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Latin American and the Caribbean Energy Magazine

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ENERLAC MAGAZINE

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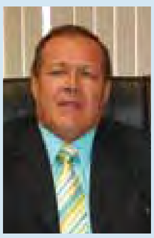
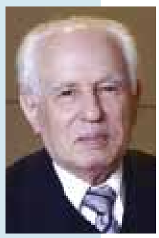




Presentation

Latin America and the Caribbean, despite their relevance on their renewable and non renewable energy resources, don't have as yet a specialized communication and discussion channel about issues of the energy sector that bring together academics, analysts, energy policy makers and other professionals. There are specialized energy bulletins, but they are not aimed at policy analysis, neither in this region.

The Latin American Energy Organization is the only intergovernmental regional organization that has the authority, among others, of: i) promoting technical cooperation, exchanging and disseminating scientific, legal and contractual information and stimulating the development and dissemination of technologies in energy-related activities and ii) encouraging the preparation and development of common energy policies as a factor for regional integration. These are two closely linked functions, since the rigorous scientific analysis should support the design, implementation and assessment of public policies, either nationally or regionally. Therefore, the motivating principle for launching a magazine like ENERLAC referrers to the shortage previously mentioned, fulfilling the functions of OLADE to guide regional public policy discussion in the energy area, based on the development and dissemination of technology, analysis and evaluation of policies, plans and programs.

Thus, ENERLAC Magazine was born with a proposal for discussion, which is: Sustainable Energy Development in Latin America and the Caribbean. Some of the leading specialists in the region have written articles expressing different viewpoints on that subject. These reflections are a challenge for other regional experts to use this publication as a channel of disclosure and discussion of ideas for Latin America and the Ca-ribbean energy community.

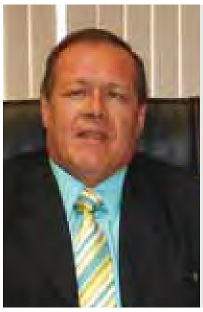
The first article refers to the Energy Agenda for 2023 of OLADE, in which there are exposed the key subjects that the organization intends to develop until the 50th anniversary of the Lima Agreement, within the context of the characteristics of the region's energy systems. To continue, the article written by Dr. Luiz Pinguelli Rosa presents an analysis of the policies developed in recent decades in the region and its relations with the global economic crisis and the context of oil prices on the world market. Later on, the magazine presents the reflections of Dr. Jose Goldemberg on the situation of Latin America and the Caribbean in regards to the development of renewable energy resources. Likewise, Dr. Alfredo Curbelo makes an analysis on the resource potential of the region, with regards particularly to biofuels. The publication ends with an analysis on ethanol and energy efficiency topics: Dr. Gilberto Jannuzzi and Dr. Rodolfo Gomes present an assessment on technologies and practices in the sustainable production of ethanol in Brazil, based on the SWOT analysis; and M.Sc. Mr. Odon de Buen Rodriguez presents some reflections on energy use in buildings (residential and commercial sector), with Mexico as reference.

We avail of this opportunity to thank those specialists who have worked with this publication and at the same time we encourage all specialists in Latin America and the Caribbean to send proposals for articles to OLADE. More information can be found at the official site of the Organization: www.olade.org.

Dr. Carlos A. Florez P.
Executive Secretary
OLADE




The Energy Agenda of OLADE to 2023



Carlos A. Florez Piedrahita

Executive Secretary
Latin American Energy Organization, OLADE.

Carlos Arturo Florez Piedrahita, Colombian citizen, is the current Executive Secretary of the Latin American Energy Organization for the period 2008-2010. He is a professional, specialized in Administrative Science in Israel, with 26 years of experience in the Social, Labour Union and Solidarity Sector. He has also 14 years of experience in the Colombian Public Sector, spending 10 of them in the energy sector.
He has held leading positions in various entities such as: the Ministry of Mines and Energy of Colombia, the Energy Mining Planning Unit (UPME), the Medellin Public Companies (EPM), ISA, among others.
Dr. Flórez was OLADE's National Coordinator in Colombia, allowing him to work on behalf of his country as Chairman of Strategy and Programming Committee of OLADE in 2005 and as a member of the Directive Committee of the Organization until 2007.

One of the major achievements of the past four decades in regards to the development of society on a planetary scale, has undoubtedly been the creation of an increasingly clear awareness that the modern way of life could only be maintained, and expanded following the criteria of sustainability. A better future necessarily depends on what is done in the present and the path we decide to undertake. The energy sector, either as one of the essential factors for economic activity or even as a condition for a dignified and modern living for all inhabitants of a country, is not apart from that concept.

However, it is important not to lose the perspective of the real needs of developing countries. Indeed, although this concept has created some restrictions for developed and developing countries, which have different levels of responsibility in the environmental impact, it has also brought great opportunities for countries in Latin America and the Caribbean.

This region is one of the top with greatest potential for development of various renewable energy resources: hydropower, solar radiation, wind and biomass resources are abundant and they are still barely exploited. Hydropower, for example, is a source available in many countries of the region, but only a 22% of the potential in stock has been used so far. What was remarkable about the use of this energy source is that there are endogenous technologies that allow its conversion into electricity, an energy form that allows for many different end uses with high yields of energy transformation. This is the same situation for biomass, with special attention to biofuels. Some of the countries of the region - particularly Brazil, but not exclusively - have developed technologies to increase productivity in the whole industry chain, and have expanded their use as a fully viable alternative to fossil fuels, that despite its undeniable importance, are of limited availability and its use bring along increased emissions of greenhouse gases.

Biofuels have a high potential for development in the region, whether by the availability of suitable soils for agriculture, abundant solar energy and water resources available in great part of Latin America and the Caribbean. Furthermore, the development of endogenous technologies that increase productivity in various segments of this industry is an example around the world and it can be used to replicate and expand production.

Just by considering the two renewable energy sources quoted above, the future for the region will be promising. But there are also other sources such as solar radiation and wind, which certainly are having a great momentum in the world and in Latin America and the Caribbean (LA & C), mainly during the last five years. As much as the region develops its own technologies for self use or it increases the participation of regional resources in the value chain, these new renewable energy sources will certainly become increasingly important. This impulse may have some impact, although it will be small in the medium term, in the structure of final energy consumption in LA & C.

It should be noted here that the region is characterized by an energy matrix with great influence of renewable sources. Although this fact is found uniformly in all countries, the average is high compared to other regions or countries. In 2007, AL & C had 25% of renewable energy in domestic supply of energy, while in OCDE[1]

1 Member Countries of the Organization for Economic Cooperation and Development: Germany, Australia, Austria, Belgium, Canada, South Korea, Denmark, Slovakia, Spain, United States, Finland, France, Greece, Hungary, Ireland, Italy, Iceland, Japan , Luxembourg, Mexico, Norway, New Zealand, Netherlands, Poland, Portugal, United Kingdom, Czech Republic, Sweden, Switzerland, Turkey.

countries such participation reached less than 7% and the world average in the same year was of 13%. Furthermore, if we were to consider the level of electricity supply in AL&C, there is a population of 39 million people who still lack access to this form of energy. For the universalization of electricity, the importance that renewable energy sources will have is essential.

Notwithstanding the foregoing, the renewable energy sources alone will not supply the energy requirements in the region, but it is unquestionable that they are an alternative that rely on the reduction of use of fossil fuels. They are also an alternative in fuel imports from other countries, which represent a saving of foreign exchange, an alternative in environmental protection for the possible reduction of greenhouse gases and in generating employment, especially in the rural agricultural sector. OLADE studies for the future, with the horizon of 2032, show that the participation of fossil fuels as a whole will not represent major changes. It is expected to increase the consumption of coal and natural gas at the expense of oil. It is also awaiting a notable increase in the usage of nuclear energy.

In turn, the generation of electricity from the energy use of nuclear fission (or fusion, still under development) is considered an option for improving the energy supply of AL&C countries. There are not only reserves of uranium and thorium in the countries of the region (Brazil has around 5% of world reserves of uranium), but there are also regional developments in production technologies and in fuel enrichment, design of materials and nuclear reactors. In this sense, the technological development in Argentina, Brazil and Mexico presents successful experiences.

Many experts say that the power to combine the use of renewable energy sources, together with the rational and efficient use of energy, will provide our countries significant cost savings. The Energy Efficiency concept does not refer to a restrictive measure in terms of energy consumption, but as a measure of efficient use, using appropriate technology and with full respect for the environment.

The financing issue is a topic often noted as one of the greatest barriers to sustainable development, particularly when it comes to expanding the use of technologies of renewable energy conversion, since they require in terms of capital costs and in general, greater financial resources. However, funding depends essentially on two aspects: a) the decision of a society to allocate resources (either public or private sources) for energy, which can be guided through public policies and tariff regulations; b) use of external financial resources, either through investment or through loans from international financial systems. Finally, these two aspects are directly related to the creation of a propitious institutional framework so the energy sector cooperates with the sustainable development. The context of the international financial crisis originated in the U.S. and immediately globalized reveals the fragility of the international financial system instead of an insurmountable barrier to the development. The restriction is not so much the volume of money available but the way it is managed, audited, distributed and allocated.

The above mentioned shows, on one hand, the complexity of energy systems and its close relations with other sectors, such as: economics, finance and environment. On the other hand, it shows the wealth of energy resources in Latin America and the Caribbean. The challenge is to use them effectively mainly to benefit the population of the region.

The need to prepare for energy development scenarios, but based on individual and regional conditions, has led the Organization to redesign itself, while maintaining its existing principles to be regarded as the intergovernmental body at the regional level that knows, gives opinions and proposes on energy issues. To meet this challenge, officials of the Organization have undertaken the unprecedented task of creating and maintaining a culture of strategic planning. It starts from the idea that only an ongoing reflection on the position of OLADE within its Member Countries' framework but also within other international organizations' framework can focus its operational plans on a more effective way to cope with the challenges that have arisen.

A year ago, at the 35th anniversary of the Latin American Energy Organization, it was mentioned that the main institutional challenge was to proactively influence in energy policies of the countries of AL&C. This is not about replacing the fundamental role of energy authorities of the Member Countries in formulating and implementing policies, but to contribute to national efforts to be more effective by capitalizing the great strength that OLADE has: the regional approach.

Indeed, maintaining existing relationships with Member Countries while seeking alliances with other agencies, strengthening the position of OLADE on energy and on global scale, are the basis of future operations of the Organization. In other words, the general objectives of the organization in the regional context seem to be clear. What was concerted in the Lima Agreement remains in effect. What to look for is the constant renewal of operational plans, but having a structure without plastering the actions directed towards those goals, with specific results.

In this context, the strategic planning exercise of OLADE has defined a key subject's proposal, called the Energy Agenda of OLADE to 2023.

1. Institutional Strengthening

Institutional strengthening involves offering useful tools for agencies and energy agencies of Member Countries, to enable them to better fulfill its functions.

OLADE proposed in this key subject, to support Member Countries in areas such as: planning, institutional framework, corporate social responsibility, professionalism and availability of resources.

2. Information Technologies

Information technologies nowadays constitute a powerful platform to facilitate and expand options for various types of services. These are also options that allow optimizing resource use. OLADE has carried out some of its activities based on these technologies. The intensive use of the Internet and specialized applications can provide far-reaching virtual courses. Nearly 3,500 participants in 45 courses taught in the last 36 months from the 26 Member Countries and Participant Country - unprecedented training scope in history of OLADE - are the proof that the path is correct.

Other departments of the Organization - including the one regarding to the administration - can be modernized, providing access to the technical proposal of OLADE. Technological change not only results in a more rational use of resources but also in a wider scope of products and services.

3. Energy Studies

The approach intended to give to some of the studies is based on the Information Systems of the Organization. The validation of the energy statistics database is per se a task of great value. However, there are attempts to go beyond the data. It is intended to use the information on energy sector analysis and through specific indicators.

Also, the periodic OLADE Energy Prospective study will help guide national and regional policies. In this sense, regional energy integration, so frequently mentioned in speeches, is still a goal not fully achieved. Bilateral projects of great significance and some political statements are already available. Little progress has been made in supranational policy and regional projects.

4. Exchange of experiences

This key subject generates unprecedented exchange opportunities between different actors in the region, who can facilitate the research and development between countries with some degree of similarity in scientific and technological advance. But it can also represent even more important for benefits for countries with less developed internal technology, through various cooperative activities. At the same time, all countries in the region can not remain indifferent to technological innovations taking place in the global arena. It is essential to maintain a dialogue among centers of excellence in the region and in the world, knowing and disseminating results, and working at the frontiers of science and technology.

In this issue there are various forms of activities considered: from chat rooms (forums, events), that can not stay in a fragmented and isolated dialogue, to the creation of thematic networks of experts to facilitate collaborative work between the centers of national science systems, technology and innovation both in the region and worldwide.

5. Communication

It has been stressed the importance of maintaining contact and continuing relationship, first between OLADE and the energy authorities of the Member Countries, as well as with energy companies (mainly public) regulatory agencies and other authorities and agencies related to the energy sector.

OLADE relations with other international agencies have dramatically increased in the current administration, which is linked to a process of consolidation of the organization as regional prolocutor on energy. Joint actions of international agencies are well received by governments, not only because of the synergies that may result from the collaboration but also because it optimizes the allocation and use of resources of the Member Countries of these organizations.

Finally, it is worth mentioning that OLADE has not proposed a closed and consolidated Energy Agenda to 2023. It is an exercise that must be followed within the Organization, but it should also be closely linked with energy officials from Member Countries. It must continually be adapted and improved to benefit the energy sector in Latin America and the Caribbean.

The Energy Policy in South America and the Return of the State:

Price of Oil, Climate Change and the Economic Crisis

Luiz Pinguelli Rosa

Professor of the Energy Planning Graduate Program and Director of Alberto Luiz Coimbra Institute - Graduate School and Research in Engineering, Federal University of Rio de Janeiro (COPPE/UFRJ)

Luiz Pinguelli Rosa graduated in Physics from the Federal University of Rio de Janeiro (UFRJ) achieved a MSc in Nuclear Engineering from the same university and a PhD in Physics from the Catholic University of Rio de Janeiro (1974). He was Director of Alberto Luiz Coimbra Institute of Engineering Graduate Program and Research of the URFJ (COPPE / UFRJ) for three periods and was former President of Eletrobrás. He is currently the Director of COPPE / UFRJ, Professor of the Energy Planning Program of this Institute and Executive Secretary of the Brazilian Forum on Climate Change.
His current areas of research are: energy planning, climate change and epistemology and history of science. Previous researches are linked to the areas of: nuclear engineering, reactor physics, theoretical physics and particle physics. Prof. Pinguelli Rosa was a visiting lecturer and researcher in several universities and institutes worldwide, such as: the Stanford University (SLAC) and the University of Pennsylvania in USA, the University of Grenoble in France and the Krakow University in Poland, the Centre International de Recherche sur l'Environnement et le Développement in Paris, the Centro Studi Energia Enzo Tasseli and the Ente Nazioanale per l'Energia Nucleare e Fonti Alternative, both in Italy and at the Bariloche Foundation in Argentina. He was also a member of the Pugwash Council (1999-2001) - an entity founded by Albert Einstein and Bertrand Russell - which won the Nobel Peace Prize in 1995 and has participated in the Intergovernmental Panel on Climate Change (IPCC), an institution that also was awarded with the Nobel Peace Prize in 2007.

1 - Introduction: The Return of the State

This article seeks to give an overview of current energy policies of the countries of South America, highlighting Brazil and its relationships in view of the South American energy integration. Therefore, it does not intend to be a complete, neither a neutral analysis. Thus, this study focuses on certain more important aspects, instead of paying attention to details of each country and on all energy sources technically feasible, but not always economically important. It aims to serve as an instrument of policy, to provide basis for decision making and planning actions, contextualizing South America and Latin America in the world. In this context, considerations should be given to the impact of the dizzying rise in oil prices, its subsequent fall with the global economic crisis that came to Latin America in 2009, leveraged by excessive financing of the global economy, and the recent rise in the oil barrel price. This impact has as counterpoint the finding of the oil bearing pre-salt in Brazil, which increases the potential size of the South American oil reserves.

Among the various primary sources of energy, there are those with a bigger role in the current and potential integration: hydroelectric power, oil and natural gas. These have been the object of various specific studies and therefore will not be seen in the same detail. In the current context, alternative sources have gained importance, particularly biofuels and especially Brazilian ethanol. This was the subject of intense international controversy due to the worldwide rising food prices, attributed by some, hypothetically to the competition of biofuels, which are also accused of contributing to the deforestation of the Amazon in Brazil.

We are in a world where state intervention has returned to national economies with the global economic crisis. In the energy area this happened in several South America countries. This is neither new nor exclusive to South America. Worldwide, the oil shocks of 1973 and 1979 led to national policies on energy and energy planning by governments, either to ensure the supply of oil or to develop other conventional and alternative sources. This occurred not only in South America, but around the world.

In the second half of the 1980s there was a drop in oil prices and consequently a much reduced role of the state in energy control, leaving it up to the market. In the 1990s, due to several factors, policies labeled as neo-liberal increased in the world. And in Latin America there was a deregulation and privatization of state energy companies. In South America this was particularly intense in Chile during Pinochet's administration, and afterwards in various countries such as Argentina and Brazil to different degrees and at different times. This situation is now reversing within a new and more complex context, not just as a simple return to the previous status quo, and it varies from country to country.

Deregulation of energy was a part of the liberalization of the economy under financial globalization, which was the root of the global crisis. It started in USA in 2008 and worsened in 2009 reaching South America and some countries in particular, such as Brazil.

In the case of energy, the effects of the financial crisis are added to the environmental crisis due to climate change caused by global warming intensified by emissions of gases like carbon dioxide from burning fossil fuels. The greenhouse effect has become a major international political problem, because there are choices for society to decide upon and not just for companies alone. The 2007 Nobel Peace Prize was awarded to the Intergovernmental Panel on Climate Change (IPCC) which came as a result of Fourth Assessment Report issued in early 2007, and caused great concern worldwide.

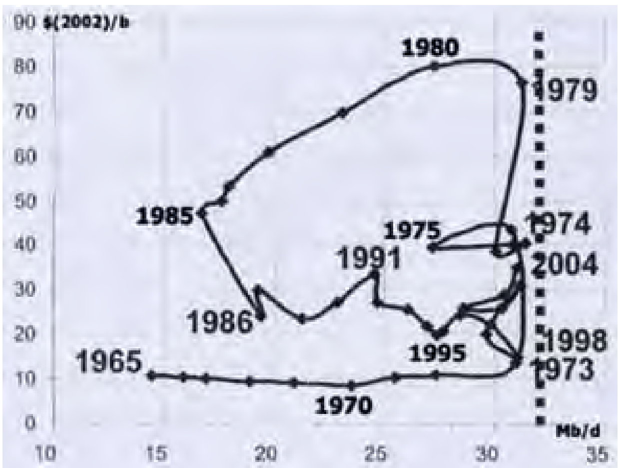
2 - The Energy Policy in the Face of Oil Price Change

The recent framework had in common with the two oil shocks, the high international price of a barrel of crude oil, which until 1973 was between US$1 and US$2 and then rose sharply until 1979 when it hit US$ 40 for some time, after which it fell sharply in the second half of the 1980s and followed an erratic path in the 1990s (Graph 1). In 1999 it came down to only US$10, but in 2006 exceeded US$ 70 and in 2008 it came close to US$ 140. In 9 years the price of oil was multiplied by 14 and it almost doubled in two years, but afterwards it fell to less than US$50, in 2009 and has now settled to around US$ 70.

Problems were caused due to Natural gas in recent years between Russia and Europe, between Argentina and Chile and more recently between Bolivia and Brazil. In electricity, there was severe rationing in 2001 for many months in Brazil and in California, both due to a lack of sector regulation.

The impact of the high international price of an oil barrel on the world economy was reflected in South American countries; however, today the participation of oil in the world economy is less than the oil shock of the '70s. Around the world costs of products participation in general are half of what it was back then.

Graph 1
Price and oil production from the Organization of the Petroleum Exporting Countries (OPEC)



Source : Jean Marie Martin, Université de Grenoble, 2004. Price of a barrel of oil (USA. $ / b) versus production of OPEC (Mb / d). The values of oil prices are in US$ of 2002. The current values of the oil price in the period before the shock were in the range of US$ 1/barrel.

Some factors contributed to this strong variation in the oil price:

a) – A prediction in the decline of world production, while in South America there have been important discoveries in the Brazilian pre-salt and the growth in consumption, especially in developing countries, driven by China but including South America.

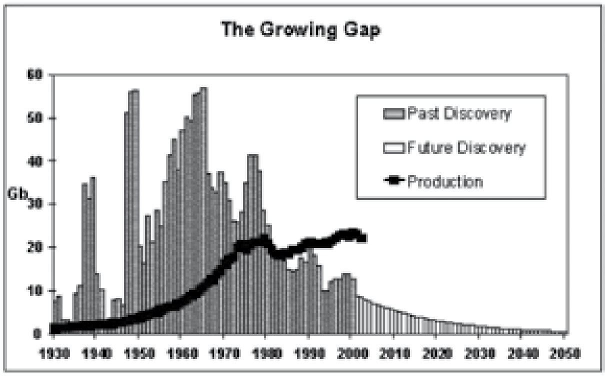
b) - The global geopolitical instability, especially in the Middle East which is a big oil-producing area and the strong dependence of OECD countries, especially the USA, on the oil import. Although to a lesser extent this instability is projected in South America with the political tension between the USA and Venezuela.

c) – The global economic crisis triggered from the USA in 2008, which impacted South America in 2009.

d) The environmental pressures, particularly emissions of carbon dioxide from the combustion of oil products, exacerbating the greenhouse effect that contributes to global warming.

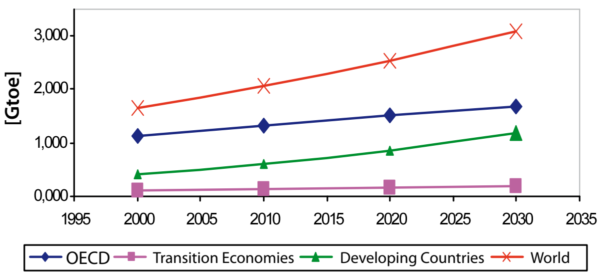
Paragraph (a) above is illustrated by Graphs 2 and 3. The first shows the development and projection of future discoveries of oil and the declining trend in its production. It should be emphasized that in South America there is a counterpoint to this trend with the discovery of oil in the pre-salt layers in Brazil.

Graph 2
Past and Future oil discoveries



Source: Colin Campbell, The Coming Oil Crisis, 2000

Graph 3
Energy in Transportation

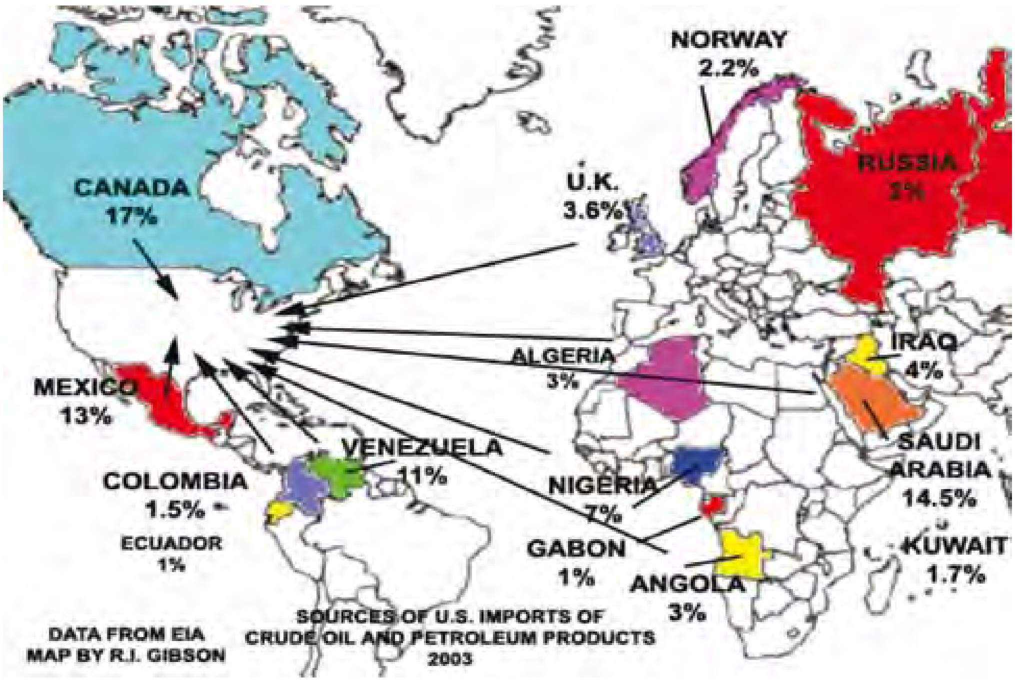


Source: Suzana K. Ribeiro, COPPE, 2005

Graph 3 shows the projection of increased consumption of oil products in transport, showing that the curve with higher derivative represents developing countries.

The geopolitical instability related to oil producers (point b) is empirically demonstrated by the conflict in Iraq, occupied by the USA forces, the Arab Israeli conflict and the tension between the USA and Iran for its uranium enrichment project. Also, in South American there is obvious political tension between the USA on one side, and Venezuela and Ecuador on the other. With President Barack Obama this tension

Map 1
Oil flows towards United States of America



decreased, but on the other hand it has increased with the announcement of a USA military agreement with Colombia and some friction between Colombia and Venezuela.

The dependence on imported oil in developed countries, also in paragraph (b), is shown in Map 1. The flow of oil towards the USA, appears as a sink in an analogy with the dynamics of fluids in physics. In Map 1, South America contributes 13.5% (Venezuela 11%, Colombia 1.5% and Ecuador 1%). For comparison, Canada supplies 17%, Saudi Arabia 14.5% and Mexico 13%. So not only South America has an important role in supplying oil to the U.S market, but on adding the Mexican 13% share it shows that Latin America as a whole takes first place. Despite the intense controversy in the political field between the USA and Venezuela in recent years, the flow of Venezuelan oil to the USA has not been interrupted.

The financial crisis triggered in the USA (related in point c) spreaded worldwide and reduced the GDPs of some countries. In several countries the government ha to intervene in the economy to save big companies from bankruptcy.

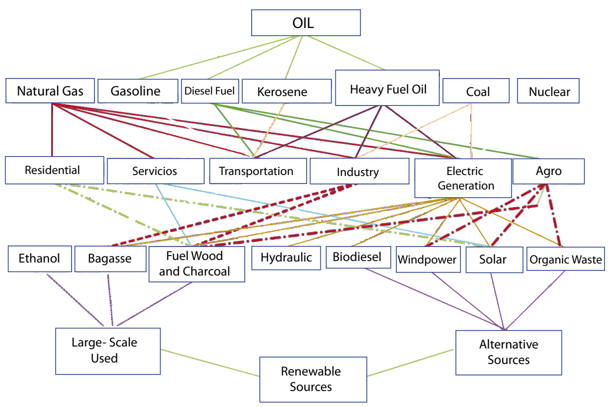
Finally, on point (d) is important to mention that the participation of renewable primary sources, particularly hydroelectric power is larger in South America than in other continents. Biofuels have great use in Brazil, whose emission of greenhouse gases, however, are influenced by deforestation.

3 - The Effect of Greenhouse Gas Emissions and Climate Change

Fossil sources are responsible for greenhouse gas emissions shown along the top of Graph 5 except for nuclear energy, which comes from fission of uranium and not from combustion, as it occurs with coal, oil and natural gas. Renewable sources (along the bottom of the Graph) do not emit greenhouse gases or if so, a little ethanol like substance, and hydroelectric power. In the case of biofuels, the carbon dioxide emitted during combustion is reabsorbed from the atmosphere during plants growth.

However, half of firewood and charcoal come from deforestation in Brazil, where the charcoal is used in steel making. The net emission in the case of ethanol is restricted to the consumption of diesel for tractors and trucks in the sugarcane crop. In the case of hydroelectric power plants, COPPE's research group carried out experimental measurements in several reservoirs in the country, confirming carbon dioxide and methane emissions, although in general the contribution of these plants is lower than the thermal electric plants.

Chart 1
Energy flows from Primary fossil and renewable sources



According to the IPCC report released in 2007 the growth of global emissions of greenhouse gases was 70% between 1970 and 2004. Among these, CO_2 emissions rose by 80% and represented 77% of anthropogenic emissions in 2004. The biggest growth in emissions between 1970 and 2004 was from the energy sector (145%), followed by transport sector (120%), industry (65%) and use of land and deforestation (40%). Table 1 gives the rates of energy per capita, CO_2 emissions per capita, energy consumption per GDP in the countries of South America.

Table 1
Energy consumption per Capita and CO_2 Index of Emissions in Energy Consumption

South American Countries	toe per capita	t CO_2 / capita	t CO_2 / toe	Kg CO_2/ 2000 US$ of GDP
Argentina	1.64	3.64	2.21	.45
Bolivia	0.58	1.29	2.23	0.51
Brazil	1.12	1.77	1.57	0.49
Chile	1.81	3.60	1.98	0.63
Colombia	0.63	1.31	2.10	0.60
Ecuador	0.79	1.77	2.24	1.14
Paraguay	0.67	0.58	0.87	0.43
Peru	0.49	1.02	2.06	0.43
Uruguay	0.84	1.52	1.81	0.24
Venezuela	2.29	5.35	2.34	0.91

Energy expressed in ton oil equivalent (toe)
Source: International Energy Agency (IEA), 2006

The meeting of the UN Convention on Climate Change in Copenhagen at the end of 2009 will represent an aspiration to find a consensus for the most effective commitment to reduce total global emissions of greenhouse gases, which contribute to the atmosphere warming near to the land surface, climatic changes and possible consequences that may be dramatic for humanity.

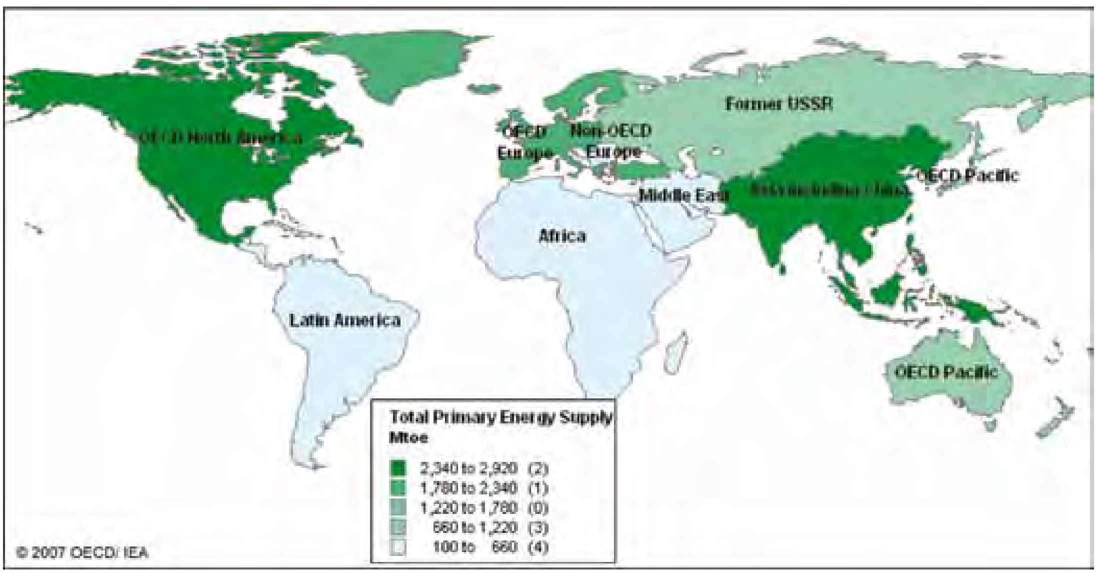
Some recent events are encouraging, but not enough to ensure that they reach a satisfactory solution, especially given the increase in atmospheric concentration of carbon dioxide, according to the 2007 Report of the IPCC. The approval by the United States House of Representatives of a proposal by President Obama is encouraging, which means a jump forward compared with the Bush's administration. However Obama's proposal for 2020 is to reduce the USA CO_2 emissions to 17% less than emitted by that country in 2005. However, this is much less than the target set by the Kyoto Protocol, whose year base on which the percentage reduction applied for each country was in 1990 and the time frame given was between 2008 and 2012. It is less that the goal of the European Union. The Kyoto Protocol was rejected by USA.

The G8 + G5 meeting in 2009 in Italy advanced little steps in terms of reaching an effective commitment involving the developed countries - represented by the G8 and led by the USA - and the developing countries - including Brazil, but with a greater influence from China followed by India. The economies of these two Asian giants were growing above 10% and it currently grows over 5% despite the economic crisis that shakes the world.

The commitment to limit the increase of global temperatures to 2° C in relation to the pre-industrial era is encouraging. The Brazilian position in the preparatory phase of the Conference in Copenhagen included this limitation, which implies a major effort to reduce emissions from rich countries and to control those of the developing countries. But this effort is not part of the commitment of the G8 + G5, which thus, leaves it without effect. An abstract target of limiting the increase in temperature was set without defining the steps to reduce emissions to achieve it.

The G8 + G5 meeting considered setting an 80% reduction in emissions from rich countries by 2050 provided that the developing countries agreed on reducing their emissions by 50% in the same year to which they disagreed. One issue is the controversy over the adoption of obligations from developing countries on their emissions. An argument to adopt them is the growth of emissions in developing countries, especially

Map 2
Primary Energy consumption in the world



China and India. But, per capita CO_2 emissions in rich countries remain far above from those of developing countries.

Brazil is the promoter of the creation of the National Plan on Climate Change approved by President Lula in December 2008, with reduction targets for deforestation, the main responsible of Brazilian emissions. There were great implications at the Climate Convention in Poznan in the same month which, incidentally gave few concrete results. It is also encouraging the forecasts from the satellite data recorded in Brazil, showing a reduction rate of deforestation of 55% this year, fulfilling the goal of the Plan.

On the other hand the plan to increase the participation of fossil fuel for electric power generation in Brazil is not so encouraging. But the good news is the growth of production and consumption of ethanol in cars, surpassing that of gasoline in Brazil, whose energy matrix is 45% renewable energy generation which includes hydroelectric and biofuels, while globally this percentage is 13% and in OECD countries only 6%.

The difference in primary energy consumption in various regions of the world is shown in Map 2. South America and Africa are on a lower consumption bracket, between 100 and 600 million tones of oil equivalent (toe), in contrast with North America, Europe and Asia, in the range between 2320 and 2960 million tons of oil equivalent.

4 - Structure of Energy Sector in South America

Latin America has about 7% of the world population, while the consumption of primary energy in Latin America is 4.4% of world consumption. If we observe the primary energy sources (IEA, Key World Energy Statistics, Paris, 2007), Latin America's participation in energy production in the world is:

- 9.0% oil
- 4.9% natural gas
- 1.4% charcoal
- 0.8% nuclear
- 20.7% hydroelectric power.

Therefore, the presence of nuclear generation of electricity in Latin America is less than 1% of nuclear generation in the world. It is restricted to Brazil, Argentina and Mexico. Meanwhile, the share of hydroelectric power exceeds 20%. Brazil, Venezuela and Peru are among the ten countries with more water resources in the world (Table 2).

Table 2
Countries with the greatest water resources of the world

	km3 / year	m3 /year / habitants
Brazil	8.2 ←	48.3
Russia	4.5	30.9
Canada	2.9	94.3
Indonesia	2.8	13.3
China	2.8	2.2
USA	2.0	7.4
Peru	1.9 ←	74.5
India	1.9	1.8
Congo	1.3	25.1
Venezuela	1.2 ←	51.0
Top ten	29.7	34.9
World	43.7	7.2

Source: FAO, ONU, 2003; Roberto D'Araujo, Seminário sobre Estratégias Energéticas, UFRJ, 2004

Table 3
Oil, Natural gas, Charcoal and Hydroelectric power

Country	Oil Millions of toe			Natural Gas Millions of toe			Charcoal Millions of toe			Hydroelectric power thousand MWh		
	Prod	Imp*	Exp*	Prod	Imp	Exp	Prod	Imp	Exp	Prod	Imp#	Exp#
Argentina	37.8	1.3	14.9	36.2	1.3	5.4	-	1.0	0.14	34.6	8.0	0.4
Bolivia	2.9	0.2	0.6	9.9	-	8.6	-	-	-	2.5	-	-
Brazil	87.3	28.0	23.4	9.2	7.5	-	2.5	11.3	-	337.4	39.2	0.1
Chile	0.3	14.3	1.7	1.7	5.3	-	0.3	3.9	-	24.8	2.1	-
Colombia	27.4	0.9	16.1	6.1	-	-	38.9	-	34.9	39.8	-	1.7
Ecuador	27.0	2.6	20.6	0.4	-	-	-	-	-	6.8	1.7	-
Paraguay	-	1.1	-	-	-	-	-	-	-	51.2	-	43.8
Peru	5.2	5.9	3.5	1.4	-	-	0.03	0.8	-	19.9	-	-
Uruguay	-	2.3	0.3	-	4.1	-	-	-	-	6.7	1.6	0.8
Venezuela	169.3	-	138.1	23.2	-	-	5. 2	-	5.2	75.0	-	-

(*) Includes crude oil and products, (#) Electricity generation including hydroelectric and thermoelectric
Source: IEA, Non OECD Countries Statistics 2006

If we compare water resources per capita, Peru and Venezuela are higher than Brazil. When we take the installed capacity of hydropower generation, the USA take the first place, Brazil goes down to third place and Venezuela to the thirteenth place, while Peru does not even appear on the list of countries with large hydroelectric generation.

The production, import and export of oil, natural gas, coal and hydroelectric power in the main South American countries is given in Table 3. Imports and exports related to oil include the addition of crude oil products. For coal the different types are computed and coke. Alongside hydroelectric power production are the import and export Graphs for electric energy.

For Table 3 the largest producers of oil in South America are Venezuela and Brazil, which is still far behind the leader. Brazil is balanced in exports (mainly heavy crude oil) and imports (light crude for refining). Argentina, Colombia and Ecuador have similar production and the are oil exporters.

Argentina is the largest natural gas producer, followed by Venezuela, Bolivia and Brazil, which is also an importer. Argentina is also an exporter (to Chile) and Bolivia (to Brazil and Argentina) . Venezuela, Argentina and Brazil are important natural gas consumers.

Colombia is a large coal producer and it exports that product. Brazil is the largest producer of hydroelectric power on the continent, coming after Venezuela and Paraguay which exports.

5 - Changes in Energy Sector in South America

Important events marked the energy sector in South America in 2000 which are:

i) - Electric energy shortage in Brazil in 2001 after privatization of major electricity companies, led to the suspension of the privatization of the Brazilian electric sector in 2003, after the election of the new president.

ii) - A change in the overall South American oil reserves with self-sufficiency in oil in Brazil and the discovery of large oil fields in the pre-salt layers.

iii) - Shortage of natural gas and electricity in Argentina, causing gas export cuts to Chile and a return to state intervention in Argentine energy.

iv) - Nationalization of oil and natural gas in Bolivia, leading to the renegotiation of gas exports to Brazil and to Argentina and the nationalization of Petrobras refineries in the country.

v) - Change of Venezuelan energy policy with greater state intervention in the oil industry, through PDVSA and also in relations with foreign oil companies and in electric energy.

vi) - Energy policy change in Ecuador with new rules for foreign oil companies, including Petrobras.

vii) - Change of the energy policy of Paraguay, in particular the binational hydroelectric power plant (with Brazil) of Itaipu.

viii) - Increased consumption of liquid biofuels with the renewal of the automotive ethanol production and the biodiesel program in Brazil as of 2003.

To understand the changes in South America, it is necessary to bear in mind the following:

a) In recent years before the 2009 crisis there has been significant growth in several countries after a period of stagnation or small growth, under monetarist policies of economic adjustment driven by the International Monetary Fund and the World Bank with the support of rich countries.

b) A large social inequality remains, even if significant improvements are happening in the social areas in some countries. In the case of Brazil it is estimated that some 20 million people have improved their income levels, moving up from Class D, the poor class, to Class C. Unfortunately this process is hampered by the economic crisis.

c) Governments of the left or with support of the left won elections and are governing several South American countries: with retrained trends in Chile, Brazil and Uruguay; nationalists in Venezuela, Bolivia and Ecuador; and in an intermediate position near the latter group in Argentina and Paraguay.

d)Venezuela has levied a new tax on extraordinary profits of oil companies. The measure was taken a few months after Exxon Mobil and Conoco Phillips left Venezuela because of the nationalization of oil. Exxon stop exploring in the Orinoco Belt in 2008.

6 - Some Energy Issues in the Southern Cone

In 2007 there was an energy crisis in Argentina. First the intense cold in the winter had greatly increased the consumption of gas, and then in the summer the use of air conditioning aggravated the situation of electricity supply. To ensure the residential supply it was necessary to cut the gas supply to industries and there was vehicular natural gas rationing, used by the entire Buenos Aires taxis fleet. In that year Brazil transferred 1 million m^3 of gas to Argentina from Bolivia, besides that of electricity.

Bolivia announced that it could not meet the gas supply of 4.6 million m^3/ day in 2008 and 2009 as it was agreed upon with Argentina. The forecast was 27.7 million m^3/ day in 2010 with the completion of the gas pipeline in Northeast Argentina. Brazil offered to supply electricity from thermoelectric power plants that were not being used. In February 2008 an agreement was signed to provide the energy owed to Argentina. Brazil began in May 2008 to send an average of 300 MW to Argentina. The agreement was for 800 MW and could reach up to 1,500 MW if needed. Part of this energy can be relayed through Uruguay. There is a limit of 72 MW of the frequency converter for sending it directly to Uruguay.

Chile has a protocol with Argentina since 1995 to import natural gas, but in 2004, Argentina issued a decree giving priority to its domestic market to the detriment of contracts for gas exports. In 2003 the participation of Chilean gas in electricity generation was more than 50% and was dependent on imports from Argentina. In August 2005, Argentina cut 59% of gas supply to Chile and in May 2007 this percentage was increased to 64% or decreased from 14 million m^3/ day of what was a total of 22 million m^3/ day, forcing the Chilean electric plants to operate with diesel power. Around 70% of the gas demand in Chile is for thermoelectric generation. A Chilean law in tax incentives for renewable energy expects that at least 5% of all new electrical projects will be renewable energy.

In 2008 Presidents Lula, Morales and Cristina Kirchner met to discuss the issue of shortage of natural gas. Although there was much excitement about the policy of nationalization in Bolivia, foreign oil companies in 2008 announced their willingness to invest 3 billion dollars there. The three largest investors are Repsol with 1 billion euros, followed by Petrobras and PDVSA. In 2008 the National Plan for Energy Efficiency in Bolivia was announced. The goal is to encourage the correct use of electricity to live with dignity. Fundings are gotten from Venezuela through the Treaty of Commerce for the People - Bolivarian Alternative of the Americas.

The chain reaction to the nationalization of gas and oil in Bolivia was offset by caution in official diplomatic pronouncements of the Lula administration, resisting the pressure expressed in statements by extremists in the Brazilian press. They were followed by harsh statements of President Morales to the international press, which caused a strong reaction from Petrobras and the Foreign Ministry leading to an official back-track of the Bolivian government to allow a negotiation to save as much as they could.

There were two problems: Petrobras as a state controlled company and the Brazilian interests to ensure the supply of natural gas at a fair price. The acquisition of these assets had its origin in the privatization of the energy sector in South America. With natural gas the situation is different. The investments made by Petrobras meant a real production and economic increase of the Bolivian gas fields as well as the pipeline for the production to be exported to Brazil. The question was of direct interest to Brazil, to ensure the supply of natural gas at a fair price.

For Bolivia, the export of its gas to Brazil is essential, because 75% of its production is delivered to Brazil, 15% to Argentina and only 10% is for domestic market. Stopping exports would cause a huge loss of around 18% of the Bolivian GDP. The issue to be solved was the contract guaranteed price in which adjustments were provided, that Bolivia wanted to change. So the negotiations were based on this, because the problem of the price of natural gas around the world tends to be driven by high oil prices, and the result was positive.

In conclusion, the gas from Bolivia is essential to Brazil in the short term, until it increases its own domestic production and promotes South American integration.

Coming to the second challenge, President Lugo, soon after being elected in Paraguay, called for the revision of the Itaipu agreement. The binational electric plant has a debt of US$ 19 billion with Eletrobrás and the Brazilian Treasury, since it was Brazil the one that built the hydroelectric plant and received the funding. This debt is amortized by the tariff paid by consumers, who are by a massive majority Brazilians.

Half of the energy generated by Itaipu belongs to Brazil and half to Paraguay, which consumes about 5% of that energy. Under the agreement, Eletrobrás purchases the remaining energy paying an amount that for many years has been high. A compulsory quota of energy from Itaipu had to be established for Brazilian electric companies. Today it is no longer expensive, because the electricity generated in Brazil became more expensive since the privatizations. The price for the energy from Itaipu (US$ 42 / MWh) is similar to the price set for the San Antonio hydroelectric power plant to be built on the Madeira River (R$ 78 / MWh).

It should be taken into account in the negotiation that, since the first election of Lula, some concessions were made in benefit of Paraguay. In the transition, in December 2002, the amount of energy from Itaipu contracted by ANDE, Paraguayan electric state company, was reduced, favoring Paraguay in about US$80 million yearly that needed no longer to payment by ANDE to Itaipu. Besides, the transfer of energy had an increment giving another US$ 25 million annually to Paraguay. Finally, the debt adjustment factor based on the American inflation was removed.

What was not accepted by Brazil in the negotiations is that the share of energy from Itaipu belonging to Paraguay was placed on the market to Argentina and Chile, with Brazil losing the right to dispose of it through Eletrobrás. Itaipu supplies about 19% of electricity in the country. The Foreign Ministry attempted a successfull negotiation, as it did in the case of Bolivian natural gas.

The result of the meeting between the two presidents, Lula and Lugo on July 25, 2009 had as result the increase in the payment by Brazil of the so called transferred energy from Itaipu, which should not be mistaken by the total energy generated belonging to Paraguay, not used in that country and transferred to Eletrobrás by ANDE according to the Agreement. Most important, however, was the decision that Paraguay could achieve progressively increasing portions of that total now sold by ANDE to Eletrobrás and to be sold by ANDE on the free market of large consumers in Brazil.

Although this solution has ended the deadlock favoring Paraguay, directing this energy to the free market will not be a good solution neither for Eletrobrás nor for the Brazilian consumer supplied by the public network, whether they are residential consumers, companies or institutions.

7 - Energy integration of Brazil in South America: Present and Future

The two main projects of energy integration between Brazil and other South America countries are the binational plant of Itaipu with Paraguay, the world's largest hydroelectric plant, whose expansion from about 12 GW to 14 GW was completed in 2008 and the import of 30 million m^3 per day of natural gas from Bolivia. Both were subject to crises, which is now settled with Bolivia and in process of negotiation with Paraguay after elected President Lugo takes office. These crises will be handled in the following section.

There is an electrical connection in the south with Argentina, which was referred in the previous section and another, in the north with Venezuela, which is projected to be significantly enlarged, and will be described below. Furthermore, there is a small connection with Uruguay.

The hydroelectric project of Santo Antonio and Jirau, already bid and in the process of beginning construction on the Madeira River, near the border with Bolivia, opens up new possibilities for electrical integration. The original project, discussed between Furnas and Eletrobrás in 2003, has in mind to build at least a third plant in Bolivia as well as dams to provide access to Bolivia, via inland waterways, to the Atlantic Ocean. Map 3 shows a map of the Madeira River.

Map 3
Madeira River Project near the Brazilian Bolivian border

Source: Eletrobrás, 2004

Due to the variation in the flow without reservoir regulation the power of these plants can be established using an integrated system of hydroelectric plant reservoirs that accumulate water when the flow is high, in order to offset the energy in the months of low flow. The flooding of the area is small. Bulb turbines will be used, but there may be a problem of electrical stability, which can be solved.

New projects that are presently under development:

a) With Argentina, the cooperation taken up in 2008 between Eletrobras and Ebisa State company for the Garabi hydroelectric feasibility on the border between the two countries. Also, a cooperation agreement in the nuclear energy field was announced, accepting the idea of a binational reactor.

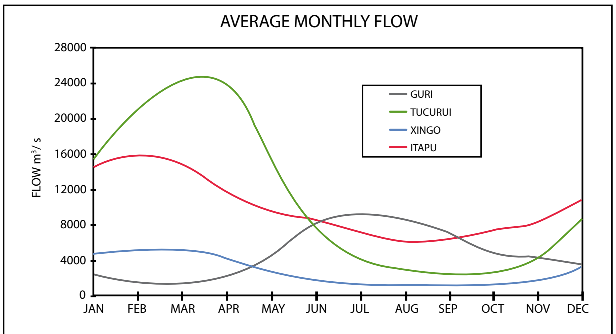
b) With Peru, studies for the construction of hydroelectric power plants, exporting the energy to Brazil. The Minister of Mines and Energy of Brazil has visited Peru and stated that Eletrobrás will soon send a research group to that country to start the study.

c) With Uruguay the construction of a 500 kV line with a capacity of 500 MW. There is also the possibility of a coal thermoelectric plant to supply energy to Uruguay.

d) With Venezuela there is a partnership with Petrobras for the Refinery in Pernambuco, with capacity to process Brazilian heavy oil and the possibility of exporting natural gas to Brazil. First, it will be liquefied natural gas (LNG) by sea but, in the long term, the construction of a long pipeline has been contemplated, however with very high investments.

Also with Venezuela, Eletrobrás has studied the expansion of the electrical connection with the North of Brazil, extending it to the Brazilian interconnected system to take advantage of the complementary flow between the river basins of the two countries (Graph 4). This allows a power transference in some part of the year in one direction and in the opposite in another part of the year.

Graph 4
Hydrological Diversity between Brazil and Venezuela Rivers Basins



Hydrological diversity: Motivational factor to link electrical systems of both countries.

Source: Eletrobrás, 2008

The idea is to make a transmission link between Carriri, near Manaus, and Macagua in Venezuela, with a 580 km line in Venezuela and a 1,000 km transmission line in Brazil. This link will complement the Tucuruí - Manaus line, whose construction is about to start.

8 - Comments about Biofuels and ethanol in Brazil

Table 4 gives the consumption of solid biomass (firewood, charcoal and agricultural waste) and liquid biofuels in South America.

Brazil is the bigest user of solid biomass - firewood and charcoal, widely used in the steel industry - and, moreover, is a big user of liquid biofuel, particularly of ethanol, and has a biodiesel program. Venezuela uses ethanol fuel on a smaller scale.

Table 4
Biomass Consumption

Countries	Solid Biomassa Thousand TJ	Liquid Biofuels Thousand TJ
Argentina	94.4	
Bolivia	31.0	
Brazil	2021.5	13.5
Chile	192.0	
Colombia	172.0	
Ecuador	221.2	
Paraguay	90.6	
Peru	95.0	
Uruguay	186.3	
Venezuela	22.6	0.03

Source: IEA, 2006

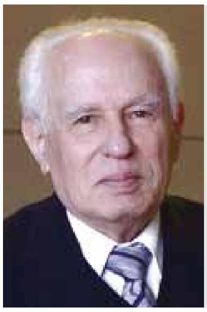
There is an international debate that blames the rising food prices in the world to biofuels, affecting the poor populations. The sugarcane occupies 7 million hectares (7 Mha), of which 3Mha are for sugar and 4Mha for ethanol; as for soybean, most of which is for export, it occupies 23 Mha. According to The Brazilian Institute of Geography and Statistics (IBGE) Brazil has 152 Mha of cropland, of which 62 Mha are used, and there are 177 Mha of pastures. Excluding the 440 Mha of native forests, there are 90 Mha for farming to expand into without deforestation. And this is without considering the conversion of degraded pastures. Only a part of these areas is suitable for sugarcane and is economically and socially viable for biofuels, such as ethanol and biodiesel. The latter, comes in a great extent from soybean, which, unlike sugarcane, causes deforestation in the Amazon.

Ethanol extracted from corn is subsidized in the USA and, unlike in Brazil, where it is made from sugarcane it affects the price of corn which is reflected in other foods. The production of ethanol from corn requires fuel oil. The bagasse of sugarcane is more than enough to produce heat for the distillation of ethanol and generate electricity for the plant and there may even be a surplus for the power grid. Therefore, ethanol produced in Brazil is more efficient in energy and in environmental terms. The capture of CO_2 from the air in the growth of sugarcane approximately equals its emissions during its production and consumption. Consequently ethanol is suitable to replace gasoline in terms of preventing emissions of gases that contribute to global warming.

The international ethanol market will grow if rich countries remove the subsidies. The USA consumes a little more automotive ethanol than Brazil, but its the percentage within gasoline is low, because its consumption of gasoline is huge, which are 10 million barrels per day or about 580 billion liters (Bl) per year. The expectation is to increase this percentage to 20%. Considering 1.3 liters of ethanol for each liter of gasoline, that would be something like 140 Bl of ethanol per year, about 6 times more than the current Brazilian production of 23 Bl / year. There is a horizon of several years for that and Brazil could export more ethanol, but it is not reasonable to supply the whole market as other South American countries have also a role to play.

The topic of biofuels has caused criticism regarding its competition with food, but the response of President Lula was to clarify that sugarcane agriculture's energy does not interfere substantially in food production in Brazil for the reasons given above.

Renewable Energy in Latin America and the Caribbean



Jose Goldemberg

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Professor Jose Goldemberg is PhD in physics from the University of São Paulo of which he was the Principal from 1986 to 1990. He was President of The Energy Company of São Paulo (CESP), President of the Brazilian Society for the Advancement of Science, Secretary of Science and Technology, Secretary of Environment of the Presidency and Minister of Education of the Federal Government. He was a professor at the University of Paris (France), Princeton (USA) and occupant of the "Joaquim Nabuco Chair "at Stanford University (United States of America). He was member of the International Academy of Environment in Geneva (Switzerland). He is the author of numerous technical papers and several books on Nuclear Physics, Energy and Environment. Prof. Goldemberg currently works as consultant of the United Nations Development Programme.

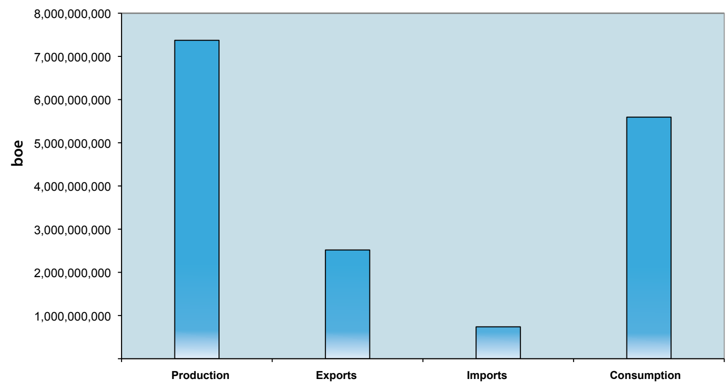
I - Introduction

Latin America as an entire region is self-sufficient in energy production and oil exports. Fossil fuels (oil, natural gas and coal) accounted for 74% of consumption in 2007, the remaining 26% are renewable sources (hydroelectricity, biomass, geothermal and others) and nuclear energy. In 2007, Latin America contributed with 4.9% to global CO^2 emissions. We will discuss here the structure of energy consumption in the region and the opportunities for increasing the participation of renewables in the energy matrix, mainly through more intensive use of hydro potential for electricity generation. This will open the possibility of reducing carbon emissions without reducing the availability of electricity.

II - The Latin American and the Caribbean Energy Matrix

The total primary energy consumption in Latin America and the Caribbean (AL&C) was 5,331,760,000 barrels of oil equivalent (boe) in 2007. The total energy produced in the region was 7,372,902,000 boe. The regions is an energy exporter with 2,517,998,000 boe (mainly crude oil and coal) and an energy importer with 738,798,000 boe, mainly of oil products.

Graph 1
Energy Production and Consumption in LA&C (2007)



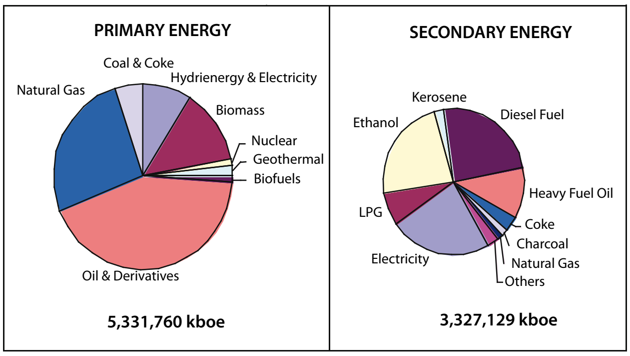
Initially, the implementation of more oil refineries with appropriate adjustments for oil products production would allow exporters to supply to energy importers, thus, making LA&C self-sufficient in fossil fuels, leaving room for further oil exports. This is a kind of integration relatively easy to achieve for this region.

There are eight energy-exporting countries: Venezuela, Colombia, Ecuador, Bolivia, Trinidad & Tobago, Paraguay, Mexico and Argentina. The other countries are importers.

Latin America and the Caribbean as a whole is self-sufficient in primary energy. Primary energy sources must go through processing (where major losses occur) before being consumed: oil goes through refineries to produce, kerosene, diesel oil, fuel oil and coke; oil, coal and gas are used to produce electricity, firewood is used as charcoal and there are non-energy uses of derivatives, such as the manufacture of plastics and fertilizers. These are considered secondary sources of energy.

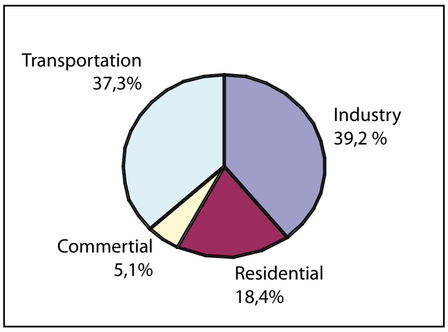
Graph 2 shows the structure of the primary and secondary energy sources in the region in 2007.

Graph 2: Sources of Primary and Secondary energy in LA&C (2007)



The sectors in which this secondary energy is consumed are shown in Graph 3. Industry is the main consumer closely followed by the transport sector.

Graph 3: Distribution of sectoral consumption of secondary energy in Latin America and the Caribbean (2007)



III - Production of Electricity

With respect to hydroelectric power, better planning of national networks and eventually the integration of networks of various countries could contribute much to the self-sufficiency and the reduction of local and global pollution.

Electricity accounted for 23% of total energy consumption in Latin America (759,253,000 boe) in 2007, of this amount 57% comes from hydroelectric power and 43% of thermal energy, with small contribution of nuclear energy.

What is surprising however, is that the installed hydroelectric capacity was only 19.9% of the hydroelectric potential of the region. Nine (9) are the countries with higher consumption which concentrate 95.6% of the hydroelectric generation in Latin America. The fraction of the hydroelectric potential used in Peru is only 5.2% and 40.1% in Venezuela. (Table I).

Table I
Electricity Potential and Generation in LA&C (2007)

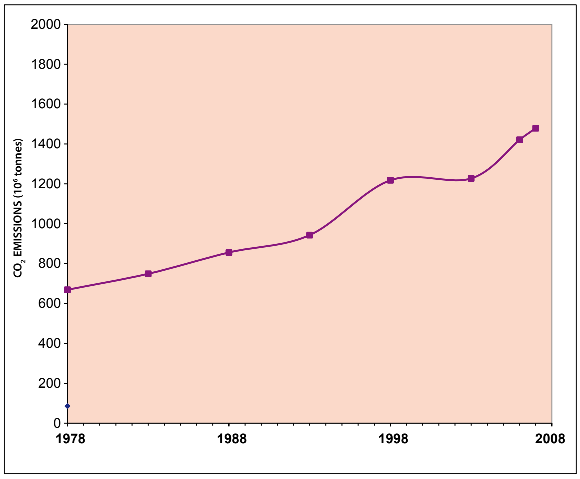
		TWh (2007)			
	%	Hydroelectricity generated	Hydroelectric Power	Thermoelectric power generation	Total power generation
Argentina	8,8	31,06	354,00	76,87	115,21
Brazil	25,1	374,38	1.490,00	58,80	447,54
Chile	20,7	22,80	110,18	35,70	58,51
Colombia	10,2	43,02	420,48	11,48	54,55
Ecuador	9,3	9,04	96,76	8,30	17,34
Mexico	11,6	27,04	232,14	185,81	232,55
Paraguay	98,0	53,71	54,82	0	53,71
Peru	5,2	20,03	385,118	9,91	29,94
Venezuela	40,1	80,81	201,48	29,29	110,10
Sub Total	19,8	661,89	3.344,97	416,16	1119,45
		95.3% of total	95.6% of total	85.6% of total	91.1% of total
Total AL & C	19,9	694,19	3.493,42	485,95	1.225,24

The rate of consumption of electricity in AL&C is increasing at around 4.0% per year which means it doubles every 17 years.

IV - CO_2 Emissions in Latin America

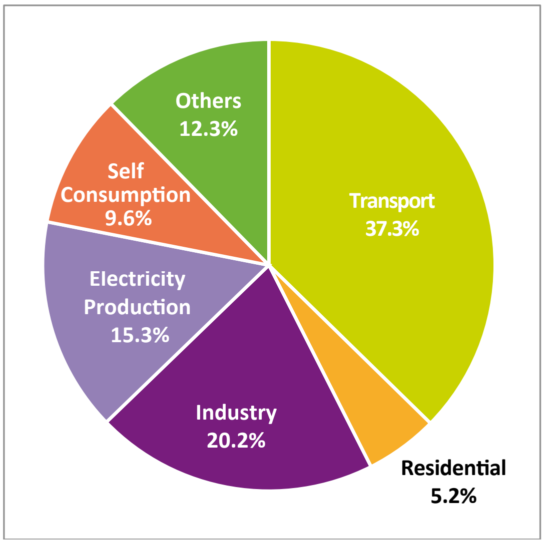
In 2007 LA & C countries were responsible of emitting 1,479,410,000 tonnes of CO_2, equivalent to 4.9% of global emissions. Emissions "per capita" of CO_2 is still low (3.26 tonnes CO_2/capita) compared with the developed OECD countries (10.08 tonnes CO_2/capita) but it tends to increase due to the economic growth of the region, and the significant increase in oil and gas production. Thermoelectric generation accounts for about 16% of CO_2 emissions.

Graph 4: CO_2 Emissions in Latin America



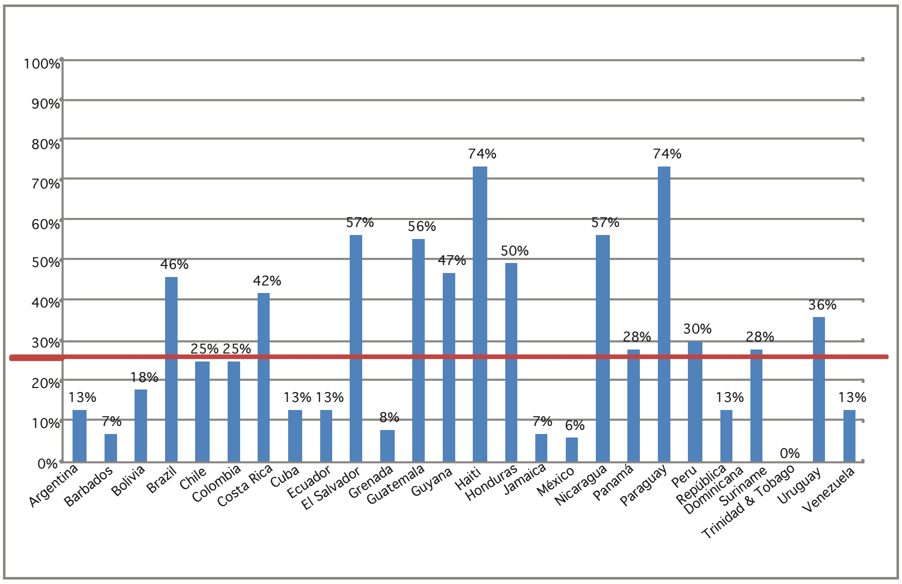
The main sectors that contribute to these emissions are shown in Graph 5. Following global trends, the transport sector is the one that contributes most to emissions. The use of biofuels locally produced, as already done by Brazil, Argentina and Colombia can reduce significantly such emissions.

Graph 5: Distribution of CO_2 emissions in LA&C (2007)



Graph 6 shows the fraction of the total primary energy coming from renewable sources ranging from 6% to 74% which shoes that great progress could be obtained to increase this fraction in many countries.

Graph 6: Renewable Energy Share in LA&C (2007)

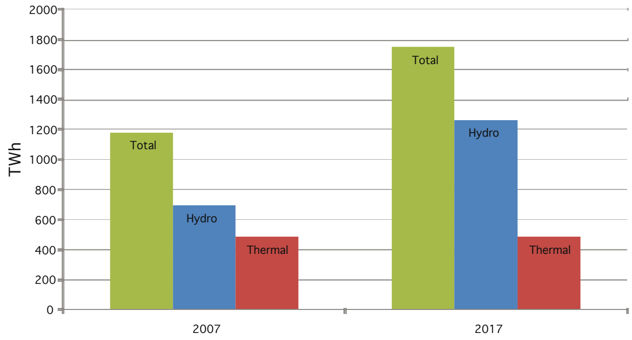


Note: Percentage Of Primary Energy Supply

An effective way of promoting economic growth without a significant increase in CO_2 emissions would be to increase the share of hydroelectricity in the generation of electricity and red uction of heat generation.

This could be achieved by increasing hydroelectric generation by 6% per year to doubling its contribution in 10 years as shown in Graph 7.

Graph 7: Electricity Production in LA&C



The adoption of this development strategy would not only reduce CO_2 emissions but also contribute to the reduction of local pollution that is inevitable when the electricity is generated with fossil fuels.

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Biomass, an underestimated energy resource in Latin America and the Caribbean

Dr. Alfredo Curbelo Alonso

Dr. Curbelo was born in Cienfuegos, Cuba, in July 1995. He is graduated in Physics in Moscow in 1979 and acquired the degree of Dr. Sc. in Technical Sciences in 1994. He began his career as a university professor at the University of Camagüey, where he was also Head of the Physics' Department from 1980 to 1992.
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He has been involved in several international projects, he was responsible for Cuba's sub-project GEF / UNEP SWERA (Energy Assessment of Solar and Wind power resources) and director of the GEF / UNEP / UNIDO "Production and commercialization of modern energy services in Cuba based in renewable energy. Case Isle of Youth "between 2002 and 2007. It is the focal point in Cuba for GEF / UNDP / CARICOM project "Program for development of renewable energy sources in the Caribbean".
He is currently senior researcher at the Center for Information Management and Energy Development (CUBAENERGIA) and head of R+D Program on "Sustainable Energy Development". As a researcher Dr. Curbelo is nowadays developing the theme of the use of renewable energy sources and particularly biomass. He specializes in biomass gasification technologies and designing technology solutions for heat and power production from lignocellulosic materials.

I - Introduction

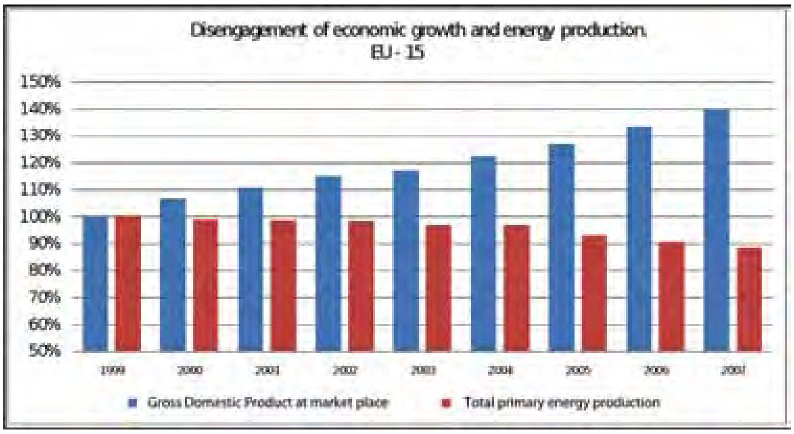
The analysis of the current energy situation is guided by the problem of global climate impacts due to the increasing greenhouse effect, the predictions of so-called peak oil and the energy geopolitics linked to the price volatility in conventional fuels.

This background has contributed to the maturation and transformation of the concept of sustainable development and energy security of an academic exercise to an analysis tool for projections in the energy field.

We can identify two basic and interrelated components to achieve the goals of sustainability: energy efficiency and renewable energy sources. Technological progress achieved in these fields has positioned cultural, political and economic subjects as major obstacles to full implementation.

European countries have been leaders both in increasing energy efficiency, (Graph. 1) as in the development of technologies for energy exploitation of renewable energy sources and its commercial introduction.

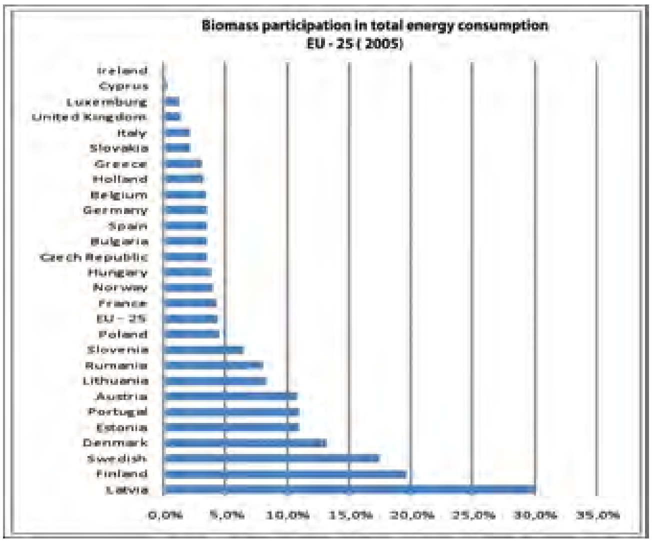
Graph 1



The European technological dominance in the field of renewable energy has led that 6 out of 10 companies that had 85% of world wind turbines' production in 2008, were European. In turn, Germany in that year carried out 23% of photovoltaic cells' world production (REN 21, 2009).

The use of biomass as fuel is no exception to these trends, and now it occupies an important role as an energy source in several EU countries (Graph. 2) (EUROSTAT, 2007).

Graph 2



Source: eurostat, 2007

The European Union established this importance declaring that "the use of biomass has many advantages over conventional energy sources and in relation to other renewable energy sources, in particular, particularly in lower costs, less dependence of the short-term weather changes, promotion of regional economic structures and the creation of alternative income sources for farmers "(CCE, Sept, 2005)

In this regard the Commission of the European Union adopted an Action Plan on Biomass (CCE, 2005), that identifies as major destinations using biomass as a renewable source: heat production, electricity and transport fuel. It is expected in 2010 to reach a biomass contribution equivalent to 75,55 and 19 million toe, respectively.

Latin America has more suitable natural and economic conditions to achieve higher penetration of biomass as a renewable energy source than Europe. This assertion could be proven using indicators like forest area and arable land per capita and per unit of primary energy consumption, based on database TERRASTAT FAO (FAO/AGL, 2003) and data of the International Energy Agency (IEA, 2009). It shows that the biomass production potential for energy related to land is at least two times higher in Latin America than in European OECD countries, as shown in Graph3.

However, in contrast with recognition of the role of biomass in the energy future of Europe, major regional agencies that deal with energy issues, are still allocating it a limited role. ECLAC in one of its researches (CEPAL, 2004) recognizes a renewed interest within the region to power generation using bagasse and other agro-industrial wastes. It discusses the conditions for using wood as a renewable source of energy, but restricting this use to household and local small industry sectors, and supports the production of biofuels for transport , promoting its development.

Meanwhile, OLADE, in "Energy perspective in Latin America and the Caribbean" (Luna, 2008) predicts a reduction in the role of biomass as energy source in the region. While, it recovered 14% of the energy demand in 2007, it would cover an 11% in 2018, despite a raise in liquid biofuels use from 1% to 3% in the same period.

Our intention is to show that within the region there is a significant potential to increase the participation of biomass in the energy matrix of Latin America and the Caribbean without competing with food production or provoking negative environmental impacts.

We are going to consider as biofuels to any fuel produced from biomass and not only liquid biofuels for transportation, as it has become a practice during the last time. In the analysis, we are going to assess only liquid biofuels production for transportation and solid biofuels from lignocellulosic materials for electricity and heat production.

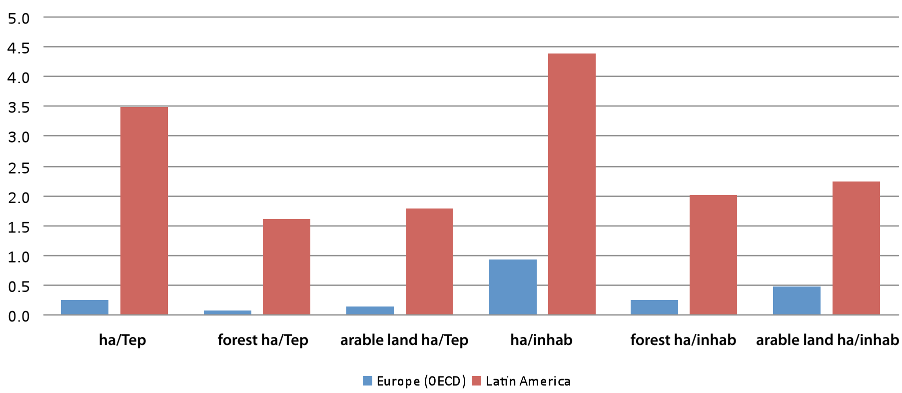
A basic assumption is that it is possible to utilize modern biomass energy technologies, already proven on a commercial basis in some regions or countries around the world.

By using the Energy-Economic Information System of OLADE, as a primary source of data, the Latin America and the Caribbean information is consistent with that of the countries included in SIEE.

Development

Nowadays the contribution of renewable energy sources that meets humankind energy needs, is relatively insufficient.

Graph 3: Land Forest Resource

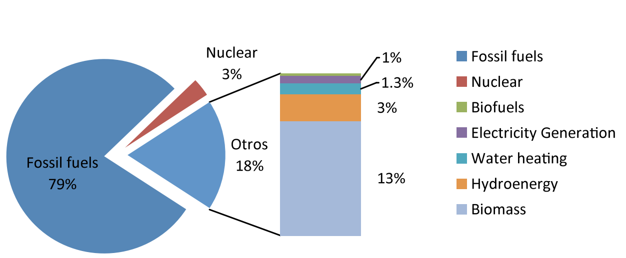


Sources: FAO/AGL, 2003; IEA, 2009

Assessment on the Global Status of Renewable Energies in 2007 (REN21, 2007), shows that the contribution of renewables to worldwide total energy consumption is focused on traditional biomass (13%) Graph 4. Biomass is called traditional biomass, mainly fuelwood, which its main use is estimated to be as the sole source of energy to approximately 2 billion people without any access to modern energy services. Next renewable energy sources contribution are by large hydroelectric plants and finally what is called new renewable energy technologies.

Graph 4

Global Final Energy Consumption 2006

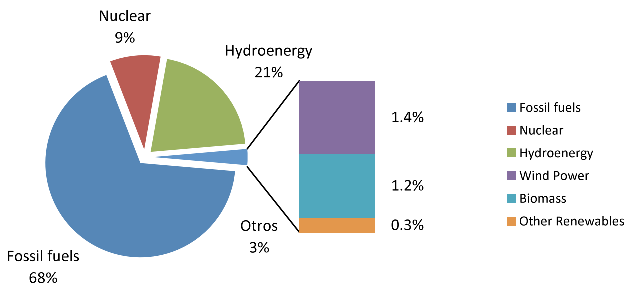


Source: Renewable 2007 Global Status Report REN 21

The participation of renewable energy technologies in globally electricity generation (REN21, 2007), is only a very modest 3% (Graph 5), with the predominance of wind power and biomass. Within the new renewable technologies for electricity generation are wind generation, solar photovoltaic and biomass as well as other technologies still in technology - commercial development.

Graph 5

Global Electricity Generation 2006



Source: Renewable 2007 Global Status Report REN 21

Projections on the participation of biomass and other renewable energy sources in the energy matrix

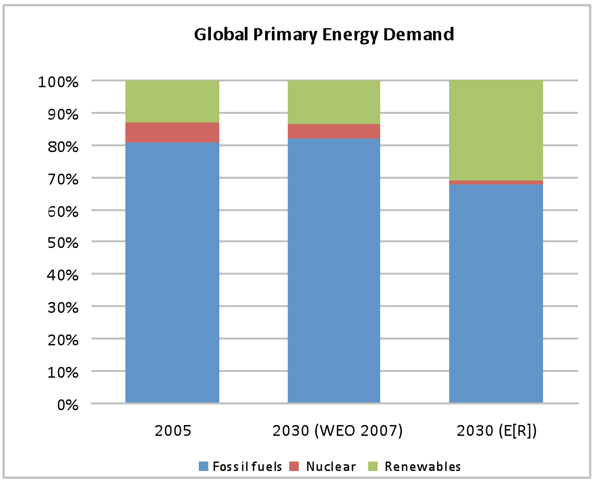
The projection of energy demand-supply and the participation of renewable energy sources has been evaluated by various bodies and specialized agencies about the basis of trends that reflect the overview of the authors.

An example of the differences in results to be obtained by modeling future energy scenarios from the same initial conditions are the World Energy Outlook 2007 (WEO 2007) (International Energy Agency, 2008) and the Energy [R] evolution scenario. While WEO 2007 is prepared on the basis of current trends, the second of these scenarios provides a radical change in energy development policy that is expressed in the successful implementation of five basic principles:

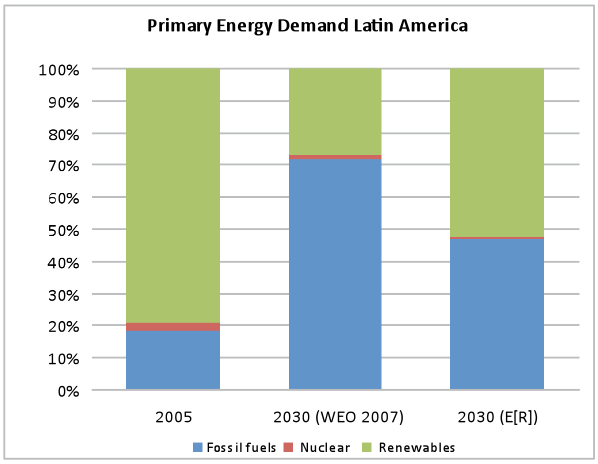
- To implement renewable energy solutions, especially through decentralized energy systems.
- To respect the natural limits of the environment.
- To replace polluting and unsustainable energy sources.
- To create greater equity in resource use.
- Decouple energy growth in consumption of fossil fuels.

In Latin America the share of renewable energy sources in primary energy demand is about 27% and it is higher than the global average that reaches 13%. When making the projection of this indicator to 2030, WEO 2007 keeps it at the same level, while the E [R] doubles it up to 53% (Graph 6 and 7).

Graph 6



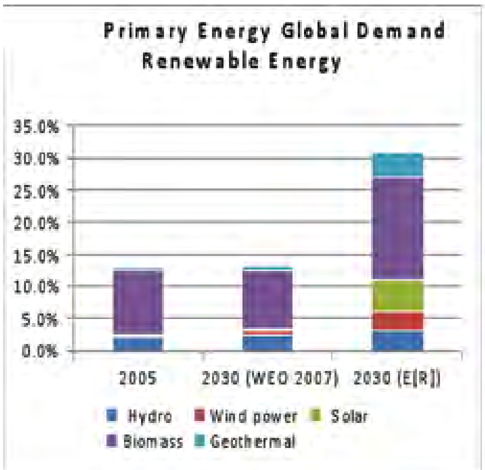
Graph 7



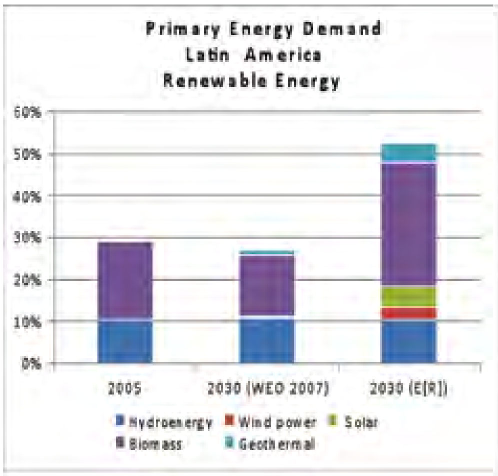
Source: WEO, 2007

Within the region, the share of renewable energy sources in primary energy demand is characterized by a contribution of hydropower and biomass higher to global average. The evolution of this structure provided by the E[R] is that the share of renewable energy sources is increased to 50% while maintaining the same share of hydropower, biomass contribution reach to 30% of the total primary energy supply, while WEO 2007 projects present a slight decrease of these contributions (Graph 8 and 9).

Graph 8



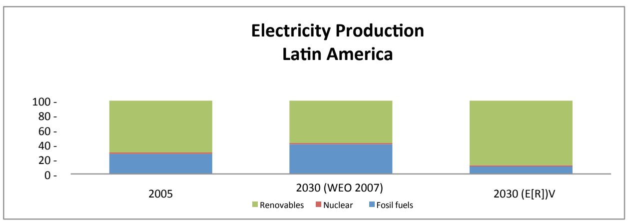
Graph 9



Note that the biomass in both scenarios and geographical scales is the main source of renewable energy to meet the demand for primary energy.

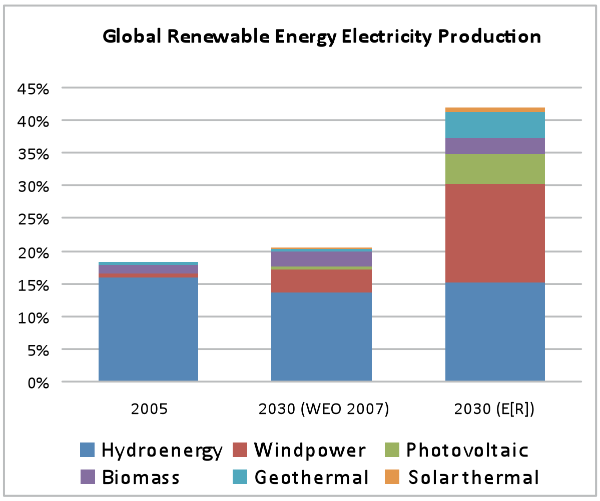
Electricity production in Latin America by renewable energy sources is currently very significant (Graph 10) since it meets 71% of the total. This Graph is almost four times higher than the global one (18%). While WEO 2007 projection reduces this share, E [R] continues to increase it up to 88% in 2030 in Latin America (Graph 10).

Graph 10

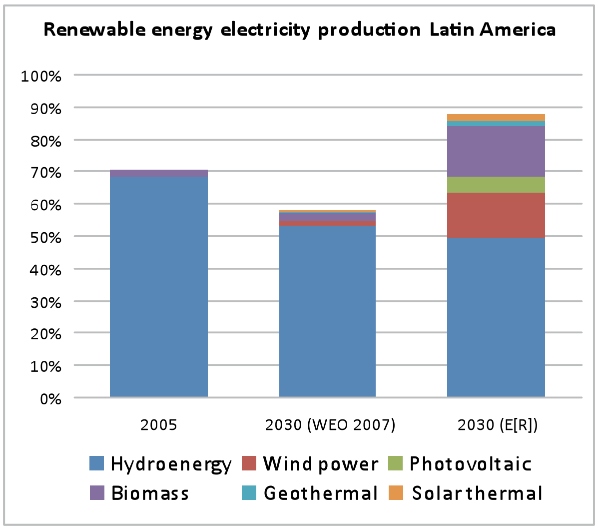


By projecting evolution of electricity generation using renewable energy sources, WEO 2007 research keeps the dominant role of hydropower, while E [R] introduces a significant increase in other sources. For Latin America projected growth is based on biomass (16%) and wind power (14%). (See Graph 11, 12).

Graph 11



Graph 12



Both scenarios show recognition of the potential of biomass as a renewable energy source in Latin America. The participation of biomass in primary energy demand increases in absolute figures respect to 2005 between 1.4 and 2.1 times, according to WEO 2007 and to E [R] respectively. The participation in power generation would be between 2.8 and 12.9 times higher compared to 2005 according to these models.

Opportunities for biomass as a renawable energy source in Latin America and the Caribbean

The opportunities of biomass penetration as an energy carrier in the energy markets in the region are different for electricity and direct use of fuels.

In Latin America (2007) 84.5% of fuels was directly used, which included 12.7% of biofuels, while only 12.7% is aimed to electricity generation (SIEE/OLADE).
A first step to identify opportunities for increased participation of biomass fuels in final energy consumption is the analysis of how the direct use of conventional fuels and alternative technological opportunities exist.

Five are the fuels that cover 85% of the total direct use. (Table 1).

Table 1

Major direct use fuels

Fuel	Participation of the total direct consumption (%)
Diesel Oil	27%
Gasoline/ethanol	25%
Natural Gas	20%
Liquefied Gas	8%
Fuel Oil	5%
Total	**85%**

Options for substitution of those fuels by biomass are primarily given by its final use. It is close related to final use sectors in which they are predominantly used. This analysis shows that over 80% of the use of these selected fuels is at most in two final use sectors as shown in Table 2.

Table 2: Distribution of consumption of major direct fuels by industry (percentage of fuel used by sector)

Fuel	TRANSPORT	INDUSTRY	RESIDENTIAL	AGRO,FISHING, MINING	Accumulated
Diesel Oil	76%			13%	89%
Gasoline/ethanol	99%				99%
Natural Gas		72%	16%		88%
Liquefied Gas		16%	67%		83%
Fuel Oil	18%	63%			81%

Let's analyze the replacing options from this concentional fuels to biofuels, considering the technologies that have already proven its technological and commercial feasibility at least in some regions of the world.

Diesel oil is mainly used in transport, agriculture, fishing and mining sectors.

The most attractive technological option for the replacement of diesel oil in the transportation sector is by using biodiesel. The replacement of the 20% of diesel consumed in 2007 in this sector requires an annual production of 15 million toe of biodiesel.

In the agriculture, fishing and mining sectors, the diesel oil is mainly used in furnaces, in small and medium capacity steam boilers and in internal combustion engines. We are going to focus on diesel oil replacement by biomass in steam boilers and furnaces using biomass gasification technologies (Berkes) and solid biofuel burners. In the absence of more detailed statistics on the final use of this fuel, it is estimated that 70% of diesel oil is used in furnaces and boilers and 50% of this amount could be replaced. Under these conditions, it would be necessary to produce and commercialize solid biofuel equivalent to 7.5 million ktoe annually.

The analysis of gasoline substitution is simpler. It's because, it is used as fuel only in internal combustion engines used for automotive transportation. In this case, the replacement options are ethanol gasoline mixtures. We will assume a 100% gasoline substitution in the region by a mixture containing 10% ethanol. Annual production of ethanol required for this purpose is equivalent to 17 million toe.

Natural gas, due to its price and features as fuel, will not be considered as a candidate to be replaced by biomass.

The main use of liquefied gas is at the residential and industrial sector. In the residential sector it is primarily used as fuel for cooking and today, the replacement of this gas by biomass-related technologies is not possible. Its use in the industrial sector is focused on furnaces and boilers. We are going to estimate that 90% of liquefied gas is used in those equipments, and the goal is to replace 20% of it by wood gas produced through biomass gasification technologies. The annual amount of solid biofuel required to introduce it in the market is 0.26 million toe.

Finally, fuel oil is predominantly used in industry as fuel in large boilers and furnaces industry sector. To estimate the replacement potential in this area, we will assume that 90% of fuel oil is used in furnaces and boilers and its 50% replacement it's been considered. Under these conditions, the production and marketing of 5.2 million toe of solid biofuel it's required.

Summarizing, substitution of conventional fuels requires two groups of biofuels: liquid fuels for transportation and lignocellulosic solid fuels for use in furnaces and boilers. Solid biofuels would be mainly trades as wood logs, pellets and briquettes.

In the case of replacing diesel oil by biodiesel, it is assumed the replacement of all diesel consumed in the region by a B - 20 mixture (80% diesel oil, 20% biodiesel). As for gasoline it is also assumed the replacement of all consumed gasoline by a 10% ethanol mixture. Liquid biofuel requirements under these conditions are summarized in Table 3.

Table 3

Replacement of direct use fuel in transportation

Fuel	Replacement at	Blend	t	ktoe	
Diesel Oil	100%	20%	19,620,311	18,835	biodiesel
Gasoline	100%	10%	24,476,417	17,327	ethanol

The estimated fuel solid lignocellulosic demand for replacing direct fuel use is very complex due to the lack of information on its final use in furnaces and boilers. Table 4 reflects the criteria used and the resulting demand for achieving the replacement rate raised.

Table 4

Direct use conventional fuel substitution in steam boilers and furnaces by sector.

	INDUSTRY		AGRO, FISHING, MINING		DEMAND OF SOLID BIOFUEL	
Fuel	Used in furnaces and steam boilers	Rate of substitution	Used in furnaces and steam boilers	Rate of substitution	ktoe	Thousand of t
Diesel Oil	70%	50%	70%	50%	7,503	24,758
Liquefied Gas	90%	20%			266	877
Fuel Oil	90%	50%			5,279	17,419
Total					13,047	43,054

As for electricity generation, the hypothesis is to annually produce 10% of 2007 electricity consumption based on biofuels, which is 122,000 Gwh.

The technological parameters used to calculate the solid biofuels demands are:

- Power generation energy efficiency: 25%
- Biofuel consumption rate: 1 tonn/MWh
- Technical availability: 90%
- Technologies: Thermo Power Plants (Power unit capacity higher than 20 MW) and biomass gasification plants (Power unit capacity no higher than 1.5 MW)

(Dassapa, Paul, Mukunda, Rajan, Sridar, & Shridar 2004).
The biofuels demand to reach replacement levels raised are reflected in Table 5.

Table 5

Demand of biofuels		
Biofuels		Amount (thousand t / year)
Solid biofuel	For heat	43,054
	For power	178,578
	Total	221,623
Ethanol		24,476
Biodiesel		19,620

Liquid biofuels production:

Biodiesel production:

Potential competition for agricultural land use due to vegetable oil production vegetable oil for biodiesel, forces us to consider solutions to avoid this conflict. An attractive option is Jatropha curcas L, oilseed native species from Central America and the Caribbean. There is a growing interest in Central America on Jatropha curcas L to produce biodiesel, but the wider experience is in Asian countries (Siang, 2009).

National Biodiesel Mission is a national program in India (Varghese, 2008), with a government budget of about $ 376 million to develop 400,000 ha of Jatropha curcas L, to achieve 20% replacement of diesel consumption by 2012, based on 43 million hectares of unused land.

The government of Indonesia has promoted a program to achieve by 2015 the production of 15 million tonnes of biodiesel from Jatropha curcas L using 3 million ha of land (Wirawan & Tambunan, 2006).

It is reported that this species reaches average yields of 1.3 oil tonnes per ha which is below 1.5 tonnes/ha suitable for marginal lands (Saxena,2006) by using land that does not allow food production in it due to its low productivity and lack of rain. (Falasca & Ulberich, 2008), (Jongschaap,Corre, Bindraban,& Brandenbueg, 2007). Under these assumptions it is necessary to have in production about 15 million ha of land with the above mentioned characteristics to achieve the production volumes listed in Table 5.

The assessment of the availability of such quantities of soil is performed using the FAO data (FAO/AGL, 2003). According to this source, the required planting area could be selected out of several land categories described in Table 6.

Table 6: Eligible land for Jatropha curcas plantations

Category	Total	Área (millions ha)	Share that represent 15 million ha for biodiesel (%)
Very severe degradation	Total	96	16%
	Due to agricultural activities	31	48%
Severe degradation	Total	416	4%
	Due to agricultural activities	149	10%
Dry lands	Dry subhumid	182	8%
	Semi arid	105	14%

While it is true that besides those general soil conditions, other more specific soil and climate conditions must be met for the selection of lands for plantation. Data in Table 6, indicates that the availability of land is not a constraint to establish 15 million ha of Jatropha curcas L plantations in the region.

Ethanol Production

The use of the blend of ethanol and gasoline as fuel in internal combustion engines has been a proven technological solution for many years in Brazil.

In ethanol production, there are two different well-defined stages with specific indicators of productivity: the agricultural phase characterized by the yield of tonnes of sugarcane per hectare and the industrial phase whose performance indicator are the liters of ethanol per tonnes of processed cane. The combination of both indicators produces the index that shows the efficiency of the entire production cycle: production of ethanol per ha.

The industrial performance depends on technological schemes used for the production of ethanol. It could be produced by depletion of molasses in the process of sugar production, affecting or not the production of sugar, or directly from cane juice without sugar production. It is recommended as benchmark performance a production rate of 8.6 l / tonnes sugarcane in the case of molasses depletion C, technological process that is implemented in distilleries annexed to sugar mills and 80 l / tonnes cane when it occurs directly from sugarcane juices in autonomous distilleries (Nogueira, 2007).

Most of the manufacturing facilities engaged in ethanol production in Brazil include distilleries annexed to sugar factories (about 60% of total), followed by a large number of autonomous distilleries (about 35%) and a few factories exclusively for sugar production.

A useful indicator to estimate the potential of ethanol production in the region is the average ethanol production per area planted with sugarcane. The area planted with sugarcane in Brazil in 2006 was 7.08 million ha (FAO/AGL, 2003). There were harvested 5.4 million ha and 55% of harvested sugarcane was for ethanol production (BNDES - CGEE, 2008), producing 17.7 billion liters (UNICA / MAPA, 2008). With that information we find that country average rate of ethanol production is 3.5 tonnes / ha.

The total sugarcane planted area in the region after excluding Brazil is 3 million ha (FAOSTAT). Using this area with the same productivity as Brazil did in 2007 the production capacity of the rest of the region would be 10.5 million tonnes of ethanol.

To produce 12.2 million tonnes of ethanol annually required for all gasoline market in the region with a composition of 10% ethanol, it would require an additional production of 1.7 million tonnes of ethanol. The most rational way for this increase is the scheme of autonomous ethanol distilleries with a a rate of 4.1 tonne/ha, considering a yield of 75 tonnes of sugarcane per hectare.

Under such conditions it is required to plant an additional area of 410, 000 ha of sugarcane. It means 14% increment of sugarcane planted area in the region, excluding Brazil. The potential land area in the region for this crop cultivation is estimated at 75.8 million ha, which is reduced to 46.0 million after excluding Brazil (Carlos Razo, 2007). Thus, the area dedicated to sugarcane in the region, excluding Brazil, to ensure the production of ethanol would be of 3.5 million ha. A Graph below shows the above mentioned potential.

Electricity cogeneration in the sugar industry

Widespread introduction of cogeneration in the sugar industry has significant potential in the region. The amount of electricity that can be delivered to the grid depends on several key factors: parameters for generating steam, steam consumption rate for sugar production and a possible use of a second fuel in addition to bagasse for power generation in the after harvest period.

A study about the potential for cogeneration using conventional technologies in sugarcane industry conditions of Brazil (BNDES - CGEE, 2008) shows that the supply of electricity to the grid can vary between 10.4 and 153 kWh / tonnes of sugarcane, depending on technological parameters.

Assessment of the potential capacity of cogeneration in the sugar industry of the region is based on next criteria:

- Along with the development of ethanol production is introduced power cogeneration in the sugar industry.
- Two technological schemes are considered for power generation:
  - A medium efficiency scheme that allows delivering to the grid of 25.4kWh/tonne of sugarcane with parameters: temperature and steam pressure 42 bar, 450°C and steam consumption in the industry of 500 kg steam/tonne of sugarcane.
  - A high efficiency scheme that allows delivering to the grid 57.6 kWh/tonne sugarcane (Dasappa). Paul Makunda, Rajan, Shridar,& Shridar, 2004) with parameters of steam pressure and temperature of 65 bar, 480°C and steam consumption in the industry of 500 kg steam/tonne of sugarcane.
- Development of power cogeneration capacity is based on equal share of both technological schemes.

The solid biofuel production in LA&C was 707 million tonnes (FAO/AGL,2003) in 2007 that would allow a power generation of 30,300 Gwh per year under described conditions.

In the case of additional areas of sugarcane for ethanol production (410,000 ha) mentioned before, new autonomous alcohol distilleries would be integrated with high efficiency power plants. It would allow delivering to the grid 71.6 kWh / tonnes of sugarcane with parameters: steam pressure and temperatures of 65 bar and 480°C and a steam consumption in the industry of 350 kg/tonnes of sugarcane. This power cogeneraration capacity would produce 1,600 Gwh per year.

In conclusion, the sugar industry in the region would be able to deliver 32,000 GWh.

Solid biofuel production:

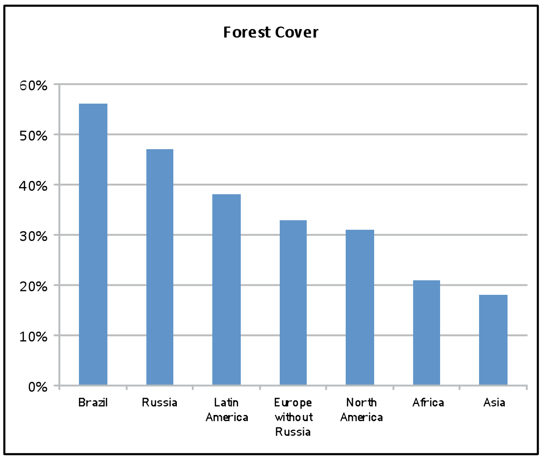
Forestry and wood industry is a source of biomass for energy that is extended across Latin America. The industry of sugarcane, that is also a significant source of solid biofuel, is already evaluated in the previous section for power generation.

The contribution of Latin America and the Caribbean to the world's forests is significant. Its forestry area represents 22% of the forests on the planet, only after Europe that represents 25%, as it includes the Russian Federation which alone accounts for 20% of forestry area. (FAO, 2005).

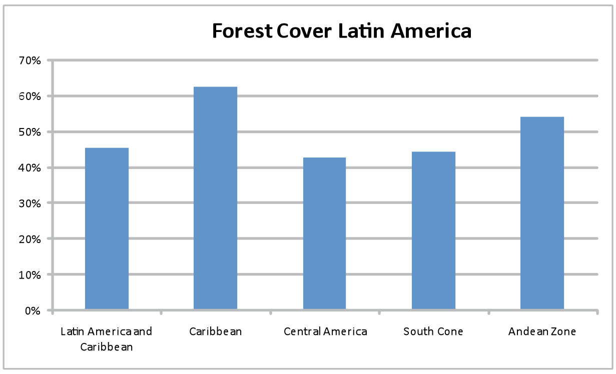
In Latin America, Brazil is the most relevant country in relation to forest areas. It has 56% of the forest area in the region. However, the rest of the region also occupies an important place in this indicator with 38% of its forested area, behind of Brazil and Russia (47%) (See Graph 13).

The distribution of forest areas in Latin America is relatively uniform as shown in Graph 14. Only the Graph obtained for the Caribbean may seem distorted, but it is because Surinam and Guyana joined to this sub region. These countries have a forest area over 70% and a land area larger than most Caribbean countries.

Graph 13



Graph 14



The main sources of forest biomass to produce solid biofuels in forestry are: wood of no commercial value obtained by forest thinning, residues from timber production processes and industrial forest plantations, established for energy purposes (energy plantations).

Average biomass annual increment in the forest of the region can be estimated in the order of 5 tonnes of biomass / ha.year (D.O. Hall). The forest area of the countries included in the SIEE statistics, is 860.3 million ha that would annually produce 4.3 million tonnes of biomass.

The annual removal of roundwood in the region is estimated 283 million cubic meters and fuelwood 286 million cubic meters (FAO, 2005), representing only 6.6% of the annual increase in forest biomass.

The potential contribution of these forest products are the residues from industrial processing of roundwood and the surplus of fuelwood that could be obtained if energy efficiency appliances that use this fuel would be increased.

It is estimated that 50% of industrial processed roundwod in the region becomes residues. In this study is assumed that 40% of these residues would be transformed in solid biofuel, which means a contribution of 23.8 million of tonnes of biofuel annually.

In the case of fuelwood, there are experiences that show the possibility to increase energy efficiency up to 70% in final use devices of this fuel. In this study, we have considered that by implementing this type of measure it could released 30% of fuelwood consumed currently and that 50% of this amount is traded as solid biofuel, which means a contribution of 20.5 million tonnes.

For the calculation of forest logging residues, which are those that remain in the field while performing the extraction of wood for commercial purposes, it is used the criteria described in (Anttila, Karjalainen, & Asikainen, 2009). These authors believe that these residues are between 5% and 15% of the volume of roundwood that is removed from the forest area. We have used in this study a rate of production residues of 10% and consider that 60% of residues are transformed into solid biofuel. In these conditions, the production of solid biofuels reaches 17.1 million tonnes per year.

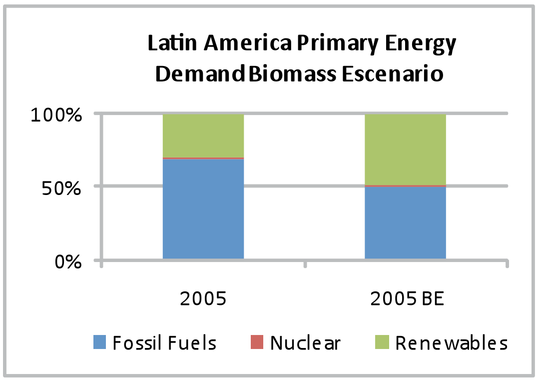
The production of 61.4 million tonnes of solid biofuel from considered sources, would meet the demand of 43 million tonnes to replace conventional fuels in heat production (Table 5) and to generate 18,800 Gwh at biomass power plants.

To produce with biomass the 10% of electricity generated in 2007, it is necessary to generate 71,300 GWh in addition to those generated in the sugar industry and forestry residues. To this end, it would be necessary to produce additionally each year 69.5 million tonnes of solid biofuel. The sources of biomass to cover this demand would be new forest plantations designed especially for this purpose. The assessment of these plantations is based on: an annual growth rate of 20 tonnes/ ha.year, a rotating period of 7 years (FAO, 2001) and that it is transformed to solid biofuel 75% of produced forest biomass. Under these conditions the area of energy plantation required to generate 71,300 GWh annually is 32.4 million ha. The area of primary forest in the region is estimated to decrease by 31.3 million ha (FAO, 2005) during the last 10 years.

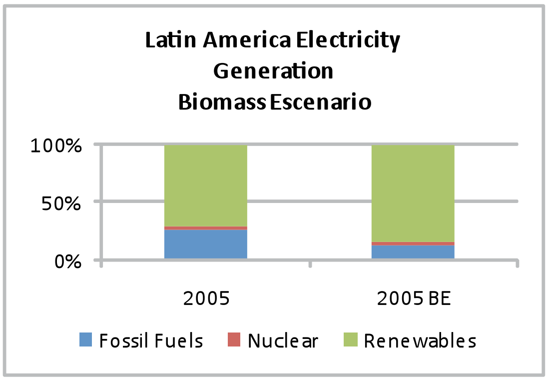
Summary of biofuels' supply - demand

Participation of renewables in primary energy demand (Graph 15 and 16) would be increased from 29% to 49% and in electricity generation from 71% to 84% according to 2005 data. (GPI/EREC, 2008) if the above mentioned goals were achieved.

Graph 15



Graph 16



Due to the nature of this study and the difficulties of a detailed analysis, there were not included as potential sources of biofuel resources as: municipal solid waste, organic material for biogas production, agro-industrial and harvesting waste, etc. These sources of biomass are not considered a reserve to meet the goals described.

A summary of evaluated sources of biofuel is shown in Table 7.

Regardless of this figures, biomass could play a much more significant role in the energy balance of the region. It could be reduced if some other type of biomass would be included in the analysis.

The progress in harnessing the opportunities of the development attained by the energy technologies and the potential for biofuel production in the region is a process influenced by factors such as:

- The stakeholders' understanding of the economic, social and environmental advantages when increasing participation of renewable energy, and particularly biomass
- The political will to create an appropriate legal and regulatory framework
- The consolidation of new energy paradigms:
  - distributed generation of electricity
  - energy decentralization
  - increased local participation in

Table 7

Biofuels' Supply and Demand

Biofuels		Annual Demand (thousand tonnes)	Source of supply
Solid Biofuels	For heat	43,054	Source of biofuels: • 40% of waste from the forestry industry • 15 % of current production of fuelwood • 60% of logging residues
	For Electricity	178,578	Production of solid biofuel from logging residues to produce 15% of biomass power. Expansion of cogeneration in the sugar industry, achieving to produce 25 % of biomass power. Establishment of 32.4 million hectares of energy plantation to produce 60% of biomass power. It is similar to recover lost area of primary forest during last 10 years.
	Total	221,623	
Ethanol		24,476	Updating of the region's sugar industry to the average performance of Brazilian industry. Expansion of sugarcane plantations by 14% (0.4 million of ha).
Biodiesel		19,620	Plantation of 15 million hectares of Jatropha curcas on lands unsuitable for food production

meeting energy demand
- implementation of efficient markets for solid biofuels, among others.

Analysis of the international experience shows that achievements of most developed countries in the use biomass as renewable energy source are based on its revalorization as a modern energy carrier.

Rational development of the biomass energy potential in the region will be possible only if it is abandoned the view that biomass is a second-class fuel, and instead we adopt a modern and contemporary approach to its development as one of the mainstays of energy, social and economic development of Latin America and the Caribbean countries.

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Aspects of Environmental Sustainability of Ethanol Production in Brazil: Technologies and Practices

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The interests of Dr. Gomes are related to renewable energy sources, energy efficiency, energy and environmental policy, and science and technology policy.

Abstract

The article aims to provide a kind of SWOT analysis to assess the environmental sustainability aspects of the production of ethanol in Brazil. SWOT analysis is often used to inform decision makers and the critical determinants of a particular situation under study. It aims to reduce uncertainty and to assist in formulating strategies explaining the factors that may influence the success of a project. Known impacts are recorded in seven environmental factors, considered the most critical for the expansion of cultivation of sugarcane in the country, air quality, water resources, biodiversity, soil occupation, soil preservation, agricultural use of pesticides, and use of agricultural fertilizers. We conclude that there has been progress toward sustainability improving aspect however, new agricultural practices and technologies that minimize the use of water and effluents are required.

Introduction

The development and use of biofuels, especially ethanol and biodiesel have acquired great importance not only in Brazil but also internationally. The European Union has set ambitious targets to create a market for biofuels to reduce its dependence on imported fossil fuels and as part of its strategy to meet the goals of the Kyoto Protocol. Japan and USA also have ambitious plans to replace part of its demand for gasoline with ethanol (Doornbosch and Steenblik 2007).

Brazil has a successful experience over thirty years in developing a domestic market for ethanol produced from sugarcane. During this period

1 ***The author would like to thank the support received from agencies FAPESP and DAAD for partial implementation of this work.***

it were developed agricultural and industrial technologies, varieties of sugarcane which, together with public policies and regulation resulted in the creation of a final product very competitive with gasoline (Macedo 2007, Goldemberg et al. 2004, Goldemberg, Coelho, and Lucon 2004) .

The Brazilian ethanol is able to replace gasoline with significant environmental benefits, avoiding the emissions of 2,6-1,7 t CO_2/m^3 ([2]) and a current value of 8.3 times more energy produced (renewable energy in ethanol) than the fossil fuel energy input, calculated on basis of the life cycle of ethanol (Macedo, Seabra, e Silva 2008).

A large expansion of sugarcane - ethanol is aimed to be planted in Brazil and other regions, especially given the positive balances of carbon and attractive international prices when considering the alternatives to fossil fuels. At the same time, it is a growing concern with issues of socio-environmental sustainability of these systems. Several studies have shown different impacts on local biodiversity, use of water resources use and soil erosion, air pollution, among others (Macedo 2005, Doornbosch and Steenblik 2007).

The dimension of social-economic and environmental impact of an expansion plan as expected will be huge. In Brazil, the cultivation of sugarcane besides of being a potential generator of renewable energy contributing to the replacement of fossil fuels and developing a promising scenario of Agro-Energy, is also known as a major transforming agent of the regions where it operates. An expansion of ethanol production on the required scale might cause various types of regional impacts, whether direct or indirect (Sparovek et al. 2009). The cumulative effects over the years, including increased population, introduction of services in infrastructure, trade and industrial activities are also effects that should be considered in an assessment of sustainability, as they are arising from the main activity that are outlined for the regions where the production should occur (Sparovek et al. 2007).

Understanding The Problem

The concern with the growth of the importance of biofuels in general and ethanol in particular has encouraged the interest in ways to ensure that best practices and technologies are being employed to maintain the quality of fuel and reduced environmental impact. Environmental certification processes have been discussed recently by several authors. In addition to the technical parameters of quality it is increasing the incorporation of socioeconomic and environmental aspects of production.

Recently several efforts are being deployed to establish criteria and indicators for certification with concerns about the sustainability of biofuel production (Smeets et al. 2006; Delzeit, Bohle, and Holm-Müller 2007; Delzeit and Holm-Müller 2009, Lewandowski and Faaij 2006). Some of these studies seek to develop or propose a variety of criteria and indicators from existing certification systems, or are incorporating some special features according to different interests. The emergence of commercial trades of ethanol also led to new formulations of indicators of biofuels sustainability. International trade has somewhat tried to do efforts to harmonize procedures for environmental certification (Dehue, Meyer, and Hettinger 2007) and even the harmonization of technical standards (Anon. 2007).

This paper examines the current state of technologies and practices in use in Brazil related to the ethanol production chain and its environmental impacts. The objective is also to point out opportunities for improvements to ensure greater sustainability for the production expansion of such fuel, taking also into account the cumulative effects over time.

The approach of a SWOT analysis is adopted, as it will be detailed below to summarize the state of the existing knowledge. Initially the concept of sustainability and the limits assumed for this analysis will be better discussed.

The Concept of Sustainability

An analysis presented by various technicians shows several solutions that can contribute to the achievement of the proposed production targets. Many of these solutions are technically and / or economically viable within the envisaged timescale. The environmental impacts can be assessed from the perspective of the technician. However, an initiative such as the large-scale production of a biofuel such as ethanol, with profound implications for regional development, should also recognize the necessary coverage for the concept of sustainability.

In a way the responsibility of the technician is limited in the sense that he is responsible for the scientific legitimacy of the solutions suggested, but not for the implementation of strategies and their impacts on socio-environmental context. But the decision-maker or the formulator of public policy has this function and responsibility. The decision process at this level requires qualified and timely information to examine the implications and acceptability of decisions. The concept of sustainability must incorporate all these dimensions.

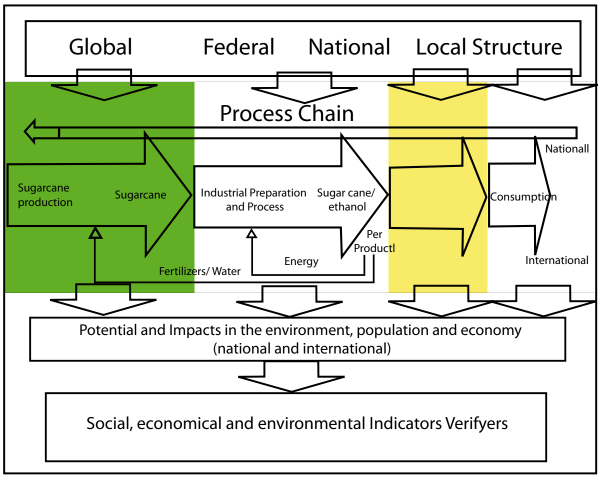
Sustainability is a normative concept, including values, perceptions and preferences prior to a technical or scientific analysis (Omann 2000). There are several ways to define concepts and consequently indicators to assess sustainable development (Meadows 1998, Bell and Morse 2003; Bossel 1999).

The analysis developed here is restricted only to

2 Figures for the production of the central-south of Brazil and for anhydrous and hydrated ethanol respectively.

the scope of technical solutions and processes and their environmental impacts for ethanol production. Graph 1 shows the outline of the production and use of ethanol. The different stages of the process have potential social impacts, as well as economic and environmental. Several indicators and criteria may be chosen to monitor and evaluate the potential effects of the activities involved. Applies to the SWOT analysis only to the portion called "chain of process" of Chart 1.

Chart 1: Sustainability Analysis of the Production, Distribution and Use of Ethanol



Source: R. Delzeit e K. Holm-Müller 2009

Within these limitations, this effort is to evaluate and organize information and analysis prepared according to the perceptions of environmental impacts that are potentially presented for Brazil. This type of analysis may be useful to distinguish the solutions shown in the different degrees of impacts perceived by technicians and contribute to the decision-making process and possible strategies for implementing the expansion of ethanol production.

SWOT Analysis of Sustainability of the Production Expansion

SWOT analysis is often used to inform decision makers of the critical determinants of a particular situation under study. It aims to reduce uncertainty and assist in formulating strategies explaining the factors that may influence the success of a project.

It is a fairly simple type of analysis, developed originally within the corporate environment and currently being used in the formulation of public policies and studies of Strategic Environmental Analysis (see, for example, Domingos (2006)).

SWOT is an acronym for four groups of characterizations that seeks to analyze a problem or situation. It means: Strength, Weakness, Opportunities and Threats. SWOT analysis applied to this case for expansion of the ethanol production in Brazil includes the features that add "strength" or benefits observed with respect to lower environmental impacts (S), points of weakness and that can harm the environment in relation to the current situation, (W) opportunities that are offered by the expansion of production according to the alternatives offered (O); finally the possible threats (T) that can compromise the environment if these actions are implemented.

It is important to emphasize that the environmental and social issues, including food security should not be treated separately but simultaneously. The problems which ecology deals with, not only affect the environment but also human beings and vice versa (Gadotti, 2000). Ferraz (2007) conceptualized that a environmental commodity pled by ethanol, "is one that works closely with social and environmental issues." This SWOT analysis examines only the environmental impacts, recognizing its restriction by being necessary to override the analysis of social issues involved.

The "Environmental Factors"

All SWOT analysis presented here is performed in accordance with 7 environmental factors, considered the most critical for the expansion of cultivation of sugarcane in the country, such as:

AIR QUALITY

Air quality is the term that is usually used to translate the degree of air pollution of local and global impact and weather features such as air humidity. The sources of air pollutants are numerous and variable and may be anthropogenic or natural.

In the case of producing sugar and ethanol, air quality concerns, for example, the practice of burning the sugarcane and the emissions resulting from the use of fossil fuels in the preparation of land, harvest, transport to the mill and disposal of ethanol and sugar production, for example.

WATER RESOURCES

All the water that can be used for consumption and production in a place and in a period of time is called water resources. It can be found on the surface, such as rivers, lakes and springs or under it, in underground water.

BIODIVERSITY

Biodiversity is the term used to define the variability of living organisms, flora, fauna, macroscopic fungi and microorganisms, encompassing the diversity of genes and populations of a species, species diversity, the diversity of inter-relationships, or ecosystems, in which the existence of a species directly affects many others.

LAND USE

The process of land use and occupation is the spatial representation of the production system for goods and cultural development of men. This system aims to meet the basic needs of human beings.

The environmental impacts relate primarily to the adulteration of the natural environment from the total and indiscriminate removal of native vegetation and even staple crops, to apply the new technology of land preparation and harvesting through mechanization, for example.

SOIL CONSERVATION

It is understood as the maintenance and improvement of its productive capacity.

The non-compliance with correct practice of land use and soil preservation, puts at risk the agricultural land that is the basis for agriculture, causing loss of land far beyond the tolerable levels. Loss of nutrients and organic matter, changes in texture, structure and falls in the infiltration rates and water retention are some of the effects of erosion on soil characteristics. Soil compaction due to mechanization of agriculture reduces and even disables the soil for retaining nutrients, water and prevents growth vegetation.

USE OF AGRICULTURAL PESTICIDES

The agricultural pesticides are insecticides, herbicides, fungicides and other for pests control that attack crops. However, these substances can reach the ground water which makes it toxic for most of the human beings.

USE OF FERTILIZERS

Compensation for the loss of nutrients, is usually made by replacing industrial fertilizers in the soil. The leaching of fertilizers pollutes the soil and water bodies or areas of water recharge.

The nitrate, a fertilizer component, is found in groundwater due to high rates of leaching occurred mainly in soils under continuous cultivation, supported by application of large quantities of inorganic fertilizers, and more recently, organic.

RESULTS

IMPACTS ON AIR QUALITY

Impacts on air quality of areas of sugarcane planting are more closely related to the burning of sugarcane and the use of fossil fuels (mainly diesel) in agricultural practice (tillage of the land, planting, harvesting and transport) and in the transport of ethanol.

STRENGTH

Legislation

There is legislation to control and ban the practice of burning sugarcane.

At national level, the Decree no. 2661, of July 8, 1998, provides among other measures, the gradual elimination of the employment of burning the sugarcane fields where the industrial harvesting is technologically possible. It mandates a reduction of at least 25% of the area (slope less than 12%) for each period of five years starting since 1998. Additionally, it states that a controlled burning should be previously authorized by the body of the National System of Environment (SISNAMA) with activities in the area where the operation will take place. Therefore, the decree states that in 2018 there will be the end of burning at 100% of harvesting areas in the country.

In the state of Sao Paulo[3] there is a legislation to control fire and a deadline to end that practice by replacing it with the mechanized harvest (unburned cane). The suspension is mandated by state law 11,241 of 2002, which determines the gradual elimination of burning cane fields in mechanizable areas (with slope of up to 12%) by 2021 and in the non-mechanizable areas (slope above 12%) by 2031. For the schedule in 2006, the burning of 30% of mechanizable areas was vetoed.

Recently, the government of the State of Sao Paulo signed the Agro-environmental Protocol with UNICA[4] to reduce the timeframe from 2021 to 2014 in mechanizable areas and from 2031 to 2017 in non-mechanizable areas. Currently 80% of the mills from Sao Paulo joined the Protocol, since the adherence to protocol is voluntary. In harvest season 2008/2009, 49% of the harvest occurred without burning (SMA, 2009).

WEAKNESS

Burning Of Sugarcane

The burning of sugarcane is an environmental and public health problem. The practice is ancient and widespread in the producer states, being used to increase the productivity of labor in harvesting and reduce transportation costs. About 51% of the harvest is manual in the State of São Paulo, that is responsible for 60% of national production, which requires the burning of the cane.

As environmental problems, the air pollution by gases and soot, destruction and degradation of ecosystems (see section on occupation of the soil biodiversity) and soil (see section soil conservation) are highlighted.

The burning of sugarcane results in emissions potentially harmful to human health: CO_2, CH_4, organic compounds and particulate materials. It is also related to increased concentrations of ozone in cities around the sugarcane plantations. The caused urban pollution is further aggravated during winter, when thermal inversions frequently occur. There are studies that say that there is direct relationship, and others that state that there is no relationship between the burning of sugarcane and acute respiratory diseases and chronic infections (Smeets et al., 2006). Studies of the Department of Pathology of the Faculty of Medicine at the University of São Paulo (Saldivia & Miraglia, 2004) argue that this relationship exists, affecting more to children and elders. It is unknown yet the magnitude of acute chronic infections in the country caused by particles from burning of fuels or biomass.

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3 São Paulo es the main sugarcane producer State in Brazil, concentrating close to 60% of the overall production.

4 The Brazilian Sugarcane Industry Association (UNICA) is the largest organization in Brazil representing sucar, ethanol and bioelectricity producers.

Moreover, the practice of sugarcane burning damages the infrastructure (power grid transmission and distribution, highways, railroads) and forest reserves. The burning of forest reserves or adjacent plantations increases the emission of pollutant and greenhouse gases.

The Audit

Failures in supervision and enforcement of existing legislation.

Soil Compaction, Use of Energy and Emissions

The agriculture mechanization brought positive contributions to agriculture, such as increased productivity, but also brought negative contributions to the environment, such as soil compaction (see item of the soil) and increased emissions of pollutants by using fossil fuels. (Table 1: Consumption of diesel as current and future introduction of new technologies and practices).

For emissions, the fuel expense by conventional machining equipment and vehicles to move on loose soil for the most part has been used to deform the ground, i.e to generate compaction. This in turn demand, again, investment, machinery and fuel for decompaction operations subsequent cultivation of stumps (also referred to as rootstocks) or preparation for planting. Periods of rain make it more difficult the movement of traffic more difficult and, consequently, require more fuel.

OPPORTUNITY

There are opportunities to reduce and / or completely eliminate the practice of burning and reduce emissions of greenhouse gases from the burning and the transportation of ethanol.

Exemplary Audit

One alternative is to improve and enforce effective monitoring by the existing legislation which envisages for the end of burning. Shortening the time for complete ban of burning at national level is an alternative to be considered. An example is the Agro-environmental Protocol of the State of São Paulo. However, it is not a simple alternative due to the social aspects involved, which is outside the scope of this article.

Technology for traffic control

Another opportunity is the use of structures for traffic control (ETC's), that enable the harvesting of green cane on land with slope of up to 40% and consume less diesel per hectare, resulting in lower greenhouse gas pollutants and particulates emissions. The Table1 shows the consumption of diesel for different harvest systems. The ETC's make the practice of no-tillage system an alternative that will promote the conservation of soil, water resources and the reduction of the use of agrochemicals.

Table 1: Consumption of Diesel as Current and Future Introduction of New Technologies and Practices

Index	current	2015	2025
1- ETC's use (%)	0	0	100
2- Use of no-tillage system (%)	<5	10	100
3- Use of GIS maps of productivity (%)	0	10	100
4- Use of precision agriculture (%)	0	10	100
5- Consumption of diesel in the soil preparation and planting(l/tc)	0,35	0,32	0,04
6- Consumption of diesel in the harvest of sugarcane (l/tc)	0,9	0,8	0,38
7- Consumption of diesel in the transport of 25 km(l/tc)	0,98	0,95	0,88
8- Agricultural consumption of diesel (l/tc)	3,5	2,5	1,7

Source: Report of Phase 2 of the Ethanol Project (NIPE, 2007).

The ETCs units are power units that carry agricultural implements with extra large axles, 20 to 30 m, with topographic restriction (slope inclination) of the order of 40% (12% for conventional harvesters of one line) and that enables the introduction of no-tillage system. The ETC's use permanent traffic lines, well compact with high traction efficiency and without interference with the planted area, located between lines of traffic. In the case of ETC with an axle of 30 m, there is an area of only 4% dedicated to traffic and the rest dedicated to the development of the mill. The current mechanization uses intense traffic in approximately 30% of the area, with low traction efficiency and mills growing in physical damaged.

THREAT

Even with the gradual reduction of the areas where the practice of sugarcane burning is permitted, there is the risk of, until the complete ban on burning, degrading the remaining forest (riparian forest, covering springs, areas of conservation) and impediment of natural regeneration (perennial degradation).

SUPPLY AND WATER QUALITY

There is no detailed information available on the level of water pollution of rivers and basins in various regions and what is the contribution of sugarcane crop and ethanol production. The main impacts of water use are concentrated in the stage of the production of sugar and ethanol. (Smeets et al., 2006).

There is also the pollutants resulting from production of sugarcane and ethanol that can contaminate the aquifers (fresh ground water reserves) and springs. The two major types of pollutants are organic (production of ethanol: vinasse and filter cake) and chemicals (sugarcane: fertilizers and agricultural chemicals).

STRENGTH

Relatively Low Demand Of Water For Cultivation Of Sugarcane

The cultivation of sugarcane in Brazil is mainly irrigated by rain (Smeets et al., 2006; Macedo, 2005). Thus, there is less use of water for irrigation. The little or non practice of irrigation is of great importance in reducing environmental impacts, not only by the lower water use but also to avoid dragging of nutrients, waste pesticides, loss of soil etc. Irrigation in sugarcane is more widespread in the Brazilian Northeast Region.

However, the use of irrigation is increasing. The increasing demand for incorporation of new areas for sugarcane in the Center-South of Brazil has led to the exploration of areas with more pronounced water deficits.

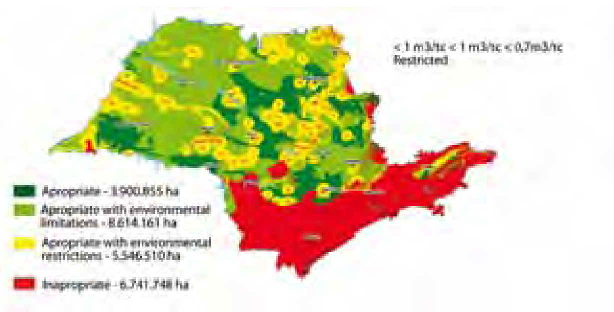
The application of vinasse in farming reduces the need for water collection for irrigation. Additionally, it allows the lower use of mineral fertilizers, reducing the chances of contamination of aquifers and springs.

Much of the water used is recycled and reused (fertirrigation). Consequently, the water collection, consumption and release are lower.

Another important advantage is the newly established Agro-Environmental zoning for the Sugarcane Sector of the State of São Paulo. As the main producing region of the country, it has an important impact on the environmental planning of the state to discipline the expansion and land use and water quality, air quality and biodiversity, for example.

Based on Agro-Environmental zoning, the Agro-Environmental zoning Secretariat of Environment of the State of São Paulo adopted the Resolution SMA 88, March 19, 2009, which defines the technical guidelines for the environmental licensing of sugar-ethanol sector's enterprises within the state. In areas considered adequate, there is an upper collection limit of of 1 m^3 / tonne of cane, with restriction of 0.7 m^3 / tonne of cane to the adequate areas with environmental restrictions (Map 1).

Map 1: Agro-Environmental Zoning for Sugar-Ethanol Sector of the State of São Paulo



Source: from CIIAGRO (2009).

Low impact on water quality

An evaluation of EMBRAPA classifies the impacts of today's crop of sugarcane in water quality at 1 (no impact) (Embrapa, 2003).

WEAKNESS

Burning Of Cane

The practice of burning the sugarcane reduces the amount of soil water due to intense heat, it changes the structural characteristics of the soil, which, consequently, have erosive effects, and causes the occurrence of floods (loss of soil, nutrients and water) due to reduced vegetation cover. Also, it can compromise or eliminate watershed by erosion and silt by destroying the riparian areas.

Great demand in the industrial phase

Industrial production is an important importer of water in the environment. Despite the need for more studies, some references indicate mean values of uptake of water ranging from 3000 to 5000 liters of water per tonne of cane (Ferraz, 2007; Neto, 2005). Surveys conducted by UNICA, although published as internal report ("reserved"), point out average collection of 1,830 liters of water per tonne of cane (Neto, 2005). There is an outlook of the sector to reduce the uptake to 1,000 liters / tonne of cane.

Contamination of aquifers and groundwater

According to Ferraz (2007), the Guarani Aquifer[5] is covered by sugarcane with several studies pointing to its contamination with herbicides.

The application of vinasse as a fertilizer can lead to the salinization of groundwater by leaching of these elements, but it can also cause nitrification of soil and water contamination of groundwater, and cause of serious diseases in humans (Veiga Filho, 2007). The regulation of its use (the Standard Cetesb of 2005) for the use in areas close to mills and already saturated shows that even though the vinasse is an organic subproduct and contains water and nutrients,its use must be controlled.

Contamination of surface water

The floods can carry soil, pesticides and organic and inorganic fertilizers for next water sheds, which can compromise the quality of water for contamination and cause siltation and burial to these watersheds.

In some regions, according to Ferraz (2007), all watersheds surrounded by sugarcane are contaminated by chemicals.

With the employment of the new second generation technologies (enzymatic and acid hydrolysis), there will be a high need for water consumption.

5 The Guaraní Aquifer , located beneath the surface of Argentina, Brazil, Paraguay and Uruguay, is one of the world's largest aquifer systems and is an important source of fresh water.

OPPORTUNITY

There are several alternatives to reduce impacts on the quality and supply of water ranging from agricultural to industrial phase.

The future should consider the conversion of surface irrigation systems, the main method of irrigation in the country, whose efficiency is very low. In the case of regions with water deficits, irrigation can be environmentally and economically viable, especially with the use of more efficient methods: equipment easier to control, proper management of surface irrigation systems, systems for greater uniformity of water application (sprinkling) and drip irrigation (drip and micro). For example, drip irrigation, as experiments conducted by the Sugarcane Technology Center in the sugarcane region of Ribeirão Preto showed its economic viability.

It should also be considered to reduce the collection, use and water release. About 87% of water uses occur in four cases:sugarcane washing (25.4%), condenser / multijets in evaporation and vacuum (28.5%), fermentation cooling and ethanol (33.3%) (Neto, 2005). The use of water in the sugarcane washing (5 m^3 / tonne of cane) can be reduced with the dry cleaning of the cane. It seems possible to reach values close to 1 m^3 / tonne of cane (collection) and zero release, with optimization of the use and re-use of waste water in fertirrigation.

Moisture and soil compaction are factors strongly linked to the longevity of the sugarcane field. Technologies for control of traffic and no-tillage attack specifically those production parameters, to provide more soil moisture, better use of rain water (water stored and retained in the soil), reduced soil compaction and therefore the occurrence of floods (loss of soil, nutrients and water), lower use of herbicides and fertilizers.

The controlled use of vinasse (fertirrigation) reduces the use of inorganic fertilizers in farming, reducing the risk of contamination of aquifers.

Additionally, the thermal concentration of vinasse may reduce the uptake of water by use of condensate.

There is the development of new sugarcane varieties with increased resistance to water stress, with less need for irrigation in areas with water deficits.

The resumption of the development of anaerobic biodigestion of vinasse is an alternative to reduce the load of organic matter, raising the pH and the removal of sulfate from the vinasse.

The example of São Paulo State, in the establishment of a National Agro-environmental zoning as an important planning tool, is considered a crucial measure to discipline the industry expansion and land use.

THREATS

If alternatives and solutions are not taken, the expansion of ethanol production, can provoke:

1- The increase use of herbicides, pesticides and mineral fertilizers, which can cause contamination of aquifers;
2- Increase demand for irrigation in areas with water deficit;
3- Increase of uncontrolled disposal of vinasse in soil and near water resources.

LAND COVER AND BIODIVERSITY

STRENGTH

There is an availability of land to meet the production of 205 million m^3 of ethanol in 2025 according to the Ethanol Project (NIPE, 2007), i.e 10% of the world gasoline. The scenarios of NIPE (2007) considered the establishment of reserves in 20% of the planted area the non-use of areas of forest reserves, indigenous reserves, parks etc.

Both scenarios for ethanol production (104.5 and 205 million m^3) for the year 2025,due to increased productivity of sugarcane and ethanol to the situation of "progressive technology", reduce the needed areas. This will reduce possible displacement of crops and pastures and impacts on biodiversity.

The increased productivity will be due to the higher energy efficiency in the use of bagasse in the industrial process and a greater trash recovery during harvest, which would reach 50%[6].

These gains in productivity would mean a reduction of 8% and 17% in the sugarcane production in 2015 and 2025, respectively. And a reduction of 17% and 23% in the number of distilleries in 2015 and 2025 compared to the scenario without technology.

One advantage mentioned is that the sugarcane cultivation provides the recovery of the soil with the planting of other crops.

The Agro-Environmental Zoning of the State of São Paulo is an important advantage because it is the main producing region of the country. The zoning disciplines to the sugarcane expansion and land use, among other important environmental issues. Resolution SMA 88, March 19, 2009, based on the Agro-Environmental Zoning, states that in areas deemed adequate, actions related to the land use and preservation and restoration of biodiversity must be taken. In some areas it requires the formation of ecological corridors.

6 The scenario of 104.5 million m3 provides an increase in yield of 93.3 l / tonnes of cane and 100.2 l / tonnes of cane in 2015 and 2025 respectively, an increase of 10% and 18% compared to the scenario without technology (85 l / tonnnes of cane) and the current situation. The scenario of 205 million m3 provides an increase in income of 92.6 l / tonnes of cane and 102.1 l / tc in 2015 and 2025 respectively, an increase of 9% and 20% compared to the scenario without technology (85 l / tonnes of cane) and the current situation (NIPE, 2007).

WEAKNESS

The practice of sugarcane burning damages the biodiversity and ecosystems, with clear reduction of populations of vertebrates and insects species by the elimination of habitat or death by fire and burning of the plant cover. The environmental reserves, riparian areas and watershed covers are also threatened by the expansion of the culture and / or practice of burning.

Diversification of terrestrial and humid habitats is also frequently associated with a fragmentation[7] of habitat, leading to profound changes in the balance between countryside and shore species and may cause the genetic isolation of populations, as well as mortality associated with dispersion movements of animals.

The speech of the government and sugar and ethanol producers emphasizes that the expansion of sugarcane is occurring on degraded areas and pastures. On the other hand, according to environmental organizations, indirectly displacement of less profitable livestock and crops may be occurring on native forests and cerrado. Ferraz (2007), of Embrapa Environment, said that "concern about the devastation of forest, and the occupation of food producer areas is the same as in soybean phenomenon". These indirect impacts should not be despised and should be considered in studies of land use and impacts on biodiversity.

OPPORTUNITY

As the example of São Paulo State, the establishment of a National Agro-environmental Zoning as an important planning tool, is considered a crucial measure to discipline the production expansion of industry land use.

As well as the creation of corridors of biodiversity[8] in sugarcane plantation.

And, to stimulate the production of ethanol by organic systems[9] that, among other practices, makes the harvesting without burning and thus, complies with the areas of legal reserve.

There is a discussion on the best alternative to maintain areas of environmental preservation. Whether the current legal practice that ensures at least 20% of the planted area of sugarcane planted area for environmental reserves or the need for each State to define an environmental reserve area compatible with their needs, for example.

THREAT

If the sugarcane production expansion occurs by the conventional system, it is likely to have a reduction of biodiversity in large areas of planting, as indicated by the survey carried out by Embrapa Satellite Monitoring in properties in the region of Ribeirão Preto at Sao Paulo State. In a conventional cane plantation, there are no more than 30 species, while in properties that use the organic production system, 248 species have been identified (Embrapa, 2005).

There is also the risk of degradation and burning of reserve areas, which are recurring events, but little in the media. As an example, the Ecological Station of Sao Carlos, Conservation Unit at the City of Brotas (Sao Paulo), has a history of direct and indirect damage caused by burning sugarcane which is extends out of the boundaries of sugarcane area (Ferreira, 2007).

With the use of "organic production", there may be a risk of an increase in pests and weeds, with possible impacts on production and on the local ecological balance.

In local terms, there may be pressure on the supply and on the food production costs[10].

PRESERVATION OF AGRICULTURAL LAND

STRENGTH

The soil loss is lower comparing sugarcane with many other crops. Only corn, beans and sweet potatoes have less or the same loss as sugarcane.

The technological evolution of sugarcane production has allowed, in some areas, the management of harvesting without burning. The management of harvesting without burning and the reduced tillage should improve the level of soil conservation. The reduction of losses of soil and water between the burned straw and letting the straw on the land surface is of 68% and 69% respectively (Donzelli, 2005).

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7 Fragmentation is a whole process of human origin (human) that causes the splitting of natural ecosystems into continued smaller pieces often disconnected from other areas like, which leads to isolation of the species and its consequent extinction.

8 The Corridor of Biodiversity is a strategic area for the environmental conservation on a regional scale. It comprises a network of protected areas, interspersed with areas with varying degrees of human occupation. The management is integrated to enlarge the possibility of survival of all species, the maintenance of ecological and evolutionary processes and the development of a regional economy based on sustainable use of natural resources. In areas of high forest fragmentation, as the Atlantic, the corridors of biodiversity also have the goal of rehabilitation and connection of fragments of forests. Thus, it is expected to overcome the isolation of protected areas and increase the connectivity of native environments, allowing the transit of species of flora and fauna among the remnants.

9 Embrapa Satellite Monitoring did work on the faunal biodiversity in farms of sugarcane in Ribeirão Preto (SP) which changed the conventional system of production for the organic system. Through surveys, conducted between 2002 and 2003, 248 species, ere identified showing an increase of biodiversity - in the plantation of conventional cane there were found no more than 30 species.

10 It is recognized that the growing land concentration of land in new sugarcane expansion areas, as the west region of the State of São Paulo, in the form of lease and purchase of land (Veiga Filho, 2007). One consequence is the disruption of social and productive tissue, with the activities of less expression in macro-region level, but important at the local level, but disarticulated. Small productive associations, built during a long time, and that solidified relations with local socio-economic characteristics of sustainability, can be broken by the impact of the cane.

The controlled use of vinasse (fertirrigation) as an organic fertilizer reduces the need for application of chemical fertilizer, then recycling nutrients and waste from the production of ethanol.

Analysis on the effects of vinasse on soil properties indicate that its addition in natura on the soil is a good option for the use of this product, being an excellent fertilizer and bringing more benefits to the physical, chemical and biological soil.

Advantages of using vinasse are the raise of the pH, increase of the cation exchange capacity, the availability of certain nutrients, the improvement of soil structure, increase of the water retention and development of the soil's microflora and microfauna.

The cultivation of sugarcane can regenerate degraded areas, since the best production practice of production from an environmental standpoint is met.

WEAKNESS

The practice of burning the sugarcane has harmful consequences for the physical characteristics and structure of the soil such as:

- The change of gas concentration;
- Decreased soil fertility and moisture;
- The loss of volatile nutrients and
- The exposure to the effects of land erosion.

As mentioned earlier, the mechanization of agriculture has brought some positive and negative contributions, such as compaction of soil resulting from the traffic, that affects the sustainability of farming sugarcane in terms of cost of production and soil conservation. With the modernization of agriculture, the weight of equipment and intensity of land use increased drastically, with changes of soil physical properties, such as increased density and penetration resistance.

The conventional mechanization causes:

- Modification of soil physical properties (increased density and penetration resistance);
- Intense traffic in ~ 30% of the planted area.

The application of vinasse as a fertilizer is very common and almost all vinasse is recycled. In general, 10 to 15 liters of vinasse per liter of ethanol is produced, depending on the sugarcane characteristics and its processing (Macedo, 2005). One of the most significant impacts is the effect of sulfate anion (SO_4^{2}-) in the soil. The presence of sulfate in ethanol distilleries of sugarcane is a result of the use of sulfuric acid in the fermentation. In the case of an autonomous distillery,it is used about 5 kilograms of sulfuric acid (98% concentration) per m^3 of ethanol, a value that indicates that comparatively high doses of sulfate are being applied in the soil.

A large number of studies related to leaching and potential contamination of groundwater by the recycling of vinasse indicate that in general there is no harmful impact to applications below 300 m^3/ha. The Technical Standard P4.231/2005 of CETESB[11], part of the Secretariat Secretariat of Environment (São Paulo), regulates all aspects: risk areas (prohibition); dosages permitted; technologies.

OPPORTUNITY

The concept of traffic control, among other functions that it performs, aims to solve the problem of soil compaction A simple analysis of this vicious cycle of energy spent in successive compression and decompression operations, takes to the concept of controlled traffic, it consists in the separation of areas used for the plant growing from those used for the traffic of equipment.

Biological Removal of sulfate by anaerobic digestion: technology development. The sulfate removed can be recycled and used in the production of sulfuric acid.

USE OF AGRICULTURAL PESTICIDES AND FERTILIZERS

STRENGTH

The use of insecticides, fungicides, acaricides and other chemicals in the cultivation of sugarcane in Brazil is lower than in the cultivation of citrus, corn, coffee and soybeans.

Controlled use of vinasse (fertirrigation) reduces the use of inorganic fertilizers in farming and allows the recycling of waste from sugar and ethanol production.

WEAKNESS

The use of herbicides, pesticides and mineral fertilizers can result in contamination of aquifers, which are underground reserves of fresh water.

The pollutant power of vinasse, about one hundred times higher than that of domestic sewage, arises from its richness in organic matter, low pH, high corrosion and high levels of biochemical oxygen demand -BOD (20,000 to 35,000 mg / l) as well high temperature at the exit of distillers (85 to 90°C); vinasse is considered highly harmful to fauna, flora,

11 The Environmental Agency for the State of São Paulo (www.cetesb.sp.gov.br/).

microfauna and microflora of freshwater, and marine wildlife coming back to Brazil shores for procreation (Da Silva et al., 2007 apud Freire & Cortez, 2000).

Weeds lead to large losses in the cultivation of sugarcane, with losses in productivity ranging from 10% to over 80% (Junior, 2005). Compared with other crops, in Brazil, sugarcane uses more herbicides than coffee and corn and a little less than citrus, equaling the soybean. The values are close.

OPPORTUNITY

The practice of no-tillage and the use of ETC's would reduce the use of agricultural chemicals and inorganic fertilizers.

The increased use and study of biological control of pests and weeds, as well as new varieties resistant to them also reduce the need for agricultural chemicals.

The precision agriculture is another practice that facilitates the process of environmental management.

THREAT

The expansion of the ethanol production can, if alternatives and solutions are not taken, lead to the increased use of herbicides, pesticides and mineral fertilizers.

In many situations today, the interest in new technologies based on the use of genetic modification in mills to add resistance to pests and characteristics of pesticides starts to grow. However, there is the potential for problems like the spread of genes, adverse impacts on non-target organisms, potential contamination of food etc.

CONCLUSIONS

The Chart below presents a summary of the SWOT analysis performed in this work. It can be seen through the analysis that important aspects of environmental sustainability of production of ethanol production in Brazil have evolved positively. There are, however, other aspects that need more attention and supervision. Greater knowledge of the cumulative effects of land use and waste disposal also need to advance to better assess their impacts and mitigating measures.

Chart 2: Summary of SWOT analysis

S - None or small need of irrigation - Reuse/recycle of large part of the water used - Integral recycling of the industrial effluents (vinasse, filter cake and residual water) - Legislation of control and sugarcane burning ban - Higher soil conservation compared to other crops (fertirriting and optimization) - Agro-enviromental Zoning of the State of Sao Paulo	W - Soil structural changes (loss of water, nutrients, soil, salinization, acidity) - High water collection - Air pollution (pollutants and soot): sugarcane burning and agricultural mechanization - Flawed inspection (sugarcane burning and vinasse) - Soil compaction - Salinization and contamination of groundwater and watersheds (vinasse, fertilizers and agrochemicals) - Leaching and silt - Habitats fragmentation and reduction of biodiversity
O - Practice of no-tillage - Use of ETC's (presupposes no sugarcane burning) - Precision agriculture - Information tecnology - Controlled use of vinasse - Corridors of biodiversity - Reduction of water collection, use and release - Sugarcane breeding - Enzymatic and acid hydrolysis - Thermal concentration and biogestion of vinasse - National Agro-environmental Zoning	T - Cumulative effects of the use of soil and agrochemicals - Water resources depletion: increase irrigation demand in areas with water deficits and increase industrial water use - Increase in the use of agrochemicals and inorganic fertilizers - Displacement of agricultural cultures and pasture lands - Risk of degradation and burning of reserve areas

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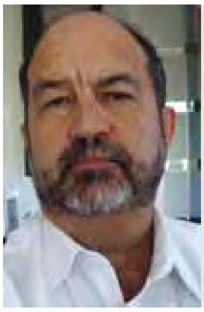
Energy use in residential and commercial sectors in Latin America: consumption factors and outlook of the use in buildings with Mexico as reference



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Abstract

This paper examines the various factors that influence the energy needs used in homes and businesses in the industry and urban services in Latin America and Mexico based on regional data. As of these factors, some measures are outlined which can be conducted to maintain levels of energy services for a growing population in urban settings without increasing power consumption.

Introduction

In the context of current concerns about energy supply (price and environmental impacts) the importance of urban centers is very significant, especially the buildings that are placed on them.

While occupying less than 1% of the planet's surface, due to its large concentration of population, its highest level of consumption of goods and services, economic activity and large mobility needs, the urban centers concentrate enormous consumption of all kinds of energy, and therefore they are responsible for most emissions of greenhouse gases leading to climate change [1].

Latin America is no stranger to this process. With different nuances and different times, our region has become in recent decades, from predominantly rural to urban. Between 1950 and 2005, the percentage of urban population in Latin America and the Caribbean increased from 41.9% to 77.6% and four of the world's 24 megacities (with over 8 million people) are in the region [2].

This growth is reflected in the future energy needs in the region. According to the International Energy Agency (IEA), if current growth trend continues, Latin America will require 75% more energy in 2030 than in 2004, and electricity production will expand in approximately 50% over the next 10 years [3].

In addition to its economic and social implications, urbanization leads to changes in energy needs and end uses of energy in the different countries of the region.

In particular, and without considering its impact on the transport and industry, the integration of population into the urban environment involves the use of technologies and fuels that were not accessible, either by price or availability, in rural areas.

In this regard, what was done with woodfuel (cooking, water heating) is now done with gas or electricity, which increases its demand. Similarly, what before was not possible (such as food cooling or entertainment devices that use electricity) is now possible due to access to new forms of energy, which leads to increased consumption, particularly of electricity. In parallel, and only in cases in which migration occurs between areas with different climates, it is also generating new end uses, including air conditioning and / or heating.

All this makes the energy use in buildings increasingly important, and it is understood as the space in which people live, and where many of their daily activities take place [4].

Energy Use In Latin America

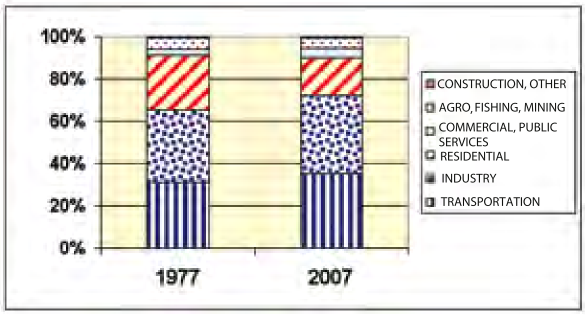
According to the Latin American Energy Organization (OLADE), Latin America consumed more than 3.9 billion barrels of oil equivalent (BOE) in 2007. About 80% of this consumption corresponded to five countries: Brazil (36%), Mexico (20.5%), Argentina (9.9%), Venezuela (7.5%) and Colombia (4.3%). Out of this consumption, 62% comes from petroleum products [5].

Also in 2007, 1'223, 092 GWh of electricity were generated in Latin America, of which 64.9% came from hydroelectric plants, 27.5% from thermal, 3.4% from nuclear and 4.1% from geothermal plants. In this regard, Brazil and Mexico stand out, where they generated 56% of total in the region, as well as by type of generation, since Brazil generated 54% of the total hydropower, while Mexico produced 44% of total generation through thermal plants [5].

In turn, energy consumption grew at a rate of 2.5% per year between 1997 and 2007, while economic growth was 0.5% during the same period [5].

In a 30 years outlook (1977-2007), it stands out the fact that the total energy consumption has doubled, with a higher relative growth of the sectors of transportation and industry, which accounted for 72.5% of the energy demand 2007 (Graph 1).

Graph 1 Percentages of Final Energy Consumption by sector in Latin America, 1977-2007



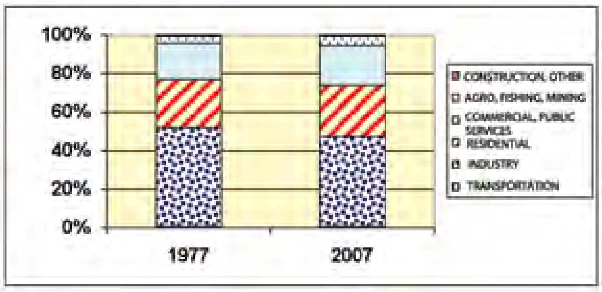
Source: from CIIAGRO (2009).

The Importance of Residential, Commercial and Services Sectors

When reviewing the electricity consumption, we can see the importance of the residential, commercial and services sectors as major consumers of energy.

The consumption of electricity in the region has not only grown more than four times in thirty years (double the growth in total final consumption of energy), but this growth has taken a growing role in the residential, commercial and services sectors, which came to be about 50% of the total consumption of electricity in 2007 (Graph 2).

Graph 2 Percentages of Final Electricity Consumption by Sector in Latin America, 1977-2007



Source: OLADE [5].

However, this increasing importance is not necessarily reflected in an adequate response in terms of saving policies and efficient use of energy in the residential, commercial and services sector, perhaps because of the greater importance that the transportation and industrial sectors have in the national energy balances.

In that regard, there is a very limited availability of detailed information about these sectors, and in many cases these are included in other sectors. That is the case of Mexico, where the major buildings are accounted and classified as industry, minimizing its importance [6].[1]

This results in significant difficulties to analyze and greater limitations in assessing alternatives (in regional and national level) for a more rational and /or more efficient use of the energy in homes and commercial sectors, which nevertheless does not let them apart.

Besides its increasing importance in electricity consumption, the residential sector is particularly important for social reasons, and because in many countries of the region this important residential electricity demand corresponds to the demand points of the sector.

In turn, the important business sector as a consumer of energy is, if we stick to the trend of "outsourcing" of the economy in a developed world, in its high growth potential.

1 This underestimation appears to be originated in the fact that the Federal Commission of Electricity (CFE) classified as "commercial" only to users in tariffs 2, 3 and 7, which correspond to services that are delivered at the distribution level, ie at low voltage. According to estimates that are described in this document it is stated that consumption of the facilities in the sector is possibly three times higher than that CFE defines "commercial".

Factors that Determine the Growth in Energy Consumption of the Residential, Commercial and Services Sectors.

In addition to urbanization, other factors have also influenced on the evolution of energy consumption of residential and commercial services, as described below.

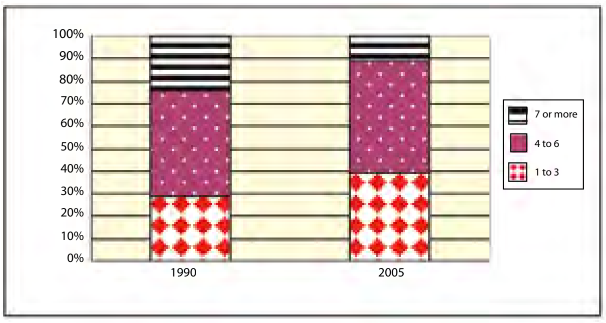
Population growth

The population of Latin America, which came to just over 560 million people in 2005, has been increasing at decreasing rates, but at rates above the world average, which is reflected in trends of growth in energy demand of the residential sector. While in 2000 the growth rate of world population per year was 1.25%, for the region it was 1.8% [7] [8].

Size of family unit (persons per household)

In Latin America the social habits and economic situation of the majority of the population gave rise to big families, implying greater consumption per household, but lower per-capita consumption. However, this situation tends to change with urbanization and the expansion of housing programs. As an example, in Mexico the number of people per household tends to decrease, which is reflected in the increasing proportion of households with less than four people, with a consequent decrease in households with more than seven occupants (Graph 3).

Grpah 3 - Percentage of occupants per household, Mexico (1990 and 2005).



Source: INEGI [9, 10].

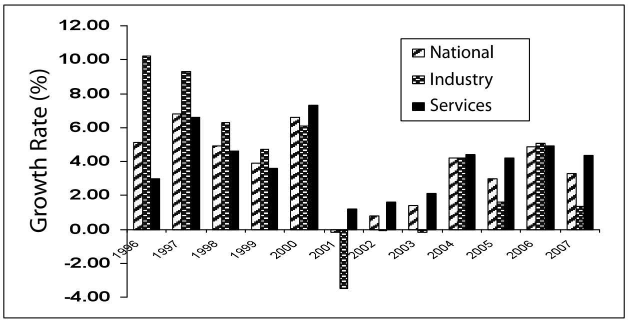
These changes will inevitably push up the demands for energy services in the residential sector in the region, with consequent impacts on the needs for resources [11].

Outsourcing Economy

According to national economic statistics, the tertiary sector (known as services and that operates in buildings) has become increasingly important. In Mexico, the Gross Domestic Product (GDP) of the services sector has grown more than the industry sector and beyond of the entire economy since 2000 (Graph 4) [12].

This has been reflected in the increasing number of new buildings used for hotel services, hospitals, schools, offices and supermarkets, among others.

Graph 4 Annual growth of total GDP and industrial and services sectors of Mexico, 1996 to 2007.



Source: INEGI [13].

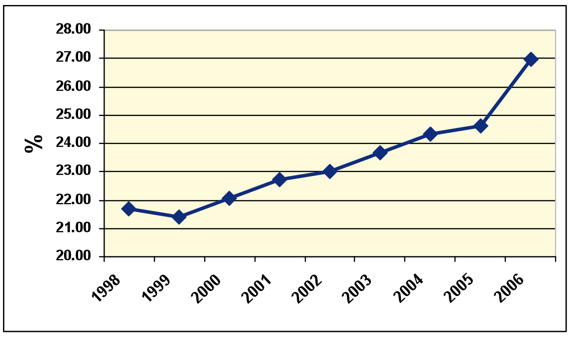
Technology

The technology, defined here as equipment and systems used to provide energy services, play a decisive role in the levels and intensities of energy consumption, and the choice of the source that provides energy in the residential sector.

Thus, the cooking that was done before on a wooden stove, today is done with stoves that use LP gas or electricity. In turn, end uses of energy that were not available such as food cooling for preservation or thermal conditioning of spaces, is carried out now based on increased use of electricity.

For example, in Mexico the use of air conditioner is increasing, as it has gone from just over 21% of total electricity consumption in the sector to about 27% in ten years (Graph 5).

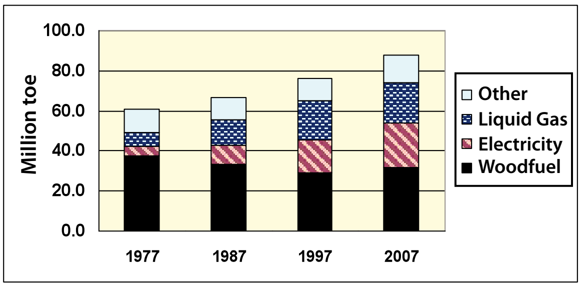
Graph 5: Estimated percentage of electricity used for air conditioning in the residential sector in Mexico.



Source: Author's estimates using data from the CFE (www.cfe.gob.mx)

In Latin America, this is a clear manifestation in the changes that the demand has taken for energy in the residential sector, where the consumption of electricity and gas has increased, and the use of wood has decreased (Graph 6).

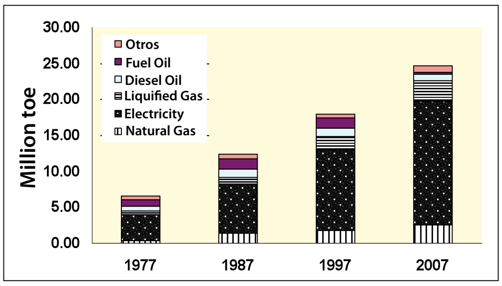
Graph 6: Evolution of energy consumption by type of energy in the residential sector of Latin America, 1977-2007.



Source: OLADE [5]

Also in the retail and services sector, growth in electricity consumption was very significant (Graph 7).

Graph 7: Evolution of energy consumption by type of energy in the commercial and services sector in Latin America, 1977-2007.



Source: OLADE [5]

This growth, however, does not seem to move along with the path of energy efficiency, since in the purchase of equipment, their price determines,- perhaps more than the price of energy - the conditions of the devices that users decide to buy. In most cases, the absence of good's financing conditions for new equipment with high-energy efficiency, makes people to focus on buying second-hand equipment [14].

Weather

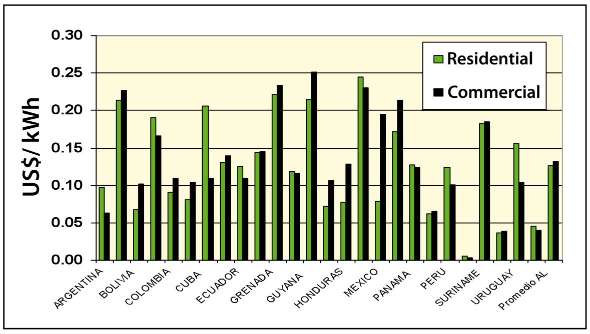
The weather is a determining factor in terms of energy consumption of the residential sector, as it affects the need for energy for air conditioning and / or heat and its intensity of use, besides of other end uses such as cooling and heating water. In most of Latin America, there is warm temperate weather most of the year, since the heating of homes is only relevant in the regions farthest from Ecuador [15].

In the case of Mexico, the new centers of economic activity are located particularly in regions of warm weather (in the north and along the coasts), where energy requirements are higher in order to meet the needs of thermal comfort of the inhabitants, making it a very important factor in the increase of electricity demand [12].

Energy prices

The average price of electricity for residential and commercial sectors vary from country to country in Latin America. While in Venezuela the cost of kWh is very low for the two sectors (less than U.S. $ 0.01) in Caribbean countries like Jamaica, Barbados, Grenada and Guyana, the price exceeds U.S. $ 0.15 (Graph 8).

Graph 8. Electricity prices for residential and commercial sectors in Latin America, 2007.



Source: http://www.eclac.org/estadisticas/bases

This price differential is explained mainly by the energy matrix of countries and subsidy policies. Thus, while nations with a higher component of hydropower have lower costs, the most dependent on fossil fuels tend to set higher prices. However, oil-rich countries like Venezuela and Mexico give high levels of subsidy on electricity for residential users [16].

Construction materials

For regions where the climate is extreme, construction materials and designs are essential in defining the energy intensity of buildings, either for residential, commercial and services' use and, besides the weather, construction materials are crucial to define the size of the equipment used to condition the spaces.

Unfortunately, in Latin America the tendency to use materials that do not go according to local climates has been dominating, which has led to a high energy consumption in certain regions. This is largely due because, for most real estate developers, the central parameter is the cost of the construction, which tends to be the minimum possible. In this case, the use of new materials may involve a higher cost, not only because of the materials themselves, but also by the depreciation of the equipment used in construction, which are significant in mass production [17].

Design practices

Design practices determine (among other factors mentioned here, such as technology and materials available on the market) the energy intensity of buildings. Thus, some practices seem to dominate modern construction in Latin America, such as those favoring the use of artificial lighting and ventilation opposed to their supply in natural forms, which only increases the need for energy, particularly electricity.

Operation and maintenance practices

Usually, the initial cost for building construction is 20 to 30 per cent of total costs during its life cycle, emphasizing the needs to consider not only the initial cost of the building, but also those of its operation each year [17].

Therefore, the operation and maintenance practices are a very important factor in energy consumption. Inadequate operation and maintenance of buildings can reduce and even eliminate the efficiencies gained by a good design with efficient equipment.

Energy efficiency standards

The existence and application of standards, technical regulations and / or energy efficiency labels for energy-using equipment is essential for reducing energy use in buildings, since its implementation may affect the needs of the buildings that will be used for more than one decade [18].

In some countries of the region, including Mexico, Brazil, Colombia, Costa Rica and Chile, there are systems of standardization and / or labeling of equipment. In Mexico, for example, refrigeration equipment for domestic use introduced in the market have reduced significantly their consumption per unit of electricity. An example is the evolution of a medium refrigerator, (15 cubic feet) that went from an annual unit consumption of more than 1,100 kWh in 1993 to about 450 kWh in 2003(Graph 9).

However, in most Latin American countries the use of standards for energy efficiency is still elementary, because there are structural and economic difficulties in fully establishing these systems. In particular, the relatively small size of the markets for equipment, their big variety and the high cost of testing and certification systems, are factors that limit their generalization.

Construction codes

Energy standards in construction codes are an important tool for regulating the intensity of energy consumption in buildings, especially since they put a limit to constructive trends that do not take into account its implications in terms of energy consumption and pushes out the best practices for design, implementation and use of materials of high energy efficiency.

However, in Latin America the existence of construction codes that make up the full savings and efficient use of energy is somewhat not very common. Even in countries like Mexico, where there is a national standard for commercial buildings, this practice is not applied since it depends on municipalities for its implementation and they have not integrated it to their construction regulations.[2]

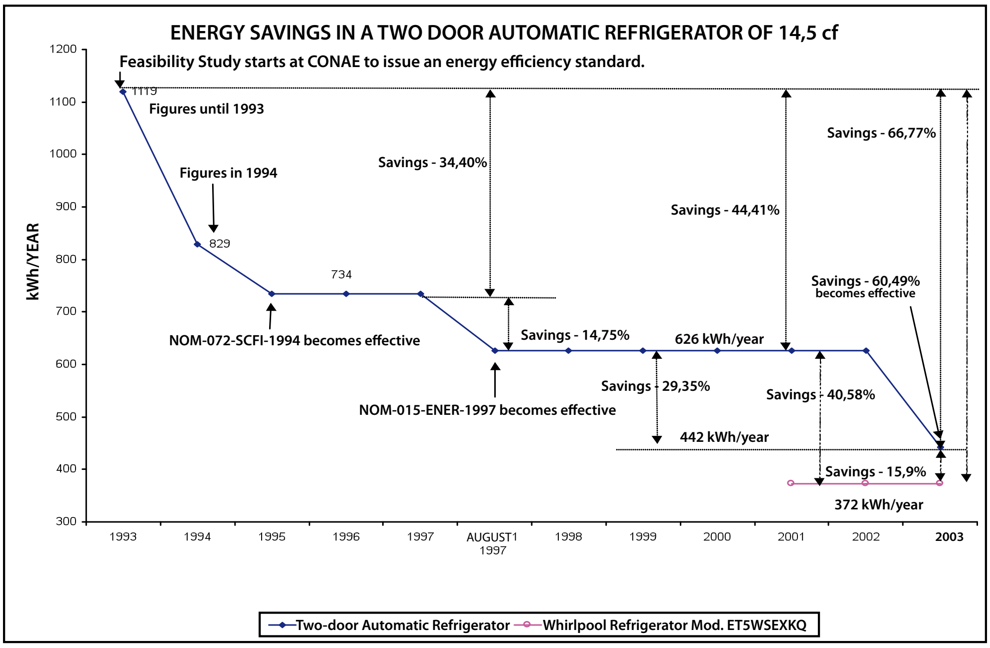
Outlook

It is clear that the phenomena of urbanization, population growth, the declining number of people per household and those related to climate are factors that can't be controlled and its evolution only leads, in practice, to scenarios of growth in energy demand.

However, factors that are determined by public policies can help maintain or reduce energy consumption, which will be required to increase the growing need for energy services.

So we can refer to a set of public policies to regulate, in the medium and long term the growth in energy intensity of the two sectors mentioned:

Graph 9. Evolution of a new medium refrigerator (14.5 FT3) (1993 to 2003).



Source: CONAE

2 *There are fewer references to five municipalities (of more than 2,200 that exist in Mexico) that have incorporated the national standard.*

- subsidies to energy,
- standards and / or technical regulations for energy efficiency,
- construction codes,
- certificates of buildings' sustainability
- equipment replacement funding programs
- training in best practice of design and operation and maintenance of buildings, and
- reduced taxes and tariffs that encourage the manufacture and / or import of materials, equipment and / or energy efficient systems.

The impact of these policies might be significant. An investigation of the Inter-American Development Bank (IDB) shows that Latin America and the Caribbean as a whole can reduce electricity consumption by 10% over the next decade by investing in technologies and equipment that are now widely available. Achieving that goal would cost about U.S. $ 17,000 million, which would reduce total energy consumption for 2018 in about 143,000 GWh [3].

In this perspective, the concept of sustainable building is worth growing in the development of the built spaces in Latin America.

Sustainable Building incorporates a wide range of design, construction, operation and maintenance activities in buildings to provide more healthy housing and working environments, and minimize environmental impacts.

The elements of sustainable building include: attention to the orientation and design of buildings, increased use of fresh air and natural light, harnessing solar energy for air and water heating, use of lighting and air conditioning of high efficiency, but also of materials and envelop components [12].

In turn, the concept of sustainable building goes beyond individual buildings to be part of programs related to urban infrastructure for sustainable urban transportation, gas and electricity, drinking water, wastewater disposal and recycling, rainwater, wastewater and sewage system management [17].

Conclusions

Residential, commercial and services sectors are becoming important energy and particularly electricity users. This growth is, and will continue to be reflected in higher energy use for lighting, space conditioning, entertainment and health, among others.

But besides the little knowledge about the details on energy consumption and on specific trends of design factors, equipment and operation of buildings, as well as the lack of knowledge on technological elements that make them up, the absence of specific public policies (such as energy efficiency standards and building codes that integrate aspects of energy efficiency) and secondly, the existence of economic policies (including subsidies) that encourage waste, plans to carry out a growing demand, which is not necessarily energy-efficient.

Therefore, it is necessary to adopt and widespread in Latin America -and the sooner, the better- public policy instruments such as: real energy prices, energy efficiency standards, building codes that fully integrate elements of energy efficiency, systems for certifying the sustainability of buildings, training in best practice of design, operation and maintenance of buildings, tax incentives or low tariffs in the manufacture and / or import of materials, equipment and / or energy efficient systems.

Only then, the region could face the growing challenges that involve the inevitable upturn in the prices of fossil fuels and combat global climate change.

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