greenhouse gas (GHG) emissions reduction compared to baseline lifecycle GHG emissions.
Advanced biofuels	Advanced biofuels is renewable fuel other than ethanol derived from corn starch, that is derived from renewable biomass, and achieves a 50 percent GHG emissions reduction requirement.
Cellulosic biofuels	Cellulosic biofuels is renewable fuel derived from any cellulose, hemicellulose, or lignin, that is derived from renewable biomass, and achieves a 60 percent GHG emission reduction requirement.

Source: Definitions (Sec. 201) in the renewable fuels program

New directive on renewable energy in EU[11]

Under Directive 2003/30/EC, the European Union established the goal of reaching a 5.75% share of renewable energy in the transport sector by 2010. A new directive (Directive 2009/28/EC of the European parliament) on the promotion of renewable energy, raises this share to a minimum 10% in every Member State in 2020. This new directive also requires that the EU uses only sustainable biofuels. They are defined as those that generate a clear and net GHG saving of 35% and have no negative impact on biodiversity and land use. This 35% threshold will be 50% in 2017 for existing plants and 60% for new production facilities.

Renewable Transport Fuel Obligation (RTFO) in UK[12]

The Renewable Transport Fuels Obligation (RTFO), requires suppliers of fossil fuels to ensure that a specified percentage of the road fuels they supply in the UK is made up of renewable fuels. The target for 2009/10 is 3.25% by volume. The RTFO requires companies to submit reports on the carbon and sustainability of the biofuels.

Roundtable on Sustainable Palm Oil RSPO[13]

RSPO was formed in 2004 with the objective promoting the growth and use of sustainable oil palm products through credible global standards and engagement of stakeholders

Japan

Biofuel is listed in the "Kyoto Target Achievement Plan" for the transport sector in Japan. This plan set the goal of replacing about 500 thousand kl-oe (kilo liter-oil equivalent) of fossil fuel with biofuel by 2010. The Petroleum Association of Japan aims to introduce 210 thousand kl-oe by ETBE. The Japanese government –through METI and the Agency for Natural Resources and Energy (ANRE) – has also introduced a proposal on sustainability criteria for biofuels. The proposal, presented last march recommends:

- Contribution to CO2 emission reductions identified by a LCA
- Set the reduction standards on an LCA basis at 50%. (similar to EU and UK)

[11] http://ec.europa.eu/energy/renewables/biofuels/biofuels_en.htm
[12] http://www.renewablefuelsagency.gov.uk/aboutthertfo
[13] http://www.rspo.org/

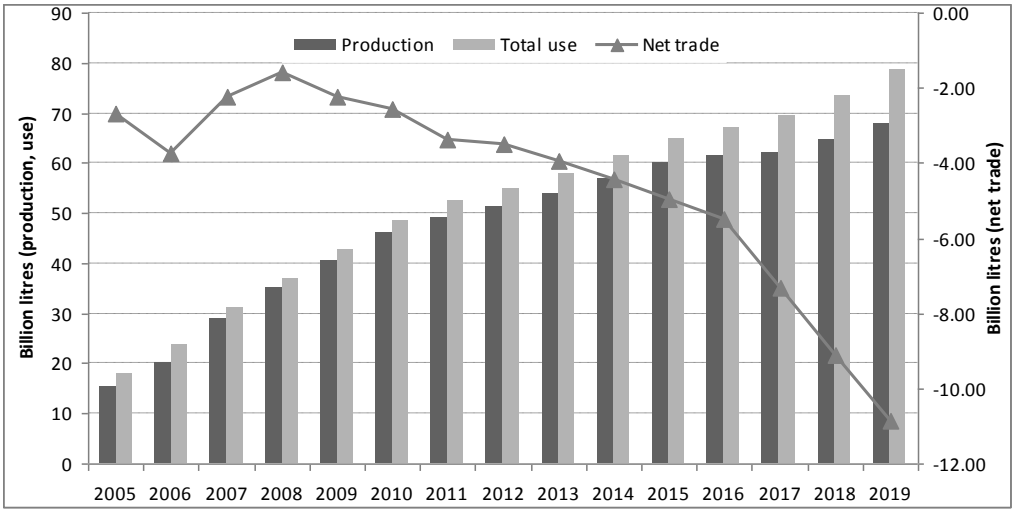
- Stability in the supply as a source of energy
- Japan should aim for a high degree of self-sufficiency in biofuel (currently 3% in Japan vs 99% in the U.S. and 60% in the EU). One future direction for Japan is to meet at least 50% of biofuel requirements through domestic production.
- Address the issue of competition with food. The related ministries should cooperate in monitoring the impact of biofuel introduction and analyzing the causes of competition in order to identify solutions. The government should also emphasize the development and dissemination of technologies for biofuel produced from grass and wood cellulose.

4.2.7 TRENDS IN MAIN MARKETS

US

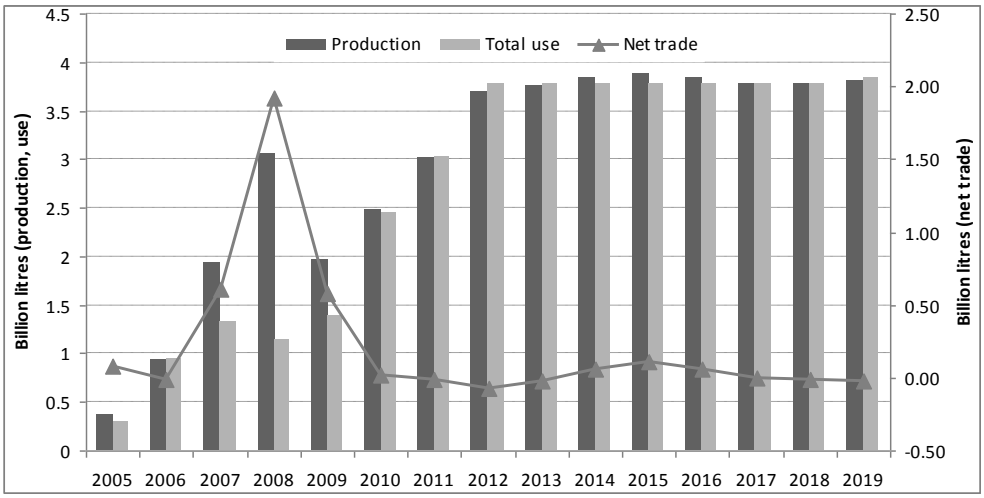
As indicated earlier the EISA of 2007 increases the volume of renewable fuel required to be blended into gasoline from 9 billion gallons in 2008 to 36 billion gallons by 2022. This will generate an increasing demand of ethanol and biodiesel in the US during the next two decades**.**

Figure 16 US ethanol market



Source: OECD-FAO Agricultural Outlook 2010-2019

Figure 17 US biodiesel market

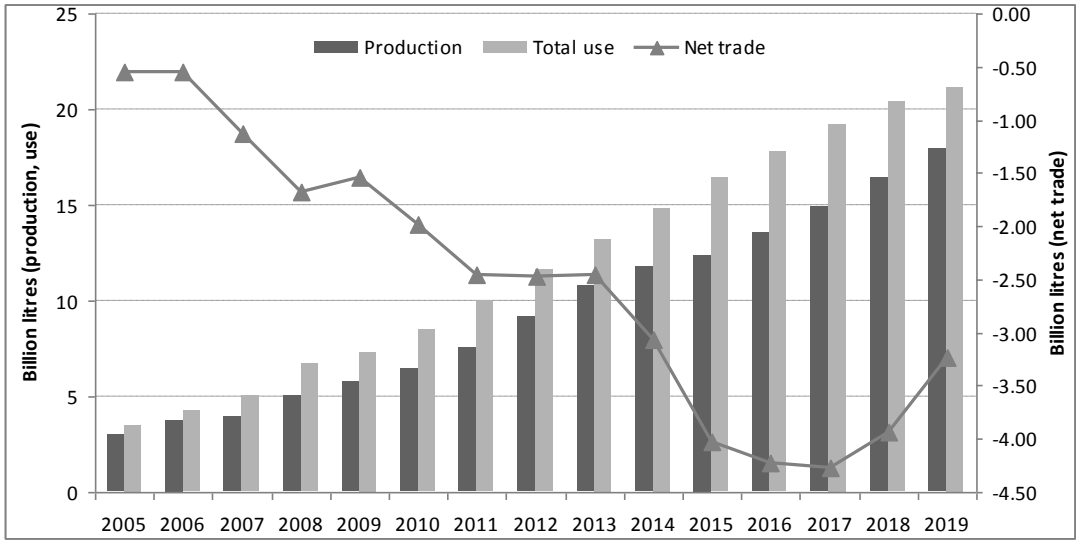


Source: OECD-FAO Agricultural Outlook 2010-2019

Europe

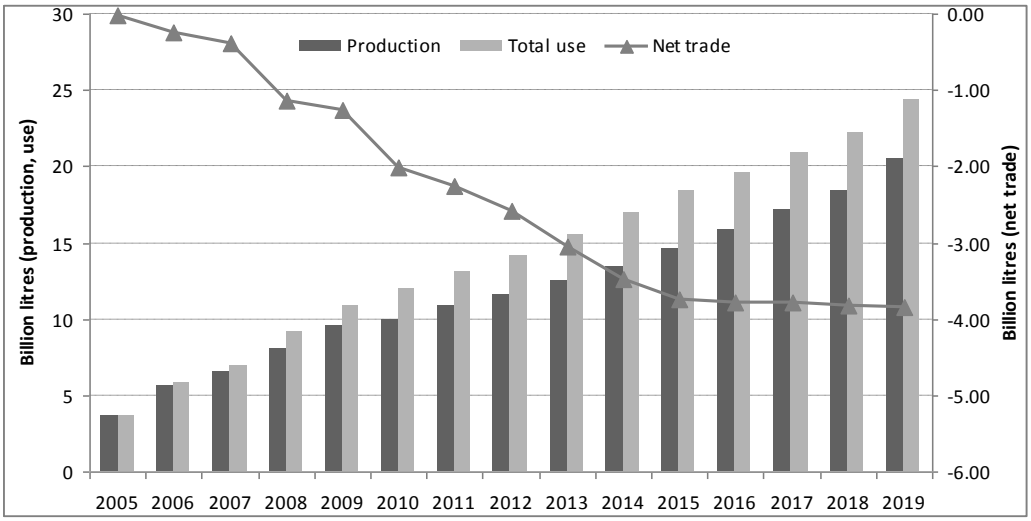
The recent EU legislation will also increases the demand of biofuels. In 2008 the EU mandated the use of biofuels in the transportation sector. In 2009 as a part of its "Climate Change Package" the EU adopted an EU-wide binding target of 10 % from renewable sources in the transport sector by 2020.

Figure 18 EU ethanol market



Source: OECD-FAO Agricultural Outlook 2010-2019

Figure 19 EU biodiesel market



Source: OECD-FAO Agricultural Outlook 2010-2019

Japan

Under the Kyoto Protocol Japan has agreed to reduce its greenhouse gas emissions by 6% from 1990 levels between 2008 and 2012. As part of this target the Petroleum Association of Japan, which groups all Japanese refiners, has committed to consume 840,000 kiloliters annually of ETBE-blended gasoline. This will require 210,000 kl/year crude equivalent of bioethanol, in fiscal 2009-2010. Currently the Government of Japan is planning to introduce the new regulation aimed to increase the use of biofuels by oil and gas companies with a target of 500 thousand kl(oil equivalent) in 2017. Considering this demand and the lack of raw materials, Japan will be one of the large importers of biofuels in the short term.

Mexico[14],

Mexico has a biofuel policy that may also have an impact on the regional market of biofules. This policy is based on three elements:

- Mexico is a large crude oil producer, but imports a large amount of oil-derived products, so diversifying energy sources represents a critical task for the Government.
- The need to reduce emissions related to fossil fuels. The use of ethanol as a substitute for gasoline additives such as Methyl Tertiary-Butyl Ether (MTBE) in metropolitan areas has been a recurrent request by NGO's.
- Rural development as a very sensitive element. Since bio-fuels use agricultural commodities as inputs, the relationship with agriculture is inevitable, and there is much political pressure to use bio-fuels to promote rural development without creating a "fuel vs. food" dispute.

[14] GAIN Report, USDA

4.3 Strengths, weaknesses, opportunities & threats for the export of biofuels in Colombia

4.3.1 STRENGTHS

Regulations and incentives.

The government of Colombia has established a policy of incentives for the production of biofuels which include tax exemptions in the net income generated for the use of new crops of late growth (oil palm), tax exemptions for investments in new oil palm plantations and machinery as the use of free trade zones. The country has also established a complete set of resolutions on blending and quality standards for biofuels. The price of ethanol and biodiesel is also defined by a national resolution issued by the MME.

Studies on sustainability

A Lyfe Cicle Assesment for the production of biodiesel and bioethanol is under development. Also a map of potential areas for the production of oil palm which takes into account social, environmental, economic and technical impacts for the land use has been developed. These studies support the analysis of the production chain of biofuels in Colombia and give valuable information for an environmental international certifications on sustainability.

Experience and know-how

The production of oil palm and sugar cane in Colombia began early 1900 and since 1940s the production became industrialized. The country has qualified personal and know-how in all the biofuels production chain. The combination of applied research together with a privileged geographic situation has contributed to high yields of sugar cane and oil palm.

Land availability

Colombia has a vast area with potential for the production of biofuels. It is estimated that only 23 % of the suitable area for agricultural crops is used.

4.3.2 WEAKNESSES

Limited production capacity

The currently production capacity of biodiesel and bioethanol covers only the internal market. The expected increase due to expansions of present plants and the development of new projects will cover only the increasingly internal demand. Moreover, in case of an implementation of the flex fuel program in 2012 the production capacity will not be enough to cover the internal market. There are currently no plans for further projects to the ones presented in this report.

Long distances between production center and ports for new projects

The principal potential area for expansion of biofuels in Colombia is the area of Llanos Orientales which is located away of the Colombian seaports. The currently plants are located in the Cauca Valley near the Buenaventura seaport and in the Caribbean Cost near the Santa Martha, Barranquilla and Cartagena Ports. The biofuel for export should be produced in these plants but the export quantities would be restricted to the existing production.

Infrastructure for transportation of biofuels

Most of Colombia's sugarcane plantations and ethanol plants are located in the Cauca Valley. As it plans for further expansion, the industry is looking beyond the Cauca due to both a lack of available land in the Cauca. New transportation infrastructure such as road both between from feedstock production sites to biofuel production sites, and between biofuel production sites and export ports will be needed.

Distance between production centers and ports

One of the key drivers of biofuel promotion is rural development. Considering this aspect, isolated rural areas will be preferable for the potential areas for sugarcane production. However, these areas are very far from the export ports, cost of transportation is very high. It is key factor of cost competitiveness. Much GHG emission of long distance transportation also disadvantage for biofuel LCA.

4.3.3 STRATEGIC OPPORTUNITIES

USA

Energy Independence and Security Act (EISA) increased the volume of renewable fuel required to be blended into transportation fuel from 9 billion gallons in 2008 to 36 billion gallons by 2022.

The Act specifies that 21 billion gallons of the 2022 target must be advanced biofuels, defined as fuels that, on a life-cycle basis, must emit 50% less greenhouse gases than the gasoline or diesel fuel it replaces.

On October 2010 The US Environmental Protection Agency (EPA) announced the decision to allow the use of E15 in certain motors once other conditions are fulfilled.

EU

The Renewable Energy Directive (RED) 2009/28/EC mandates a share of renewable energy in total transport demand in EU member countries of at least 10% by 2020.

This directive requires that, from the end of 2010, biofuels must generate greenhouse-gas emissions savings of at least 35%, compared with fossil fuels, if they are to count towards the renewables target; these savings rise to 50% in 2017 and 60% in 2018.

The contribution of second generation biofuels will be counted twice toward EU RED mitigation targets.

Japan

Recently, Government of Japan are planning to introduce the new regulation that aims to get oil and gas companies to increase their use of biofuels, under the new legal framework of Act on the Promotion of the Use of Nonfossil Energy Sources and Effective Use of Fossil Energy Source Materials by Energy Suppliers. The main points of the new law and METI sustainability criteria for biofuels (under considering) are as follows:

- Each oil company is obligated to introduce biofuels.
- Biofuels have to meet the 50% LCA reduction.
- Biodiversity and environmental and social impacts should be considerations for procurement. However, the Japanese criteria does not show the own criteria. Compliance with the domestic laws is necessary for the production of raw material and biofuels.
- There are continued concern about negative effects on food and feed. To address the competition in the food sector, related ministries should cooperate in monitoring the impact of biofuel introduction and analyzing the causes of competition in order to identify solutions.

The target volume of using biofuels is 500 thousands Kl (oil equivalent) in 2017. Due to the lack of resources of biofuels raw materials, Japan will be one of the large importers of biofuels.

4.3.4 THREATS

Adapting the sustainability criteria

Requirement for sustainability will become more severe. In EU, The Renewable Energy Directive 2009/28/EC requires that, from the end of 2010, biofuels must generate greenhouse-gas emissions savings of at least 35%, compared with fossil fuels, if they are to count towards the renewables target; these savings rise to 50% in 2017 and 60% in 2018.

Completive with advanced biofuels

1st generation biofuels that produced primarily from food crops such as sugarcane, grains, sugar beet and oil seeds, are disadvantages in the issue of GHG saving and negative impact for food and feed production. These concerns of 1st generation biofuels have increased the interest in developing biofuels produced from non-food biomass. Feedstocks from ligno-cellulosic materials include cereal straw, bagasse, forest residues, and purpose-grown energy crops such as vegetative grasses and short rotation forests. These 2nd -generation biofuels could avoid many of the concerns facing 1st generation biofuels and potentially offer greater cost reduction potential in the longer term.

Following are IEA[15] projections for short- and long-term production costs of different biofuels under two oil price scenarios. With reduced overall costs and oil price at USD 120/bbl, second-generation biofuels could be produced at lower costs than gasoline and rapeseed biodiesel and close to the costs of corn ethanol.

With oil at USD 60/bbl;

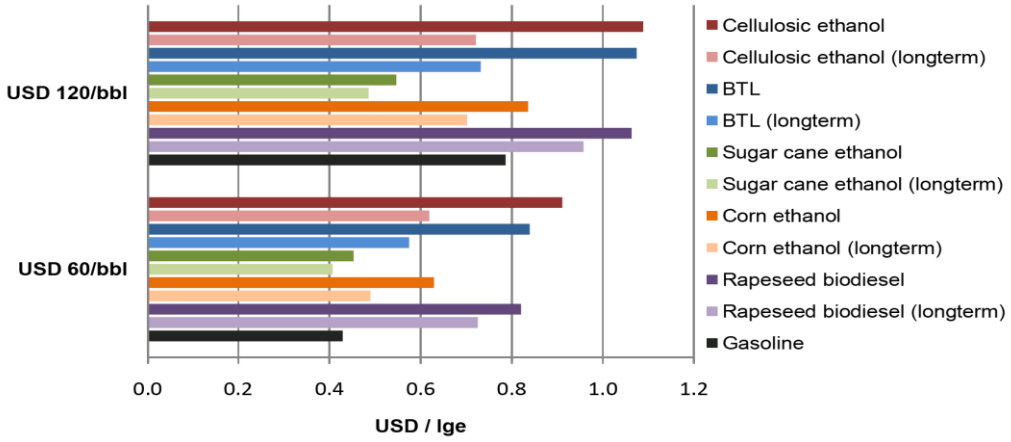
- Production costs for both BTL-diesel and lignocellulosic ethanol are currently in the range of USD 0.84–0.91/lge and thus are not competitive with fossil fuels and most firstgeneration biofuels.
- In the long term, however, with increasing plant capacities and improved conversion efficiencies, both BTL-diesel and lignocellulosic ethanol could be produced at significantly reduced costs. In this case, production costs are projected to be around USD 0.62/lge for lignocellulosic ethanol and USD 0.58/lge for BTL-diesel.
- The estimated production prices are less than those for rapeseed biodiesel, but still more expensive than gasoline and other first-generation biofuels.

With oil at USD 120/bbl;

- Production costs rise to USD 1.07/lge for BTL-diesel and USD 1.09/lge for lignocellulosic ethanol.

In the long term, prices are projected to fall to USD 0.73/lge for BTL-diesel and USD 0.72/lge for lignocellulosic ethanol.

Figure 20 Cost analysis of biofuels



Source: IEA(2010), Sustainable Production of Second Generation Biofuels : Potential and Perspectives in Major Economies and Developing Countries (Original source: IEA(2009), Transport, Energy and CO2. Moving Toward Sustainability, OECD/IEA, Paris.)

Price of biofuels

Price of biofuel is highly influenced by crude oil prices and raw material prices. The oil price is unpredictable.

[15] Sustainable Production of Second-Generation Biofuels

SWOT MATRIX

STHRENGHTS	WEAKNESSESS
• There is a strong plan of incentives to promote the use of biofuels • There are definitions about quality, quantity and process for the biofuels • There is a clear position from the government to promote the use of biofuels • There is a defined price structure	• There is not clear legislation about the land use • The extended production of biofuels can cause land use problems • The rapid growth of the market can cause an unorganized development of the industry • Competiveness with domestic biofuels in target countries • Competiveness with major exporter (Brazil, Malaysia and Indonesia) • Infrastructure for transportation of biofuels
OPORTUNITIES	**THREATS**
• The is strong international interest to develop the market of biofuels(US, EU, Japan….) • More technologies are being develop to produce biofuels	• The international concern about land use and real environmental impact of biofuels production • The real efficiency of the transforming process of agricultural products into biofuels • Completive with advanced biofuels in future • Fossil oil prices and agro-feedstock prices unpredictable and lots of uncertainty.

SWOT analysis for EU biofuel and Imprecations for Colombia biofuels

SWOT analysis for transport biofuels in the EU		Imprecations for Colombia biofuels
STHRENGHTS	• **Highly competent R&D capacity in EU27 in terms of human resources and research infrastructures, methodologies and tools.** • **Good partnerships within and beyond EU borders, providing the basis for future research work and transfer of knowledge and technology.** • **Funding within the current EU R&D Framework Programme (FP7) provides opportunities for development of biofuels both within and outside the EU.** • **Critical mass for effective R&D including collaboration between the research and industrial communities.** • Political will and market demand is getting stronger for secure and sustainable biomass supply. • **Biofuels represent today one of the most significant options for the reduction of fossil CO2 emissions from transport.** • Biofuels represent an alternative to set aside lands to satisfy the energy demand partially. • **Biofuels can contribute to the creation of new jobs.**	• Second generation of biofuels will be competitor in the future. • One of EUs drivers is also the creation of new jobs. EUs domestic biofuels are competitor politically. • CO2 reduction of LCA base is key issue.
WEAKNESSESS	• Biofuels production is a cross-sectorial issue (energy, transport, agriculture, environment) requiring difficult to achieve consistency of policy. • Biofuel production dependent on a complex matrix of feedstocks and processes with different characteristics and logistic/ handling requirements. • Appropriate strategies have yet to be created to avoid disruption in feedstock supply. • Large volume handling/ logistics are required for industrial scale production of biofuels, especially for lignocellulosic feedstocks, as current systems are designed to meet small- medium scale requirements. • **International competitiveness of current EU biofuels is poor due to high feedstock costs.** • Demonstration projects to prove technology development for next generation biofuels are lacking. • Nowadays the raw materials used compete with the food sector. • Low yields of energy crops in some European regions.	• Feedstock cost competitiveness will be key success factor not only for 1st generation biofuels, but also 2nd generation biofuels.

SWOT analysis for transport biofuels in the EU		Imprecations For Colombia biofuels
OPORTUNITIES	• Favourable political environment reflected in directives and policy documents, including the recent "Energy Package" confirmed by the European Council in March 2007. • Priority given to biofuels research in the Seventh RTD Framework Programme (FP7) and bioproducts identified as a lead market. • High oil prices tend to enhance the competitive position of biomass and biofuels in the market place. • Increasing industrial interest in biofuels with substantial current investment, especially in current generation biofuels. • **Strong industrial chain from suppliers of biomass to end use of biofuels throughout EU 27.** • **Biofuels can contribute to improved development of the agro-industry.**	• One of EUs drivers is also the agro-industry promotion. EUs domestic biofuels are competitor politically; especially cellulosic ethanol and BTL will strongly contribute to improved development of the agro-industry in EU.
THREATS	• Too long time lag between science and technology development and market implementation. • **Social perception on certain fields of plant biotechnology may hinder enhanced biomass production.** • **Competition for land and biomass to meet the multi-functional markets of food, fibre, fuel, feed.** • High investment required to realize the 25 % vision target by 2030. • A coherent and long term political framework has yet to be established in order to ensure efforts in R&D&D and create a stable scenario for investment in capital intensive new production units. • Fossil oil prices unpredictable and possibly correlated with agro-feedstock prices. • High cost of CO2 avoided with biofuels compared to other options, including other bioenergy. • **Volume of today's available biofuels less than targeted, as feedstock is limited by competition with land used for food production**	• Potentiality of arable land in Colombia will be advantage.

Source: SWOT analysis for transport biofuels in the EU from "European Biofuels Technology Platform Strategic Research Agenda & Strategy Deployment Document, January 2008"

4.4 Scenario for biofules in Colombia

4.4.1 SCENARIO OPTIONS

SCENARIO 1: Cultivating the export-driven industry model

Vision:

Fosterage of internationally competitive industries

Strategy:

Enhancing the cost competitiveness by strong government leadership and support
Enhance the investment from foreigner (technology transfer and investment promotion)
Building the strategic partnership with export target countries (trade policies)

SCENARIO 2: Shifting gradually to hybrid industry model of domestic & export driven industry

Vision:

Balancing fosterage of internationally competitive industries and creation of the new job and biofuel industry in mainly undeveloped rural areas

Strategy:

- Expansion of domestic consumption of biofuels, E15, B20
- Promotion of export biofuel to international market, and gradually expand the amount of export

SCENARIO 3: Enhancing domestic driven industry, only export surplus of production

Vision:

Create the new job and biofuel industry in mainly undeveloped rural areas

Strategy:

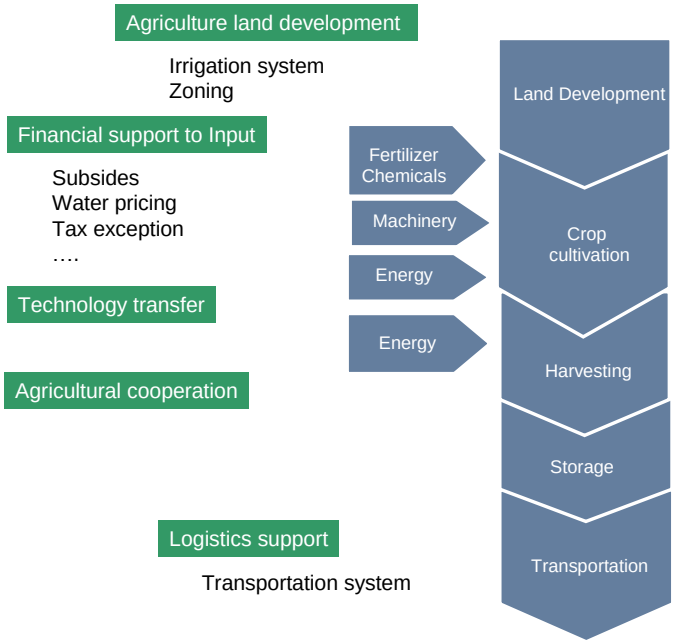
- Expansion of domestic consumption of biofuels, E15, E20, E85; B20
- Expansion of feedstock production, and biofuel production
(in mainly undeveloped rural areas)
- Export surplus of biofuel to international market

Examples of Strategy

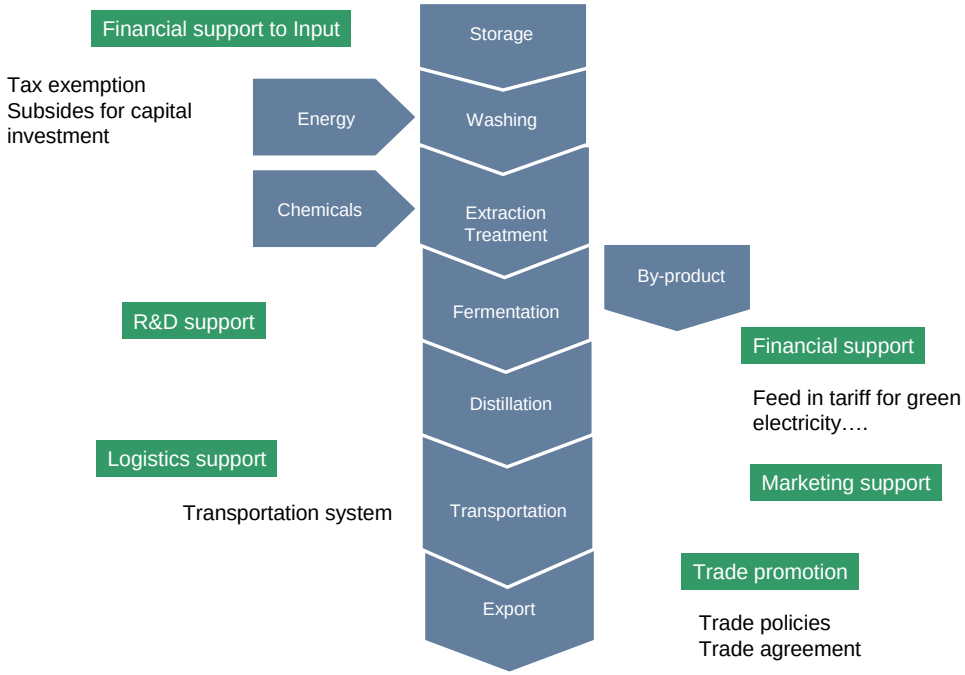
Table 8 Strategy for the scenarios

Strategy			Tactics	
			For large-scale business	For small-medium business
Enhancing the cost competiveness vs Brazilian's Domestic's	Feedstock cost reduction		Mechanization of harvest Development of variety	Technology transfer Cooperation
	Getting stronger for secure and sustainable feedstock supply		Logistics Contract farming system	
	Co-producing		Electricity for rural community (Ethanol) Effective using of glycerin (biodiesel)	
	Improving logistics and export infrastructure		National level	Local level
Adjusting the Sustainability criteria of target countries	Green field	LCA	Data collection for direct land use change effect (Direct land use change effect for US market)	-
		Biodiversity	Zoning	-
		Labor condition	Profit sharing	
	Brown field	LCA	Inventory data collection	
		Biodiversity	-	Capacity building for Adjusting the Sustainability criteria
		Labor condition	-	

Tactics in the feedstock production point



Tactics in the biofuel production points



4.4.2 ADVANTAGES AND DISADVANTAGES OF EACH SCENARIO

Scenario	Advantages	Disadvantages
SCENARIO 1 Cultivate the export-driven industry model	• **Enjoy the First mover advantage** Biofuel international market will be expanding in EU, US, Japan and other countries • **Enhancing the cost competiveness** Cost reduction is good for domestic user • **Cultivating the new agro industry in the rural area** • **Enhance the investment from foreigner**	• **Be asked to open the domestic market** • **Difficult for small-medium business, main player is big player** • **Government strong financial support will be needed (subsidy, tax reduction ect.)**
SCENARIO 2 Shifting gradually to hybrid industry model of domestic & export driven industry	• **Avoiding the risk (Wait and see strategy)** determine the development of 2nd generation biofuels • **Enhancing economical benefits of the small-medium farmers (in the short terms)**	• **Can not get the strong position in the global market** • **Lack of competitiveness in the international market (in the long term)** • **Loosing the chance of investment from foreigner**
SCENARIO 3 Enhancing domestic driven industry, only export surplus of production	• **Enhancing economical benefits of the small-medium farmers (in the short terms)**	• **Can not get the strong position in the global market** • **Lack of competitiveness in the international market (in the long term)** • **Loosing the chance of investment from foreigner** • **Market will be saturated (in the long term)** • **Government continuous strong financial support will be needed (subsidy, tax reduction ect.)**

The differences of Scenario 1 and 2 are time line and portfolio of domestic and exports.

APPENDEX 1: Ethanol and biodiesel trend

BIOFUELS PROJECTIONS : ETHANOL

	PRODUCTION (MIL L)		Growth[1] (%)	DOMESTIC USE (MIL L)		Growth[1] (%)	FUEL USE (MIL L)		Growth[1] (%)	SHARE IN GAZOLINE TYPE FUEL USE(%)				NET TRADE[2] (MIL L)	
										Energy Shares		Volume Shares			
	Average 2007-09est.	*2019*	*2010-19*	*Average 2007-09est.*	*2019*	*2010-19*	*Average 2007-09est.*	*2019*	*2010-19*	*Average 2007-09est.*	*2019*	*Average 2007-09est.*	*2019*	*Average 2007-09est.*	*2019*
North America															
Canada	1,018	1,891	3.16	1,603	2,609	2.17	1,397	2,403	2.39	2.3%	3.4%	3.4%	5.0%	-585	-718
United States	34,888	67,919	4.65	36,919	78,797	5.53	35,273	77,065	5.68	4.3%	8.4%	6.3%	12.1%	-2,031	-10,878
Western Europe															
EU(27)	4,890	17,987	11.28	6,336	21,223	10.81	3,907	18,716	13.39	1.8%	8.5%	2.7%	12.2%	-1,446	-3,237
Oceania Developed															
Australia	165	409	2.84	165	409	2.84	165	409	2.84	0.6%	1.3%	0.8%	1.9%	0	0
Other Developed															
Japan	107	618	18.17	604	1,128	5.60	9	518	36.46	n.a.	n.a.	n.a.	n.a.	-485	-510
South Africa	16	17	0.95	16	17	1.09	0	0	3.31	0.0%	0.0%	0.0%	0.0%	0	0
Sub-Saharian Africa															
Mozambique	21	42	4.93	21	29	3.35	0	9	75.27	0.0%	3.4%	0.0%	5.0%	0	13
Tanzania	28	87	13.76	32	56	6.87	0	24	41.52	0.1%	3.4%	0.1%	5.0%	-4	31
Latin America and Caribbean															
Argentina	319	571	3.02	173	509	4.84	31	268	5.53	0.4%	3.4%	0.7%	5.0%	146	62
Brazil	25,308	55,020	7.44	21,182	41,681	6.30	19,747	39,441	6.48	46.1%	70.2%	56.0%	77.9%	4,127	13,339
Colombia	343	879	7.13	349	494	1.55	285	429	1.80	4.0%	6.9%	5.9%	10.0%	-6	384
Mexico	63	90	2.88	135	270	2.88	0	0	--	0.0%	0.0%	0.0%	0.0%	-73	-179
Peru	18	194	14.31	10	124	12.87	0	116	22.88	0.0%	5.4%	0.0%	7.8%	0	0
Asia and Pacific															
China	3,917	5,999	3.55	3,725	4,809	3.03	1,970	3,873	7.01	1.8%	2.1%	2.7%	3.1%	192	1,190
India	1,949	2,803	4.50	2,026	2,852	3.80	171	895	17.37	0.9%	3.4%	1.3%	5.0%	-77	-49
Indonesia	215	648	7.07	162	396	4.95	0	241	57.47	0.0%	0.7%	0.0%	1.0%	53	252
Malaysia	65	70	0.61	90	85	0.06	0	0	3.63	0.0%	0.0%	0.0%	0.0%	-25	-14
Philippines	132	927	15.21	217	890	7.43	119	793	8.96	1.3%	6.9%	1.9%	10.0%	-85	37
Thailand	593	2,207	11.05	510	1,965	11.28	307	1,750	14.06	2.8%	14.3%	4.1%	20.0%	84	242
Turkey	54	67	0.32	92	119	2.56	47	72	3.68	0.6%	0.7%	0.8%	1.0%	-37	-53
Viet Nam	150	405	10.59	135	387	11.89	0	250	112.78	0.0%	3.4%	0.0%	5.0%	15	17
TOTAL	74,257	158,849	6.26	74,497	158,849	6.16	64,022	147,879	6.75	4.6%	9.0%	6.6%	12.9%	4,465	15,634

For notes, see end of the table.
[1] *Least-squares growth rate (see glossary).*
[2] *For total net trade exports are shown.*

est.: estimate, NA: Not available.

BIOFUELS PROJECTIONS : BIODIESEL

	PRODUCTION (MIL L)		Growth[1] (%)	DOMESTIC USE (MIL L)		Growth[1] (%)	SHARE IN DIESEL TYPE FUEL USE (%)				NET TRADE[2] (MIL L)	
							Energy Shares		Volume Shares			
	Average 2007-09est.	*2019*	*2010-19*	*Average 007-09est.*	*2019*	*2010-19*	*Average 2007-09est.*	*2019*	*Average 2007-09est.*	*2019*	*Average 2007-09est.*	*2019*
North America												
Canada	138	457	5.02	137	765	11.48	0.3%	1.6%	0.4%	2.0%	0	-307
United States	2,319	3,818	5.27	1,286	3,837	6.80	0.4%	1.1%	0.5%	1.3%	1,033	-19
Western Europe												
EU(27)	8,041	20,521	7.68	8,971	24,362	7.97	3.4%	8.0%	4.2%	9.8%	-930	-3,841
Oceania Developed												
Australia	515	711	1.17	515	711	1.17	2.3%	2.7%	2.9%	3.3%	0	0
Other Developed												
South Africa	48	50	0.96	48	62	3.32	0.0%	0.0%	0.0%	0.0%	0	-12
Sub-Saharian Africa												
Mozambique	45	67	6.10	0	23	82.95	0.0%	4.0%	0.0%	5.0%	45	44
Tanzania	44	35	0.78	0	21	134.03	0.0%	8.2%	0.0%	10.0%	44	14
Latin America and Caribbean												
Argentina	1,286	3,860	6.43	70	903	9.71	0.5%	6.0%	0.7%	7.4%	1,216	2,957
Brazil	958	3,057	4.88	958	3,057	4.88	1.7%	4.0%	2.1%	5.0%	0	0
Colombia	143	876	9.56	137	438	3.22	1.1%	4.0%	1.3%	5.0%	5	437
Peru	140	344	10.06	140	185	3.94	1.1%	4.0%	1.3%	5.0%	0	159
Asia and Pacific												
India	130	3,035	34.50	244	3,176	32.05	0.0%	6.7%	0.0%	8.2%	-114	-141
Indonesia	102	1,148	18.39	15	1,117	29.67	0.5%	5.7%	0.7%	7.0%	87	31
Malaysia	515	972	4.60	50	400	12.60	1.1%	4.0%	1.3%	5.0%	465	572
Philippines	102	305	5.91	102	246	3.73	1.1%	1.6%	1.3%	2.0%	0	60
Thailand	451	1,585	9.41	424	1,532	8.87	1.1%	4.0%	1.3%	5.0%	27	52
Turkey	188	26	0.10	188	36	3.69	0.0%	0.0%	0.0%	0.0%	0	-11
Viet Nam	6	306	39.35	0	299	110.93	0.0%	4.0%	0.0%	5.0%	6	7
TOTAL	15,170	41,171	7.33	13,286	41,171	7.55	1.6%	4.2%	2.0%	5.2%	2,269	4,332

[1] *Least-squares growth rate (see glossary).*
[2] *Exports for total net trade.*
est.: estimate.

Source: OECD-FAO Agricultural Outlook 2010-2019, Corrigenda (Revised version 1 September

APPENDEX 2: Study of breakeven price for maize Ethanol in US

A FAO report (The state of food and agriculture, FAO, 2008) analyzed the breakeven prices for maize at various crude oil prices, both on the basis of the energy content of ethanol and also including the value of the existing subsidies.

- For a crude oil price of US$60/barrel, maize ethanol would be competitive on an energy basis as long as the market price for maize remained below US$79.52/tonne, but the subsidies enable processors to pay up to US$142.51/tonne and still remain profitable.
- The maize price is higher than the breakeven point for ethanol on an energy basis and that United States maize ethanol is not competitive with fossil fuels without subsidies. The subsidies are often, but not always, enough to make maize ethanol competitive.
- Before mid-2004, crude oil prices were so low that maize could not compete as an ethanol feedstock even with the available subsidies. Crude oil prices began to rise in mid-2004, at a time when maize prices were still quite low. By early 2005, crude prices had exceeded US$60/ barrel and maize was almost competitive even without subsidies. The United States Energy Policy Act of 2005 established the Renewable Fuel Standard starting at 4 billion gallons in 2006 and rising to 7.5 billion in 2012. A rush of ethanol plant construction ensued, and the demand for maize as a feedstock for ethanol expanded rapidly.

Figure 21 Breakeven prices for maize and crude oil with and without subsidies in US

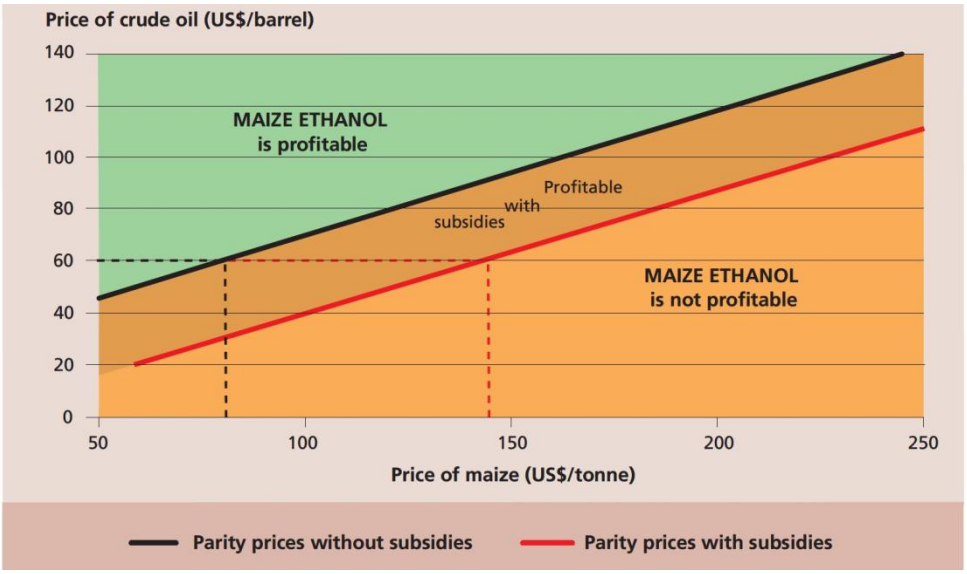
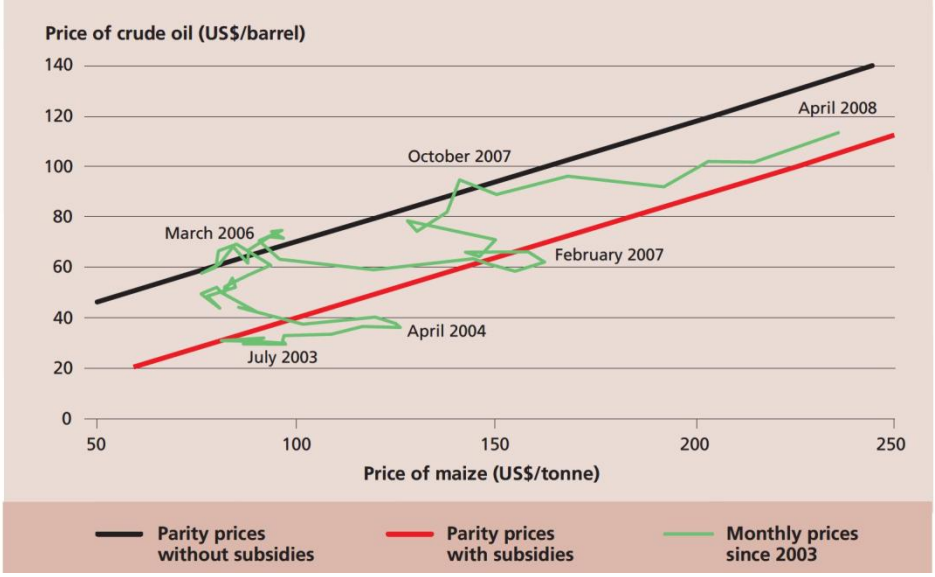


Figure 22 Maize and crude oil breakeven prices and observed prices, 2003–08



(adapted from Tyner and Taheripour, 2007. Crude oil prices: Brent crude, Chicago Board of Trade (US$/barrel). Maize prices: US Yellow No. 2, Chicago Board of Trade (US$/tonne). Prices downloaded from the Commodity Research Bureau Web site (http://www.crbtrader.com/crbindex/) on 10 June 2008.

APPENDEX 3: Trend of biofuels trade

Ethanol Trade

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Net Exporters						(Million Gallons)					
Brazil	1,165	1,169	1,466	1,820	2,124	2,395	2,818	3,268	3,647	4,236	4,896
China	52	31	13	-9	-21	-35	-44	-54	-67	-78	-91
Total Net Exports *	1,216	1,201	1,479	1,820	2,124	2,395	2,818	3,268	3,647	4,236	4,896
Net Importers											
Canada	165	260	312	364	412	460	503	550	599	657	711
European Union	318	318	352	401	436	467	494	523	559	586	617
India	0	23	59	90	107	120	130	139	153	163	172
Japan	149	196	234	273	308	343	377	412	447	481	516
South Korea	81	104	132	154	175	195	215	236	257	276	297
United States	436	195	250	353	454	528	772	1,037	1,211	1,605	2,070
ROW	67	104	140	176	212	247	282	317	353	388	423
Total Net Imports *	1,216	1,201	1,479	1,820	2,124	2,395	2,818	3,268	3,647	4,236	4,896
Prices						(U.S. Dollars per Gallon)					
Anhydrous Ethanol Price, Brazil **	1.76	1.48	1.36	1.29	1.34	1.37	1.45	1.51	1.53	1.62	1.69
Ethanol, FOB Omaha	2.47	1.68	1.75	1.81	1.91	1.99	2.10	2.19	2.17	2.06	2.00

Note: 1 gallon = 3.7857 liters; 1 metric ton = 1237.1644 liters.
* Total net exports are the sum of all positive net exports.
** Represents world ethanol price.

U.S. Biofuels Production and Consumption

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Ethanol						(Million Gallons)					
Production	9,262	10,295	11,504	12,384	13,185	13,715	14,508	15,320	15,990	16,361	16,736
Consumption	9,511	10,387	11,680	12,693	13,597	14,220	15,243	16,318	17,163	17,936	18,781
Net Trade	-436	-195	-250	-353	-454	-528	-772	-1,037	-1,211	-1,605	-2,070
Biodiesel											
Production	677	804	921	1,040	1,149	1,178	1,174	1,178	1,184	1,187	1,184
From Soybean Oil	394	429	496	578	656	668	657	658	661	663	660
From Other Fats and Oils	284	375	425	462	493	510	517	520	522	524	525
Consumption	324	482	638	796	950	1,000	1,000	1,000	1,000	1,000	1,000
Net Trade	353	322	284	244	199	178	174	178	184	187	184

Source: FAPRI 2009 U.S. and World Agricultural Outlook

APPENDEX 4: Trend of Brazilian ethanol cost (2)

	Sugarcane Production Cost ($/gal)	Operating Cost ($/gal)	Capital Cost ($/gal)	Logistical Cost ($/gal)	Port Cost ($/gal)	Transport Cost from Port to US ($/gal)	Total Cost ($/gal)
2010	0.59	0.26	0.49	0.19	0.09	0.15	1.77
2011	0.58	0.26	0.49	0.19	0.09	0.15	1.76
2012	0.57	0.26	0.49	0.19	0.09	0.15	1.75
2013	0.56	0.26	0.49	0.19	0.09	0.15	1.74
2014	0.55	0.26	0.49	0.19	0.09	0.15	1.73
2015	0.54	0.26	0.49	0.19	0.09	0.15	1.72
2016	0.54	0.26	0.49	0.19	0.09	0.15	1.72
2017	0.53	0.26	0.49	0.19	0.09	0.15	1.71
2018	0.53	0.26	0.49	0.19	0.09	0.15	1.71
2019	0.53	0.26	0.49	0.19	0.09	0.15	1.71
2020	0.52	0.26	0.49	0.19	0.09	0.15	1.70
2021	0.52	0.26	0.49	0.19	0.09	0.15	1.70
2022	**0.51**	**0.26**	**0.49**	**0.19**	**0.09**	**0.15**	**1.69**
2023	0.51	0.26	0.49	0.19	0.09	0.15	1.69
2024	0.50	0.26	0.49	0.19	0.09	0.15	1.68
2025	0.50	0.26	0.49	0.19	0.09	0.15	1.68

	Brazil Direct ($/gal)	**Brazil Direct w/ Tax & Tariff ($/gal)**	**CBI ($/gal)**	**CBI w/ Tax ($/gal)**
2010	1.77	2.35	1.77	1.81
2011	1.76	2.34	1.76	1.80
2012	1.75	2.33	1.75	1.79
2013	1.74	2.32	1.74	1.78
2014	1.73	2.32	1.73	1.78
2015	1.72	2.31	1.72	1.77
2016	1.72	2.30	1.72	1.76
2017	1.71	2.30	1.71	1.76
2018	1.71	2.29	1.71	1.75
2019	1.71	2.29	1.71	1.75
2020	1.70	2.28	1.70	1.74
2021	1.70	2.28	1.70	1.74
2022	**1.69**	**2.27**	**1.69**	**1.73**
2023	1.69	2.27	1.69	1.73
2024	1.68	2.27	1.68	1.73
2025	1.68	2.26	1.68	1.72

5 INFORMATION TECHNOLOGY ISSUES

The project has two aspects that involved information technology (IT) issues: a) the development of an information system for the projects identified in the development of the SREC (Component I) and b) the design of a toolkit for the export of biofuels as part of the Biofuel Market Study (Component II).

SREC - Information System

The Information system will include the characteristics of individual projects and the main indicators to monitor and verify the impacts of the activities, subprograms and projects under PROURE. The projects information will be processed through a Geographic Information System (GIS).

BMS - Toolkit for the export of biofuels

The toolkit will consist of a user-friendly database and its respective manual, available on-line containing at least the following information: a) main markets for Colombian biofuels; b) technical conditions and specifications required for the products; c) national and regional laboratories available for quality control; d) contact details of main buyers; and e) trade conditions (sales price, conditions, taxes, duties). This database will be articulated with other systems that are being developed under the Technical Cooperation CO-T1052, such as the Life Cycle Assessment project (LCA).

Both the Information System and the Toolkit will be designed using IT tools that are compatible with the ones currently used by the MME. For this purpose the consulting team has conducted interviews with the IT specialist of the MME and UPME as well as with the experts of the consulting team in charge of the design of the toolkit for the LCA. Below are the preliminary conclusions and items that need to be addressed for the harmonization of the systems.

MME Information systems

The MME has implemented an information system administered by UPME entitled the *Energy and Mining Information System for Colombia***,** composed by the following modules:

SIMCO:	Mining information system
SIEL:	Electric information system
SIPG:	Petroleum and gas information system
SIAME:	Environmental mining information system
SI3EA:	Energy efficiency and alternative energies information system

Each module manages information on previous studies, maps, statistics, prices and indicators. Some of them have applications to perform basic calculations or to illustrate specific aspects of the module. SIAME and SI3EA are the modules that are more relevant to the present study and are described below:

SIAME includes topics like cleaner production, methodologies for the evaluation of environmental liability and transfers of the electric sector. It allows to consult information related with the Colombian environmental committee of the electric sector, environmental management and Clean Developing Mechanism. It manages indicators on: energy consumption per capita, firewood consumption for cooking in the residential sector, total national emissions of CO2, CH4, N2O and energy intensity.

SI3EA: It contains updated information and studies developed by UPME on energy efficiency and non conventional sources of energy. The aim of the system is to support the development of energy policy, scientific research, technological development and decision making for sustainable development. In the area of energy efficiency the system contains the PROURE documents, the program on labeling for appliances, and other studies and initiatives conducted in the residential, commercial, industrial and transport sectors. In the non-conventional energy resources (FCNE) area the system has studies on wind power, solar energy, biomass, geothermal and oceanic as well as the legal framework and standards.

Geographic Information Systems

ArcGIS server is the software tool used now by UPME and MME to elaborate maps and to manage geodata.

The MME has some maps available in its website, they were elaborated by different methods and uploaded to the web using ArcGIS Server (an application of ESRI). The maps available in PDF format are: Colombian atlas of solar radiation 2005, Colombian atlas of wind power, biomass potential, small hydropower potential and geothermal power potential.

The MME also created a tool named *System for Management of Information and Knowledge in non Conventional Sources of Energy* (SGI&C). This tool seeks to provide the community with relevant information on the non conventional sources of energy in Colombia. It is designed in a way that any registered user can load and download information through specific options designed for that effect. The SGI&C contains six main modules: solar energy, wind power, geothermal power, small hydropower, biomass and ocean energy and tidal power. The information is classified in others sub modules that contain homogeneous information.

The system was implemented less than 3 years ago and does not contain indicators about energy efficiency or percentages of FNCE power. The information available in the web is limited to the studies carried out by UPME. No information exists at regional level.

The LCA toolkit

The National Center of Cleaner Production (CNPML) is building a toolkit that aims to be compatible and integrated to the System Information Tool Quick Sustainability Check for Biofuels" (SQCB - a tool to assess the environmental impact of biofuel production). LCA data are imported into the database through an XML interface. To ensure web accessibility, SQCB was developed as a module for Drupal, an open source content management system. The assessment processes covers the entire life cycle of biofuels including information on cultivation, processing, transport and use. Users must provide information about crop type, country, weather conditions, fertilizers and pesticides and energy information and materials for further processing. The system provides a graphical interface that displays the processed data (Ziep, Wohlgemuth et al. 2009).

The toolkit that is being developed in Colombia also includes maps with information on terrain, climate and sustainability of potential crops, as well as characterization of the soil, agro-climatic parameters, where different crops can be planted and expected productivity.

The tool that is being developed by CNPML is developed in the web content management system *Joomla*, (a free software tool). For maps it uses *Mapserver* (a free software for the development of web applications with georeferenced information). Additionally, the tool uses PostGIS, an open source, freely available software to extend spatial database for the PostgreSQL database management system. PostGIS adds spatial functions: distance, area, union, intersection and specialty data type to the database.

Conclusions

MME currently has various Information Systems that can be used for this project. However, in some of them information relevant for this project is limited or non-existing at all.

The consulting team will continue to work with MME on how to integrate the project information system that will be develop in this project with the systems already in place in the MME, particularly SIAME, SI3EA and SGI&C.

In the SGI&C it is necessary either to introduce the information available in the respective categories or to design an attractive strategy so that the users provide the information. A software applicative should be implemented in java that lends some service to the user for calculation (Sizing) or information (suppliers, technology etc) that make the page more attractive.

With regards to the toolkit the consulting team considers that both toolkits will be integrated via a website application. The technical details are being discussed with the CNPML.

On key factor that need to be addressed by the MME is the definition of the GIS that will be used for the preparation of maps in the toolkits. The consulting team recommends to use a system consistent with other projects such as the one on potential areas for palm oil cultivation conducted by MADR, MAVDT and IDEAM.

ANNEX A. AGENDA FIRST MISSION

Monday, Sept 27

Ministry of Mines and Energy - Hydrocarbons Division
Julio Cesar Vera, Carlos David Beltrán, Roger Rivera.

- Policies and regulations on biofuels
- Information on production, consumption, quality standards, job creation, cost structure, taxes, fees, incentives
- Transport and logistics
- Social and environmental considerations
- Institutional structure
- Information systems available

UPME (MME – Planning Division) – Hydrocarbons Group
Sandra Leyva, Juan Felipe Cárdenas

- Studies on technical, financial, social and environmental aspects of the biofuels in Colombia (e.g: feedstock, price, incentives, production, consumption, producers, quality, taxes, fees, transport)
- Institutional structure
- Information systems available

Tuesday, Sept 28

Ministry of Agriculture and Rural Development
Elzbieta Bochno

- Polices, regulations, programs and incentives to promote the production of feedstocks for biofuels in Colombia
- Information on crops, yields and cultivated areas for sugar cane and palm oil production

Consultoria Colombiana CONCOL
Javier Darío Forero, Saúl Santamaría, Roberto Albán, Ricardo Perez, Lina Wedefort

- Progress of the MME study on Flexfluel

Fedebiocombustibles (National Federation on Biofuels)
Christie J. Daza

- Views of FEDEBIOCOMBUSTIBLES and information available on production of biofuels in Colombia: technical, financial, social and environmental aspects
- Views on the potential markets to export biofuels. Strengthens and weakness of the country

Wednesday, October 29

DNP (National Planning Department)
Alejandro Castañeda, Tatiana Nuñez, Diana Paola Diaz, Giampiero Renzoni

- Progress on the DNP-IADB project on financial instruments to promote private investments in the biofuel sector

Ministry of Environment, IDEAM
Diana Carolina Lugo, Fabian Pinzón, Diana Barba, Mónica Pinzón

- National environmental and social policy regulations on biofuels
- Environmental Impact Studies on the use of biofuels in Colombia
- Sustainability criteria
- Incentives to promote carbon credit projects in Colombia

Thursday, Sept 30

Asocaña – Cenicaña
Johan Martinez

- Views and information on production of biofuels in Colombia: technical, financial, social and environmental aspects
- Views on the potential markets to export ethanol. Strengthens and weakness of the country
- Information on studies and research on productivity in the ethanol production
- Information on crops, yields and sugarcane cultivation areas
- Quality standards of feedstock and products

Fedepalma, Cenipalma
Carlos Osorio, Jesús García, Mónica Cuellar,

- Views and information on production of biofuels in Colombia: technical, financial, social and environmental aspects
- Views on the potential markets to export biofuels. Strengthens and weakness of the country
- Information on studies and research on productivity in the palm oil/biodiesel production
- Information on crops, yields and palm oil cultivation areas
- Quality standards of feedstock and products
- Fedepalma CDM projects

Friday, Oct 1

BioD – Facatativa (Biodiesel production plant)
Tito Salcedo

- Views of the company on the financial, technical, social and environmental challenges for the implementation of the processing plant
- Size and location of the market covered by the plant
- Infrastructure available for the access of raw materials and distribution of products
- Characteristics of the plant
- Tour by the facilities
- Views on the potential markets to export biofuels. Strengthens and weakness of the country

Monday, Oct 4

Colciencias
Yesid Otalora, Alejandro Angarita

- Progress on the project to promote the scientific innovation in biofuels and sustainable energy.

Tuesday, Oct 5

Ministry of Trade, Industry and Tourism and Proexport
Neyivia Cuellar, Carlos Alberto Contreras, Diego Romero, Esther Julia Areas

- Productive Transformation Program for Palm Oil: Description and Goals.

German Sanz

- Trading Technical Assistance Program.

CNMPL (National Centre on Clean Production), Universidad Pontificia bolivariana UPB.
Daiana Mira, Andrés Cardales Barrios, Claudia de los Ríos

- Progress of the IABD project on biofuels life cycle assessment in Colombia

Monday, Oct 11

Ministry of Mines and Energy – Energy Division
Andrés Taboada, Luis Fernando López, Elsa Márquez

- Energy sector and RE General Overview in Colombia.
- Resources to finance PROURE.
- Ministry's expectations on the consultancy.

CREG
Javier Diaz, Germán Castro, Diego Mariño

- General structure of Colombia energy sector.
- CREG's functions.
- Energy price establishment.

Tuesday, Oct 12

Colciencias
Yesid Ojeda

- R&D programs and projects, developed and to be developed in EE and RE.

EPM
Gerardo Montoya

- EPM general structure.
- EPM projects in RE.
- EPM experience in EE and RE project development.

ISAGEN
Luis Alberto Posada

- ISAGEN general structure.
- ISAGEN projects in RE.
- ISAGEN experience in EE and RE project development.

Wednesday, Oct 13

UPME – URE and FNCE division.
Olga Victoria González, Omar Baéz, Jousé Zapata

- PROURE presentation and goals.
- Alternatives to promote RE.
- UPME structure and Energy National Plan development.

IPSE
Carolina Ulloa, Luis Fabian Ocampo.

- IPSE structure and functions.
- RE current situation in ZNI.
- RE projects developed and planned.
- FAZNI and FNR funds.

Thursday, Oct 14

ECOPETROL
Julián Estévez

- Introduction to ECOPETROL's energy management division functions and goals.
- ECOPETROL's energy matrix and goals in RE.
- Selfgeneration and Cogeneration projects.
- ECOPETROL's energy contracts

Friday, Oct 15

CORPOEMA
Humberto Rodríguez, José Rincón, Jaime Rodríguez Lara

- RE projects developed in Colombia.
- SIN and ZNI considerations for RE projects.
- CORPOEMA's FNCE consultancy general overview.

ANNEX B. ACRONYMS

(Spanish Version)

ANH	-	Agencia Nacional de Hidrocarburos
ANRE	-	Agencia para los Recursos Naturales y Energía de Japón
BEFSCI	-	Criterios e indicadores de Seguridad Alimentaria de la FAO
BF	-	Biocombustibles
BMS	-	Estudio de mercados de Biocombustibles
CDM	-	Mecanismo de Desarrollo Limpio
CIURE	-	Comisión Intersectorial para el Uso Racional y Eficiente de la Energía
CND	-	Centro Nacional de Despacho
CNO	-	Consejo Nacional de Operación
CONPES	-	Consejo Nacional de Políticas Económicas y Sociales
COP	-	Pesos Colombianos
CREG	-	Comisión de Regulación de Energía y Gas
CTF	-	Fondo de Tecnología Limpia
DNP	-	Departamento de Planeación Nacional
EE	-	Eficiencia Energética
EISA	-	Acto de Seguridad e Independencia Energética
EPA	-	Agencia de Protección Ambiental de Estados Unidos
EPAct	-	Acto de Política Energética
EPFL	-	École Polytechnique Fédérale de Lausanne
ESCO	-	Compañías de Servicios Energéticos
FAO	-	Organización de Alimentos y Agricultura de las Naciones Unidas
FAZNI	-	Fondo de Apoyo para las áreas no interconectadas
FNCE	-	Fuentes no Convencionales de Energía
FNR	-	Fondo Nacional de Regalías
GBEP	-	Alianza Global de Bioenergía
GDP	-	Producto Interno Bruto, PIB.
GHG	-	Gases de Efecto Invernadero
GoC	-	Gobierno de Colombia
IADB	-	Banco Interamericano de Desarrollo
IEA	-	Agencia Internacional de Energía
IPC	-	Índice de Precio al Productor
IPSE	-	Instituto de Planificación y Promoción de Soluciones Energéticas para las Zonas no Interconectadas.
LCA	-	Análisis de Ciclo de Vida
LPG	-	GLP, Gas Licuado del Petróleo
MADR	-	Ministerio de Agricultura y Desarrollo Rural
MAFF	-	Ministerio de Agricultura, Bosques y Pesca de Japón
MAVDT	-	Ministerio de Ambiente, Vivienda y Desarrollo Territorial
MCIT	-	Ministerio de Comercio Industria y Turismo
METI	-	Ministerio de Economía, Comercio e Industria de Japón.
MHCP	-	Ministerio de Hacienda y Crédito Público.
MME	-	Ministerio de Minas y Energía
MRI	-	Mitsubishi Research Institute

MT - Ministerio de Transporte
NGO - Organización no Gubernamental
OECD - Organización para la Cooperación del Desarrollo Económico-
OEF - Obligación de Energía Firme
PND - Plan Nacional de Desarrollo
POT - Plan de Ordenamiento Territorial
PROURE - Programa de Uso Racional y Eficiente de la Energía
PYMES - Pequeñas y Medianas Empresas
RE - Energía Renovable
REC - Certificados de Energía Renovable
RFA - Asociación de Combustibles Renovables
RFS - Standard de Combustibles Renovables
RPS - Portafolio de Energías Renovables
RSB - Mesa Redonda de Biocombustibles Sostenibles
RSPO - Mesa Redonda de Palma de Aceite Sostenible
RTFO - Obligación de Combustibles Renovables para Transporte
SEMARNAT - Secretaría de Ambiente y Recursos Naturales de México
SIN - Sistema Nacional Interconectado
SREC - Estrategia de Energía Sostenible y Renovable para Colombia
SSPD - Superintendencia de Servicios Públicos Domiciliarios
SWOT - Análisis DOFA (Debilidades, Oportunidades, Fortalezas y Amenazas)
UNC - Universidad Nacional de Colombia
UNCTAD - Conferencia de las Naciones Unidas sobre Comercio y Desarrollo
UPME - Unidad de Planeación Minero Energética
URE - Uso Racional y Eficiente de la Energía
USD - Dólares Estadounidenses
VAT - Impuesto al Valor Agregado IVA.
ZNI - Zonas no Interconectadas

Units

gal - galon
GWh - Gigavatios - hora.
ha - Hectárea
kg - Kilogramo.
kL - Kilolitro
kWh - Kilovatios - hora.
kWh/m² - Kilovatios - hora por metro cuadrado.
l/day - Litros por día.
Mt CO2e - Tonelada métrica de dióxido de carbono equivalente.
MW - Megavatios
MWh - Megavatios - hora.
t - tonelada
t/ha - Toneladas por Hectárea
t/year - Toneladas por año