



Konrad
Adenauer
Stiftung

**WILL THE EXPANSION OF WIND AND
SOLAR ENERGY SOURCES RESIST THE
FALL IN OIL PRICES?
AN OVERVIEW OF LATIN AMERICA AND THE
CARIBBEAN**



EKLA

Regional Programme Energy
Security and Climate Change
in Latin American

WILL THE EXPANSION OF WIND AND SOLAR ENERGY SOURCES RESIST THE FALL IN OIL PRICES? AN OVERVIEW OF LATIN AMERICA AND THE CARIBBEAN

©Konrad-Adenauer-Stiftung
Regional Programme Energy Security and
Climate Change in Latin America
Calle Cantuarias 160
Oficina 202 Miraflores
Lima 18, Peru
Tel. +51 1 7312898
Energie-Klima-La@kas.de
www.kas.de/energie-klima-lateinamerika

Autor
Ciro Marques Reis
Rio de Janeiro State University - UERJ

Editorial
Christian Hübner
Karina Marzano

Translation:
Margaret Cohen
Grupo Language Link Eventos Ltda.

The views and opinions expressed in the present paper are those of the contributing author alone and do not necessarily reflect the views and positions of the organising parties.

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Abstract

270 billion dollars. That was the amount invested in clean and renewable energy sources worldwide in 2014. Most of it was used in the solar (\$ 149 billion) and wind energy (\$ 99.5 billion) markets. Markets that as of recent years are no longer European or North American, but have expanded to other regions, including Latin America and the Caribbean (LA&C). This is great news for world climate in the global effort to reduce the impacts caused by burning fossil fuels. However, this expansion movement coincided with a long period of high oil prices, which favored the investment in alternative sources, both for economic reasons and environmental concerns, and was provided in part by the excess revenue resulting from the trade of the high-priced oil. Nonetheless, the recent drop in oil prices and the prospect of a long period of low oil prices has generated uncertainty about the maintenance of investments in renewable energy, raising doubts about the sustainability of these markets. Considering the prospect of a long period of low oil prices, this paper tries to broaden the debate on the relationship between the solar and wind energy markets and oil prices, with a special look at LA&C.



Introduction

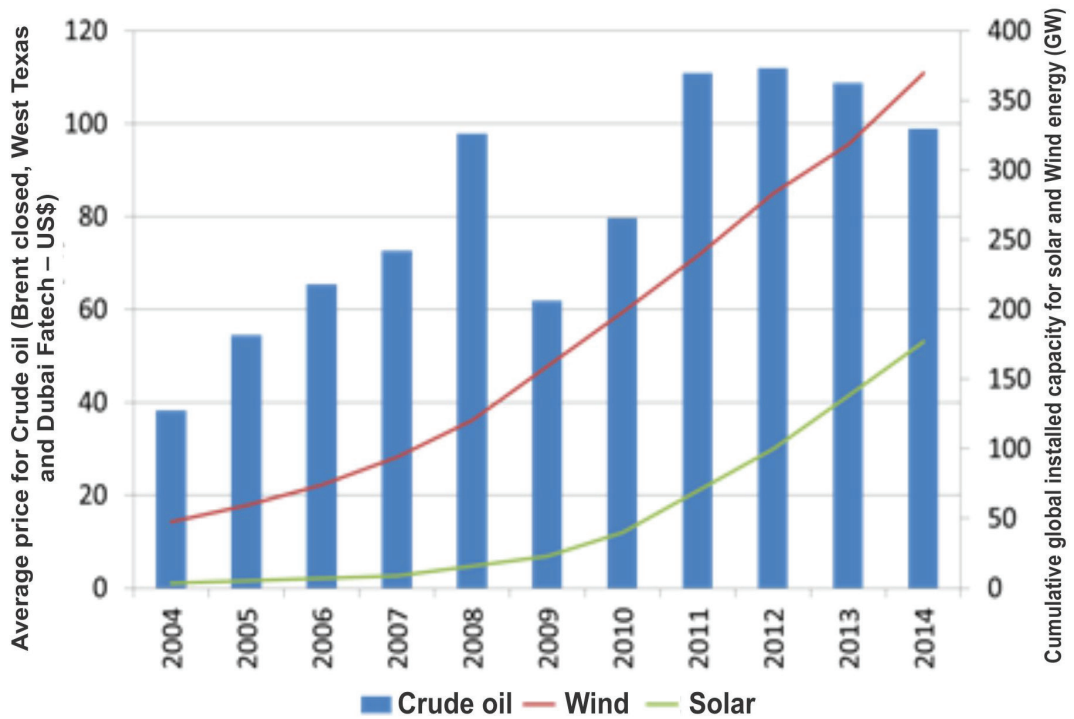
It is worth to start this text carefully. We do not intend to build a deterministic and/or reductionist analysis guided by a single variable due to the complexity of the global energy market, but to present an energy outlook for LA&C without losing track of the global perspective and its influential elements, which affect this process, such as the environmental crisis and the global economic scene. This paper is organized in three chapters. Following the introduction, an energy outlook for LA&C is presented with data on the solar and wind sectors in the region. The second chapter is dedicated to the debate on the recent history of oil prices, its formation factors and interpretations on its current behavior. The third chapter focuses on the challenges that LA&C will face if low oil prices persist and the world's economy continues to perform poorly. The paper concludes with twelve recommendations that aim to extenuate the effects of oil price's variation on Latin American energy policies. Academic articles, theses, national and international technical reports and, for being a current topic of interest, magazine and newspaper articles specialized in debating the energy sector and its relationship with economic development and the environment were used as bibliography.

Between December 2010 and July 2014, oil barrel prices were quoted, on average, above 100 dollars. During that time, there was an exponential growth in energy generation from alternative sources, mainly solar and wind sources. In other words, high oil prices seem to make countries that are financially and technically capable and highly dependent on oil, encourage research and development of alternative sources in order to reduce their dependency on such an expensive fuel in the search for more energy security.

Graph 1

Growth curve of the installed capacity of wind and solar sources in the world compared to crude oil prices

(2004-2014)



Source: Prepared by the author based on: Index Mundi; Renewables 2015 Global Status Report.

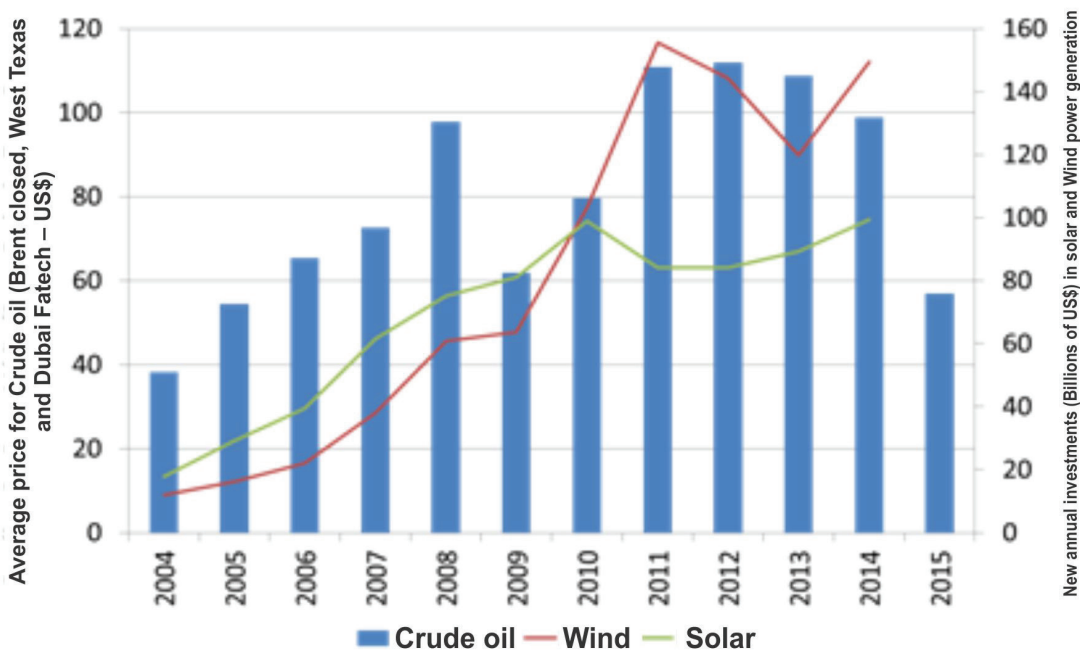
This premise seems to be validated by the past 45-year's history. The 1970s saw the oil crises. The OPEC elevated the oil barrel's price, reduced production and imposed embargos against the main oil importing economies, which were used to continued supply at low costs and saw themselves, in a short period of time, fragile in face of such dependence. In this context, the first institutional initiatives in search for alternative and renewable energy sources emerged looking to substitute power generated by thermal power plants and oil products such as diesel oil and fuel oil. The USA and developed European countries such as Germany and Denmark began promoting wind and solar power through R&D programs and research centers (Camillo, 2013, p. 73). Latin America and the Caribbean (LA&C) were apart from this process, focusing investments on hydropower plants and biofuels in an attempt to reduce the effects of the high prices for imported oil¹.

¹Brazil's ethanol program is noteworthy

With the drop in oil prices in the mid-80s, alternative sources such as solar and wind, which were still too expensive, lost importance in face of the versatile and cheap oil. A relation was established: the higher the oil price, the greater the incentive for research and development of alternative sources improved. The lower the oil price, the lower the interest in alternative sources. But, in face of the exponential growth in investments in solar and wind power generation observed in the past ten years (see graph 2), with Asia's leadership (especially China), and the substantial drop in its costs and increased production scale, a question arises: have these sources reached a level of development and independence from oil price variation? And is LA&C passing on the sidelines of this process again?

Graph 2

Oil prices and annual investments in solar and wind power in the world



Source: Prepared by the author based on: Index Mundi; Renewables 2015 Global Status Report.

Note: between 2011 and 2013 investments declined slightly due to cost reductions in alternative energy technologies and cuts in European subsidies.

This question is especially important on a global scale due to the issue of climate change, since burning fossil fuels for energy generation (including electricity) is the main source of greenhouse gases emissions and the growth of wind and solar power sources in the global energy scenario contributes to mitigate the global warming process. That is, if initially the search for alternative and renewable energy sources was prompted by economic and energy security reasons in countries highly dependent on oil, the increase in global awareness regarding climate change, the Kyoto Protocol and the impactful reports from the Intergovernmental Panel on Climate Change (IPCC) not only established environment exploration limits, but also served as motivational elements to build a less carbon-intensive society and raised the issue to a global level. Apart from developed countries' historical responsibilities, regions such as LA&C are motivated to undertake commitments towards sustainable development, particularly in the energy sector.

1. Latin America and the Caribbean: Updates on the use of solar and wind energy sources in the region

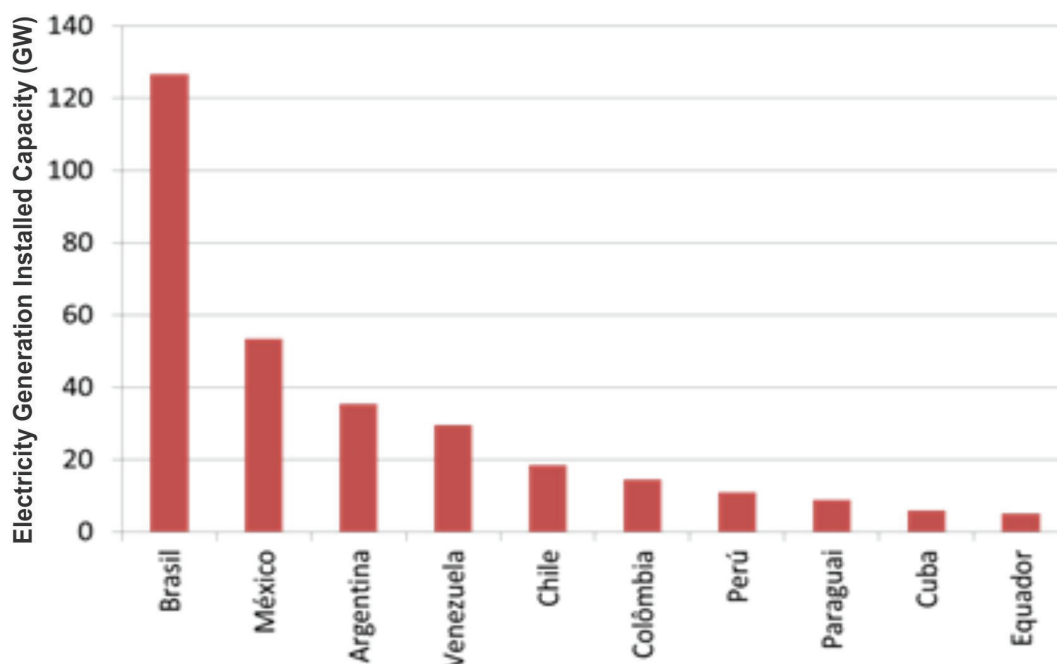
On a regional scale, specifically LA&C, the challenge is to associate an expansion strategy for energy supply that is environmentally sustainable to a growing population and meet its needs. Moreover, in the past two decades, 70 million of the region's inhabitants left poverty and rose to a new social level called the "new middle class", which means that population growth was accompanied by a new population profile and stronger demand for electricity. Access to energy is a basic condition for the social and economic development of LA&C, mainly of the poorest countries in the region (Goldemberg, 1998, p.7).

This presents a great challenge in energy management for the main Latin American economies, which, except for Brazil and Colombia, have an electric matrix based mainly on thermal power. Mexico and Argentina, the region's second and third economies, have, respectively, 73% and 68% of their installed capacity composed of thermal power plants and fossil fuels followed by Peru (67%), Chile (65.2%), Ecuador (56.6%) and Venezuela (50.1%) (Olade-SIEE,

Graph 3

10 LA&C countries with the largest electricity generation installed capacity

(2013)



Source: Prepared by the author based on: Olade-SIEE (2013)

One may say that LA&C has a hydrothermal power matrix, since of its 336.6 GW electricity-generation installed capacity, 161.2 GW are generated by hydropower plants and 165.3 GW come from its thermal power plants². However, Brazil's substantial contribution to this issue is noteworthy, because it represents 37.65% of LA&C's electricity-generation installed capacity (126.8 GW of the total 336.6 GW) and 86 GW are generated in its hydropower plants. Venezuela, the second largest hydropower contributor in the region does not surpass 15 GW; so, looking to Brazil in an analytical manner means looking analytically to the future of alternative and renewable electricity sources in the region. Without Brazilian hydropower contribution, LA&C would have a non-renewable power matrix, based on thermal power plants and fossil fuels.

Nowadays, Brazil faces restrictions to the expansion of its hydropower potential, with the impossibility of building large reservoirs, estimates indicate that the region will need to double its electricity generation capacity by 2050 (IADB, 2013). This means that wind and solar sources shall gain importance in the region's energy mix.

²Electricity generation in LA&C is complemented by: 4.42GW of nuclear energy, and 5.5GW of other sources (geothermal, solar and wind). Source: Olade-SIEE, 2013.

It is in Brazil that the prospects for wind sources are gaining ground in LA&C. By the end of 2014, the country had ranked 10th among those with the largest wind power generation installed capacity in the world, with 5.9 GW.

Figure 1

Campos Neutrais Wind Complex, in Rio Grande do Sul, Brazil. The largest wind complex in Latin America. 0.583 GW of installed capacity.



Source: <http://www.portal-energia.com/expansao-e-principais-empresas-do-setor-eolico-no-brasil/>

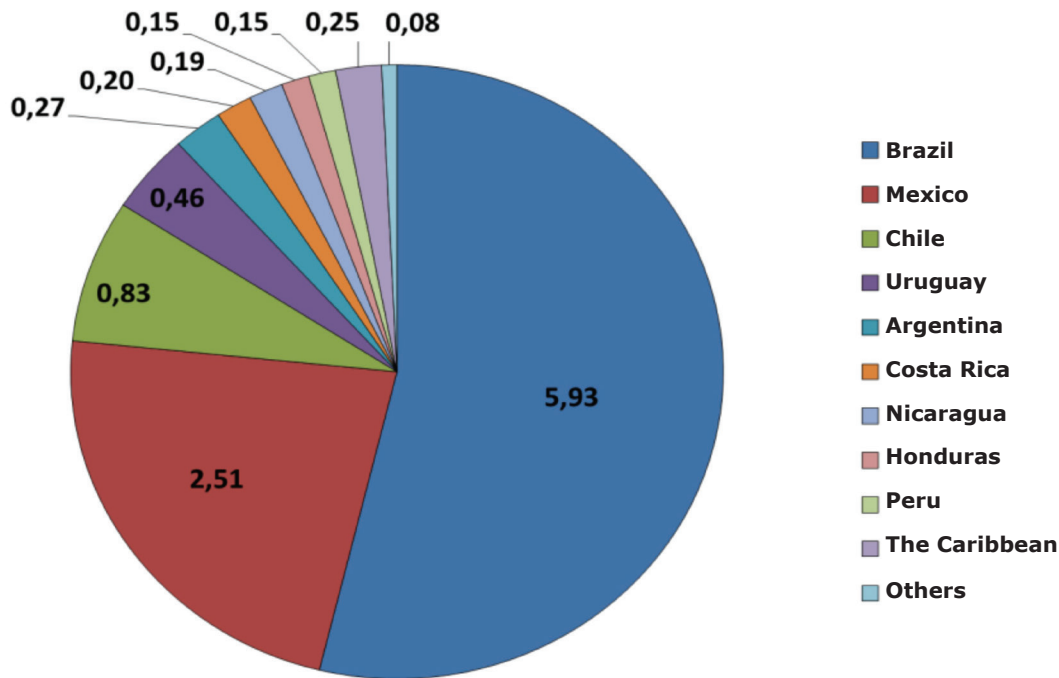
With Brazil, Mexico (2.5 GW) and the sum of all the other countries in the region (2.5 GW), LA&C totaled, by the end of 2014, a wind power installed capacity of 11 GW, which is less than 3% of the world's installed capacity (369.6 GW), but represented the largest growth globally, with an increase of 70.6% between 2013 and 2014 (Gwec, 2014, p.7). In 2014, only China (20.7 GW), Germany (5.3 GW) and the United States (4.9 GW) added more installed capacity to wind power generation than Brazil (2.5 GW) (REN21, 2015, p. 135).



Graph 4

Wind Power Generation Installed Capacity (GW) in Latin America and the Caribbean, per country (2014).

(2014)



Source: Prepared by the author based on: Global Wind 2014 Report. p.7

Note: The Caribbean: Aruba, Bonaire, Curacao, Cuba, Dominica, Guadalupe, Jamaica, Martinica, Grenada, Saint Kitts and Nevis; Others: Bolivia, Colombia, Ecuador and Venezuela.

It is worth noting the exponential expansion, in 2014, of wind power generation in Chile (from 0.331 GW to 0.836 GW), Uruguay (from 0.059 GW to 0.464 GW) and Peru (from 0.002 GW to 0.148 GW). There was also a wind power generation increase, but on a lower scale, in Argentina (0.053 GW), Costa Rica (0.050 GW), Honduras (0.050 GW) and Nicaragua (0.040 GW).

If Brazil stands out in LA&C's wind power exploration, other countries will assume the leadership in the region's still timid exploration of solar photovoltaic energy. In 2014, the world's cumulative installed capacity reached 177 GW, with countries like Germany (38.2 GW), China (28.2 GW), Japan (23.3 GW), Italy (18.5 GW) and the United States (18.3 GW) standing out. In LA&C, Chile jumped from insignificant 0.006 GW in 2012 to 0.5 GW by the

end of 2014 and leads the expansion; and prospects for growth in the country are concrete. More than 40 generation projects will be delivered or under construction by 2017 totaling 2.2 GW³ of solar energy (CNE, 2015). According to the delivery schedule for solar power plants, Chile will surpass the 1 GW milestone by the end of 2015.

Figure 2

“Amanecer Solar CAP” power plant,
Copiapó Municipality, Atacama desert, Chile. 0.1GW installed
capacity: investment of 250 million dollars. 310 thousand
photovoltaic modules in an area of 280 hectares.



Source: <http://www.sunedison.com.br>

Chile, Mexico, Honduras, Guatemala, Panama and Brazil added 0.625 GW in solar generation to the region in 2014. Projections point to a total of 2.2 GW of solar energy installed capacity in LA&C by the end of 2015.



Table 1
Short-term outlook for photovoltaic solar energy in LA&C:
main countries.

| Country | Outlook |
|-----------|---|
| Chile | Generation projects under construction: 17 photovoltaic solar power plants in 2015 (0.659 GW), 22 solar power plants in 2016 (1.34 GW) and 3 photovoltaic solar power plants in 2017 (0.198 GW). 6 projects with power generation capacity of equal or over 0.1 GW are noteworthy. The hybrid Copiapó Solar power plant is expected to come into operation in 2019 and will be the largest solar power plant in Latin America with 0.260 GW using CSP (Concentrated Solar Power) technology together with Photovoltaic technology. (National Energy Commission, Ministry of Energy / Comisión Nacional de Energía, ME, Chile, 2015) |
| Honduras | In 2014, 21 solar energy generation contracts were approved, representing 0.619 GW. As an incentive to achieving the goal, the Government of Honduras promised to pay 0.03 cents of dollar per kilowatt to generators who produced the first 0.3 GW by July 2015. It is expected that Honduras assume second place in solar energy generation in LA&C by the end of 2015, with probable 460 GW. The country recently opened the region's largest wind power park with investments of 232 million dollars and 0.146 GW of installed power during the peak hours. (ENNE, Boletín ENEE Avanza, Edición 19 de 17 a 21 de Agosto de 2015) http://www.enee.hn/index.php/noticias/boletines |
| México | With 0.067 GW installed, the country has great potential. In January 2014 the Parque Solar Aura Solar I solar power plant was opened with a 0.038 GW capacity. According to the Renewable Energy National Inventory (Inere), there are 9 photovoltaic solar parks currently in operation in Mexico, two belong to CFE (Federal Electricity Commission) and seven are privately owned. In 2014, Mexico added 0.097 GW. The recent opening of its power sector to the private initiative may give momentum to the development of photovoltaic solar energy in the country. Uncertainties and the delay in defining rules has been considered an obstacle to the effective resumption of investments. Mexico's goal is to reach 3 GW in 2015 (INERE, 2015). |
| Guatemala | In 2014 the country added 0.063 GW of photovoltaic solar energy to its electricity grid. In January 2015, the Horus I solar power plant was opened with an investment of 100 million dollars and a 0.058 GW installed capacity. The second phase of this endeavor will add another 0.048 GW (Horus II). It is estimated that by the end of 2015 the country will reach 0.1 GW of installed capacity (4E Renewable Energy and Energy Efficiency in Central America Program / 4E Programa Energías Renovables y Eficiencia Energética en Centroamérica). Until July 2015, the country's electricity company (Etesa) granted 0.772 GW in definitive licenses to build solar power plants and 1.191 GW in provisional licenses. 0.100 GW are currently under construction. (CentralAmericaData.com) |
| Brasil | In 2013 the first Energy Auction to include solar generation took place, but did not attract any interested party. In October 2014, a specific solar power auction took place and 0.88 GW were contracted (31 undertakings). The First Reserve Energy Auction of 2015, designed to contract electricity from photovoltaic solar sources registered 382 projects totaling 10.51 GW of licensed potency. 30 undertakings sold energy in the auction, with a total potency of 0.833 GW and supply expected to begin in August 2017 (Technical Informatio Aneel, 02/06/2015, e 28/08/2015). |

Source: Prepared by the author; Note 1: Estimates and information obtained with the ministries and/or secretariats and/or government bodies related to energy management in the mentioned countries and complemented by specialized sites on the region's energy such as *GTM Research Latin America PV Playbook*, and *CentralAmericaData.com*.

LA&C emerges as a new and promising market for wind and solar sources. But it is necessary for the region to learn with the rights and wrongs of Europe, USA and China to create its own development strategies for these sources. As of 2010, Europe has been cutting subsidies in the wind and solar sectors, which has pushed companies and investments to move to other regions in the world, including LA&C in the past few years. The main European issue is the total cost transferring energy to household and industrial consumers who pay the price for high investments that do not always show substantial return from the energy supply point of view. Environmental gains are drivers of this process, but also come at high prices and Germany, Spain, Denmark and Italy are reviewing and deactivating regulatory policies such as *Feed-in tariff/premium payment, and net metering*⁴, and so are the United States and China.

To ensure the sustainable expansion of these sources, LA&C must observe local realities and true energy needs. Guatemala and Honduras are already discussing the revalidation of premiums and long-term subsidized contracts, and even the exceeding projects, which, for the former represent twice the country's energy needs. If European high-income electricity consumers are questioning the high electricity prices, what will happen to the poor Latin-American consumers? Sustainability requires benefits to the environment, but also secure and democratic access to cheap electricity (7th SDG). With advances in quality of life still lacking, most Latin Americans have low incomes and spend most of it on basic needs and electricity should not weight too much on these families' budgets. In the same manner, expensive energy for the industry disables production and makes the final product more expensive, creating conditions for inflation.

Another important step for LA&C is internalization of technologies and the development of domestic industry chains for wind and solar energy. Environmental gain would be associated to economic and social gains with job generation and economic development. The region cannot create a situation of technological dependence as a sheer importer of equipment and services. This is the model in place today in the region, which imports equipment and services from Spanish, American, German and Chinese companies. LA&C still lacks qualified labor, development centers, quality certification and university research groups. It is necessary to overcome that first stage of importing technology to ensure the maintenance of projects with long lasting impacts in the economy, technical and educational development and strategic security (without technological dependence) in the Latin American energy sector.

⁴*Feed-in tariff/Premium payment*: dealers are required to pay more for renewable energy ensuring income for generating companies; *Net metering*: compensation as a discount or energy credit for consumers linked to the grid by injecting exceeding energy back in the system.

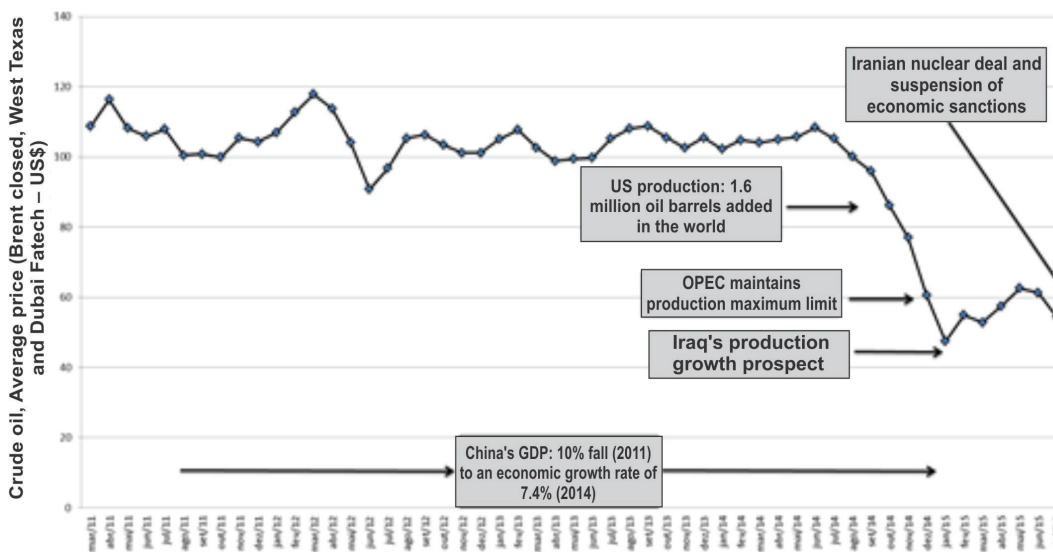
2. Oil prices

2.1. Current figures

Oil, the main and most versatile energy resource of the planet and the most strategic commodity in the modern world, has been presenting a sharp fall in its price since mid-2014. After a period of relative stability, between March 2011 and August 2014, with oil barrel prices varying between 100 and 120 dollars, oil prices fell from the three-digit level in September 2014 and dropped to 60 dollars in three months. The first half of 2015 saw oil barrel prices vary between 50 and 65 dollars and the second half began with the barrel of oil at 46 dollars. This is a new scenario and quite different from past years.

Graph 5

Oil barrel prices (2011-2015) (US\$) and economic and geopolitical events that affect its behavior



Source: prepared by the author based on: Index Mundi - <http://www.indexmundi.com/pt/pre%20os-de-mercado/?mercadoria=petr%C3%B3leo-bruto&meses=300>

2.2. Factors that affect oil price formation

Oil prices are not established only by the relation between supply and demand. There are also important geopolitical components besides a wide range of surrounding factors that affect the input's supply and demand and, consequently, its price formation:

- Technological innovations that lead to new exploratory frontiers: Technological advancement has provided the expansion of exploratory frontiers and the increase in non-conventional oil reserves. Techniques such as fracking and horizontal drilling have enabled the exploration of shale gas and oil in North America as has the mastery of deep water drilling enabled access to oil reserves in the pre-salt layer in the Brazilian coastline 7 meters deep. The increase in reserves affects supply.
- Speculation: there is a strong speculative component in oil prices. Futures markets affect current prices. This factor affects demand. For each physical barrel negotiated there are a number of "virtual" barrels negotiated in the future market.
- Terrorism and wars in production zones: geopolitical events have always been linked to oil price behavior. The Middle East has attracted attention because of this issue as well as North Africa. Political instability in conflict regions affects supply.
- National energy policies, geopolitical strategies using oil as a power tool: Because of its strategic importance, oil has motivated governments and companies to establish tense relationships in managing world reserves and oil trade. Embargos, overproduction or production cuts are strategies used by important geopolitical actors in the field of oil, with a strong impact on supply.
- Climate change that makes imperative to shift to an energy matrix that is less dependent on fossil fuels: the environmental urgency emerges as a limiting factor for the use of fossil fuels, particularly oil. Although its influence is not immediate, the environmental crisis promotes the gradual transformation of the energy matrix, pointing to a greater use of renewable sources instead of fossil fuels, aiming to prevent a climate breakdown with the increase of the planet's temperature and sea level rise. Its impacts are a reduction of both supply and demand.
- Economic booms and recession periods: a slowdown in world economy impacts demand by making it less intense or even stagnant, and periods of economic growth require greater supply of oil, impacting prices by pressure caused by the rise in demand.

-
- Extreme climate events that stop production: tornadoes, cyclones, hurricanes, earthquakes, and tsunamis impact supply chain by affecting production areas. It is common that hurricanes hit the Gulf of Mexico and halt oil production in the region.

2.3. Why did oil prices drop?

With regards to the present, some factors seem to have strongly influenced the drop in oil prices. The following are noteworthy:

- The rebirth of the North American production of shale oil and gas: the North American oil production reached the significant mark of 11.6 million barrels per day, surpassing Saudi Arabia and Russia in the list of the world's largest oil producers.
- OPEC's position not to reduce oil production, a common means to increase prices: The OPEC, led by Saudi Arabia maintained the maximum limit for oil production at about 30 million barrels a day and has not signaled with reductions in the short term.
- The end of international sanctions against Iran due to the nuclear deal will add more oil to the market: at the end of 2014, Iranian production was 3.6 million barrels a day. With the end of commercial sanctions, Iran will be able to put at least another 500 thousand barrels a day on the market.
- Iraq's production growth: between 2010 and 2014, Iraq's production increased by 795 thousand barrels a day with prospects to continue progressing.

All these events impact prices by pressing oil supply. On the other hand, low global economic growth particularly in China and the rise of the dollar have created conditions for the fall in oil prices.

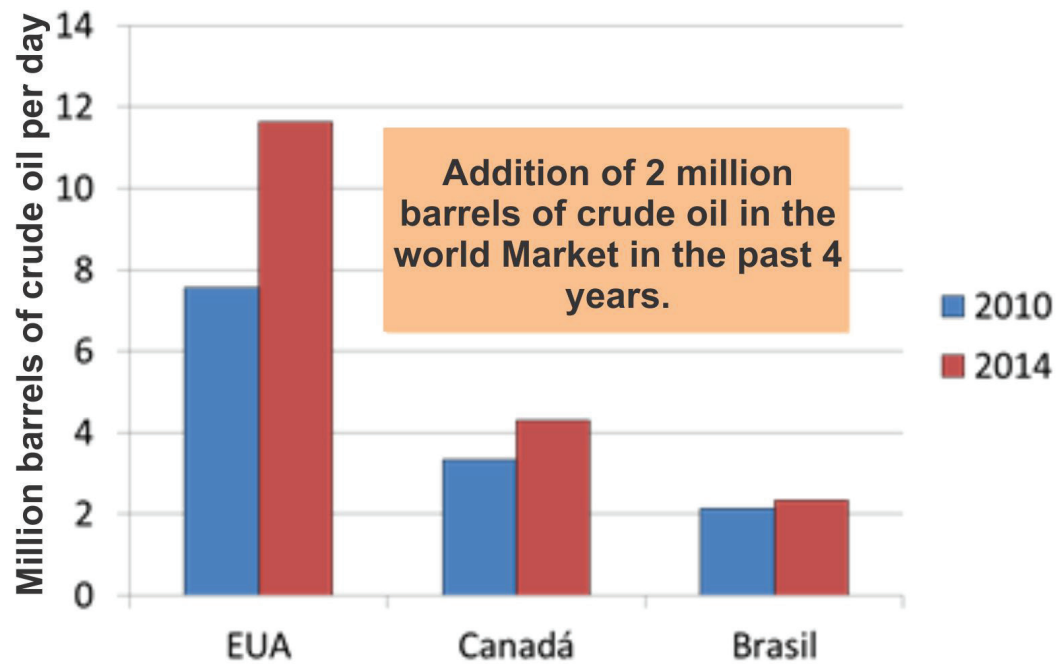
2.4. Why do oil prices tend to remain low?

The tendency for oil prices to remain low for a while seems to be reinforced by three main aspects. The first is the new geopolitical configuration of oil, with the Americas taking center stage, particularly Canada (oil sands), Brazil (pre-salt) and the USA (shale oil and gas) (see figure 6), adding 2.092 million barrels of oil daily to the market, the resumption of production in countries like Iran and Iraq and the maintenance of Russian production. The second aspect is related to the retraction tendency of the Chinese economy as well as the low recovery of the global economy, in particular in emerging countries, which implies a weak or stagnant demand; and, finally, the use of other fossil sources such as coal and natural gas that, in part, replace oil in electricity generation. So, LA&C must guide its

energy strategies for the coming years based on realistically low oil prices and its consequences or, why not, opportunities.

Graph 6

Oil production increase 2010/2014. USA, Canada, and Brazil.



Source: prepared by the author based on BP Statistical Review of World Energy, June 2015, p.8

3. Effects of the drop in oil prices in LA&C and the development of renewable sources in the region: obstacles and solutions.

3.1. The impact on revenues of oil exporting countries in the region.

Although this question should take into consideration that situations may change in the short and long terms, in general, the biggest losers with the fall of oil prices are the countries that export this commodity and a few that are economically diversified. In LA&C, the country that loses more with low oil prices is Venezuela. Oil trade accounts for more than 90% of the country's exports and a fall in prices generates less income and overthrows the country's revenue, representing great difficulty to the maintenance of its economy. Colombia recently had half of its exports tied to oil and has suffered from strong currency depreciation due to the growing dependence on oil exports. Another country dependent on oil exports in the region is Ecuador. More than 50% of Ecuadorian exports are related to oil, and the country has seen its revenue drop significantly in recent months.

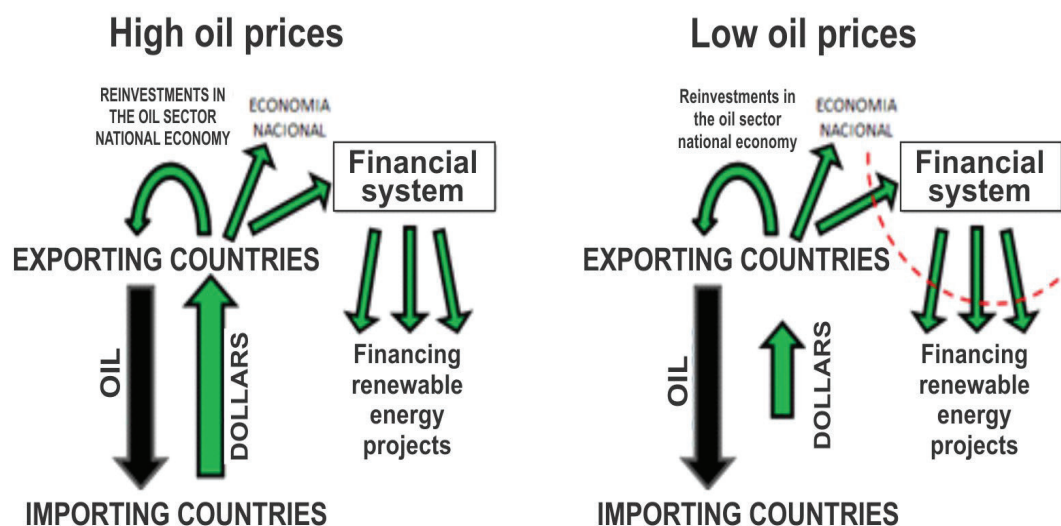
Oil contributes with a third of public income in Mexico and the fall in prices has led to strong public expenditure reduction policies at the time when the country opened its oil sector ending a 76-year period of state monopoly. Brazil sees the price of oil getting closer and closer to the economically viable minimum for exploring the pre-salt, which is of about 45 dollars and has downwardly revised its investment plans in the oil sector. Although the country is not strongly dependent on oil exports and has in the short term profited with the low prices observed since November 2014 by not automatically attaching domestic fuel prices (higher) to the international prices (lower), its great challenge will be the long-term effects with the loss of income and investment capacity. On the other hand, countries such as Argentina, Peru and Chile, who are oil importers, do not suffer a direct shock from the fall in oil prices. At first, they even benefit by importing cheaper oil, however, this may result in a lower interest in investing in oil substitutes, particularly for the generation of electricity.

3.2. The reduction in available resources to finance renewable energy projects

The main effect of a low oil price situation on the development of alternative and renewable sources, such as wind and solar power in these countries, is the decrease of government funds to finance or invest in these alternative energy sources, which are still considered high-risk ventures by the market (because of uncertainties in government rules and instability of contracts), risking the recent surge in alternative and renewable sources' growth in LA&C in recent years.

Figure 3

Scheme simplifying petrodollar cycles with, both high oil prices and low quotations



Source: Prepared by the author.

Figure 3 simplifies the cycle of petrodollars in situations of high prices (when exceeding profit is injected in the financial market) and low prices (when governments centralize spending in maintaining the domestic economy and preserving the production system). When the oil barrel price is high, a situation that persisted through the past 4 years, there is a significant transfer of funds to oil exporting countries. These, besides reinvesting in the oil sector's production structure and national expenditure, transfer part of the exceeding profit to the financial system, promoting financial institutions' lending and financing capacity and increasing the offer of credit. Companies and governments across the world access these sources to finance all types of projects, including renewable energy. When oil prices fall, this cycle becomes precarious or unsustainable. Programs

such as the Climate Fund in Brazil, mediated by the BNDES have a significant part of their budget linked to resources originated in taxes on high scale oil production⁵ and the drop in oil prices makes this tax collection unfeasible.

Loans and financing made by governments have been enabling the growth of solar and wind sources as well as bank financing contracted by private companies to develop projects. These contributions originate in private and public financial institutions such as traditional banks, national development banks (BNDES in Brazil) and international and regional development banks, such as the Central American Bank for Economic Integration and the Inter-American Development Bank for LA&C.

It is important to mention that the SE4ALL (Sustainable Energy for All Country Action) program, under the Inter-American Development Bank, has financially supported thousands of projects related to the energy sector, from energy efficiency and universal access to energy, to incentives for renewable energies (SE4ALL, annual report, p. 12). However, the challenge to finance climate change mitigation is that it requires huge investment. According to Filho & Mendes (2013, p. 7), *"the incremental investment in the energy sector alone will have to reach 36 trillion dollars over the period 2012-2050, or nearly 1 trillion dollars a year"*. In spite of established commitments under CQNUMC regarding developed countries' responsibility to allocate funds for mitigation and adaptation, these initiatives are not yet sufficiently clear, they are difficult to solve in the scope of the COPs and are limited by the global financial crisis. The financial constraints in developing countries make funding mechanisms in regions such as LA&C even more difficult due to the precariousness of public accounts and the need to focus resources on emergency issues and local issues such as the fight against poverty, improvement of basic sanitation, health and education.

⁵The National Fund on Climate Change (Climate Fund) was established by Law No. 12.114 / 2009 and regulated by Decree No. 7,343 / 2010. The Fund is an instrument of the National Policy on Climate Change (NPCC), established by Law No. 12.187 / 2009. It aims to finance projects, studies and projects aimed at mitigating (ie the reduction of impacts) of climate change and adapting to its effects. Source: BRAZIL, MMA


3.3. Resource concentration towards better profit conditions: the strength of low prices associated to the consolidated infrastructure in the oil sector.

Another factor that may restrict the development of renewable sources is the concentration of resources on non-renewable commodities due to their low prices. From an environmental point of view, unfortunately, this is the case for oil, natural gas and mineral coal. All international energy sector reports indicate a growth in natural gas and mineral coal consumption in the global energy matrix, and a certain stabilization of oil. It is a simple matter of profit for companies that migrate towards certain energy inputs, motivated by low prices, abundance, preexisting infrastructure, qualified labor and a consolidated market. A recent phenomenon has been the migration of businesses and investments to the USA during the shale gas boom, considering the low prices of natural gas. Concentration may happen because of a State policy option. Such is the case of Brazil, where the development of the pre-salt is understood as strategic and gathers a sizeable share of investments in the oil sector at the expense of renewable energy sectors (such as biofuels, for instance), which remain marginal. Similar movements are observed in Venezuela, Colombia, Ecuador and Bolivia (In Bolivia, particularly regarding natural gas).

Besides these factors, the unparalleled characteristics of oil should be considered, such as, its multi-use and, especially, its role in the transportation sector. Under these criteria, oil does not have a suitable substitute. This means that strategies to overcome this challenge depend crucially on government and state political action rather than on the market, although the market cannot be disregarded. Governments and states' role is particularly important in the initial promotion to implement these new sources, when they do not yet have competitive conditions to face traditional sources.

3.4. Public policies, market solutions, scale economy and energy infrastructure: factors to ease the effects of the drop in oil prices.

However, there are ways to avoid this dependence and they are already in place. They may even be found within the joint action of government and market. A good example of a market solution guided by state policy are the energy auctions, which have been ensuring the successful expansion of wind energy in the region. The model that has been adopted by Brazil since 2009 was recently adopted by Chile, who until last year based its solar and wind expansion on energy sales agreements with mining companies. Peru,



Uruguay and El Salvador also adopted the renewable energy auctions system. Energy auctions come with guarantees and other attractive conditions to developers such as long-term contracts and the assurance of energy purchase by power distributors at fixed prices, ensuring financial returns and, thus, reducing investment risks.

Under the specific scope of government actions, a series of regulatory policy mechanisms, tax incentives and public funding have contributed to a favorable environment to the expansion of wind and solar markets. Noteworthy are regulatory policies such as *feed-in tariff*, *electric utility quota obligation*, and *net metering*, besides tax incentives and public funding such as subsidies, loans and financing. But, all these mechanisms depend on the country's positive economic outlook. Energy auctions seem to bring more competitiveness and lower energy prices.

Another favorable factor to greater reliance on the expansion of renewables in relation to oil prices' variation is the increase in scale of the wind and solar markets in the world, reducing production costs of equipment and services related to the sector. However, this benefit is more connected to large power plants rather than micro or mini-generation plants or to the distribution market (particularly in the case of photovoltaic solar sources). Even with regulatory policies such as *net metering* in countries like Brazil, Chile, Mexico, Panama, Guatemala, Honduras, Colombia, Ecuador and Argentina, factors such as delays and red tape regarding connections to the grid and the high cost and great amount of time it takes for returns, have made expansion and mini and micro-generation of photovoltaic energy a great challenge in Latin America and the Caribbean (REN 21, p. 99-100). However, as for major plants, the tendency is that photovoltaic solar panel costs drops providing a favorable environment for the distribution expansion in households and commerce.

The electric system's infrastructure also plays an important role in neutralization the oil price impacts. The principle consists of the inter-connectivity of domestic electricity systems and, in a more complex scale, of the multinational systems. It is in isolated regions and localities, which are not connected to the inter-connected systems that thermal power plants and fossil fuels expand, such is the case in Brazil's far north. Isolated systems produce expensive and polluting energy. Inter-connection allows for energy to be transferred among regions, accessing solar power plants, wind parks, hydro power plants, geothermal power plants and biomass thermal power plants connected to the grid. This infrastructure improvement process is the physical and structural base, as well as, a condition to diversify the national and regional energy matrix.

3.5. The climate crisis as a decisive factor in energy transition: is oil really cheap?

Among all these favorable movements to dissociate renewable sources' evolution from oil price behavior, the one with greatest strength is also the one with the widest caliber. It is less specific, more complex and needs joint actions – the fight against climate change. It is the climate emergency that has given and will continue giving the tone to public policies and even to market behavior and, ultimately to consumer behavior. Hence, information dissemination and awareness raising regarding environmental harm from the use of oil become important strategies in valuing the use of renewable energy sources such as wind and solar power.

Although LA&C are not leaders in the emission of greenhouse gases from their electricity matrixes or appear among those historically responsible for global warming, they will equally suffer the effects of climate change, particularly those related to sea level rise due to this region characteristic territory occupation model favoring low coastline areas (Marzano & Cholibois, 2015, p.4), that results from the historical territorial formation process.

In a way, oil is only cheap because its value does not reflect its environmental costs. Designing mechanisms to value or price environmental damage in the cost of oil becomes an important step to make it less competitive. While it is impossible to measure social and environmental damages caused by the use of fossil fuels, particularly in the health sector, especially those connected to respiratory problems in major cities, any withdrawal of subsidies to oil or any form of overtaxing it through fees should be considered. But, here it is worth a warning. Solar and wind power sources are directed at electricity production, that is, they may avoid the use, or at least reduce the share of coal, oil and gas thermal power plants in electricity supply. At first, their contribution to reducing greenhouse gases emissions is incipient, since much of this problem is associated with the transportation sector, the great emitter of greenhouse gases in the world. This is true in the short term, but in the medium and long terms, the effects will be felt. Moreover, it is necessary to associate the expansion of supply of renewable electricity sources in LA&C with a transformation process in the means of transportation, increasing the railway and subway systems and gradually introducing electric cars in the automotive fleet.

In a way, for the expansion of wind and solar sources to be less dependent on oil prices in LA&C, the following set of factors will have a favorable role:

- Global economic stability and economic and energy diversification in the region;
- Consolidated wind and solar global markets (scale economy), with moderate saturation in traditional markets and technology transfers;
- Public policies to encourage renewable energies until the regional market is established and mature;
- Spreading of information about the climate emergency and environmental harm caused by thermal power plants that operate on oil-products and about the social and economic benefits of a green energy chain, awareness raising of the future energy consumer;
- Transformation of transportation means in the region with expansion of railroad (domestic and international) and subway systems. Introduction of the electric car in transportation (green modes of transportation);
- Cuts in subsidies to the oil industry and lower allocation of resources in the oil sector;
- Incentives for micro and mini-generation distribution in households and commerce;
- Inter-connected systems covering all national territories, with gradual exclusion of oil-products thermal power plants, promoting energy integration across the region.

4. Final thoughts and recommendations

Even if not in a deterministic manner, it is possible to note a relationship between the behavior of oil prices in the past four years and the expansion of alternative and renewable energy generation sources in the world, particularly wind and solar sources. This relationship is observed by the triangulation of resources originated in the oil industry, through its taxation to mitigate and adapt to climate change (through an international financial structure designed by multi-lateral agendas for domestic and public policies) or through the provision of credit to finance renewable energy projects as a business (private sector). However, it is worth mentioning that we are facing a recent phenomenon, because of the rise of wind and solar sources to a scale economy, with a reduction in production costs is a relatively new reality, which has not yet been established and whose resilience will be tested for the first time in a scenario of depressed oil prices, associated to a period of low global economic growth.

Establishing scenarios with the oil price as a central element has proven to be a high-risk business given its volatile character due to its price formation elements that are varied and of different natures, as we observed in this article. But, assuming as a planning exercise, a period of low oil prices and, consequently, of reduction in resources; the environmental emergency and the competitiveness of solar and wind sources in the energy market emerge as the major support factors to the continuity of these sources' expansion. For both, the role of government and states is crucial, both on the international arena through multi-lateral instruments to fight climate change as in the domestic arena, providing a "green business" environment with clear rules, attractive and secure contracts for renewable energy investors.

Latin America and the Caribbean are part of this international framework as receivers of resources to adopt sustainable development policies. But attaching energy security to a fragile financial structure exposed to market variations and difficult political agreements to transfer (needed and sizeable) resources to mitigate and adapt under CQNUMC's scope may represent the loss of the initial but important advances in the implementation of wind and solar sources in the region. In this sense, it is worth noting that technology transfer with regard to these sources is an essential step in the process of shielding LA&C against economic problems associated to the fall in oil prices. Without skip these vital tools, it is up to the region to establish its own proper strategy, according to its characteristics, with the ultimate goal to reconcile the region's social and economic development, the energy supply and respect for the environment.

An agenda that includes actions whose primary function is to reduce oil's importance to the economy and in energy generation should include the following aspects:

1 – Diversifying the most of its energy matrix through the introduction of alternative and renewable energy sources, without resulting in technological dependence or great debt;

2 –Increasing the share of wind and solar in the energy mix of the region, especially due to the constraints faced by Brazil to expand its hydroelectric potential – such the impossibility to construct large reservoirs – and the estimation that the LA&C will need to double its electric generating capacity by 2050.

3 –Ensuring sustainable expansion of these sources, LA&C needs to take into account their local realities and their real energy needs.

4 – Reduce the dependence on fossil fuels, particularly oil, due to this commodity's price volatility, as a strategy to shield the region's economy against negative effects of market variation and the world's energy geopolitical agenda;

5 – Find mechanisms to price environmental costs of fossil fuel use in order to introduce externalities caused by its intensive use in its value and make oil less competitive;

6 – Invest in innovation and the technological development of renewable energy, particularly, wind and solar, but also biofuels and biomass thermal plants;

7 – Establish a regional position in the climate debate, ensuring greater resource and technology transfers to implement a sustainable development model that includes the balanced progress of the economy, people's quality of life and environmental preservation;

8 – Improve national and regional energy infrastructure through major inter-connected energy systems that allow for a more efficient domestic and regional energy management;

9 – Transform the transportation structure in the region by diversifying its modes of transportation through the expansion of railways, waterways and improving the situation of its roads in order to reduce the use of fossil fuels such as diesel oil and gasoline;

10 – Make efforts through regulatory policies and financial incentives to develop renewable energy industry chains in the

region, ensuring job generation, labor qualification and regional market maturity for wind energy sources.

11 – The wind and solar energy expansion policy should not be based solely on the construction of large generating plants, but it should also encourage micro and mini-generation distributed among homes and commercial businesses;

12 – Expand the environmental debate on all education and research levels.

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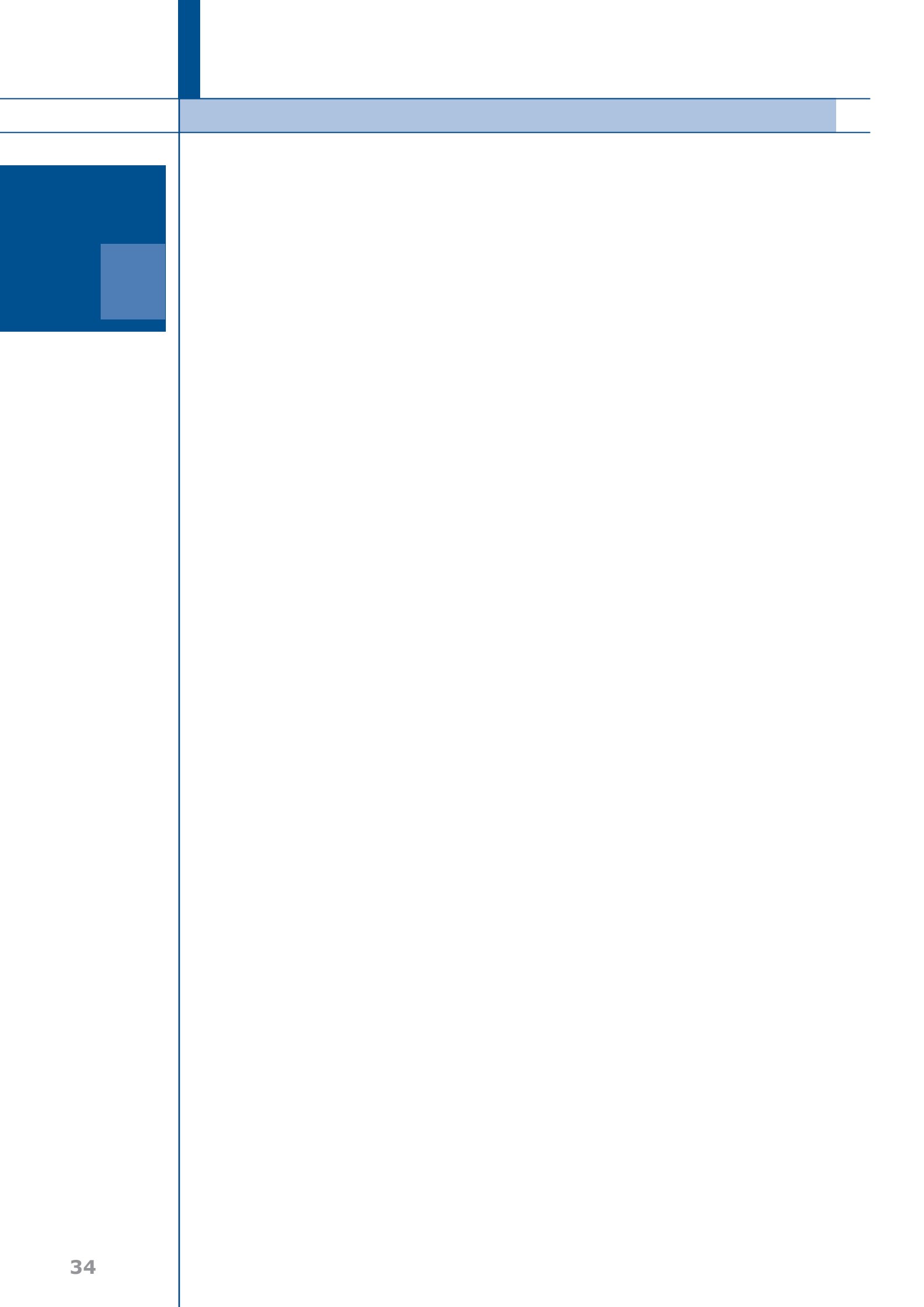
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