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Analysis of Energy Integration and the Transboundary Superstructure in South America

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Abstract: The purpose of this work is to present the difficulties of the superstructure when related to EI (Energy Integration) process in South America. The methodology aims to give emphasis to related projects within a binational and multinational scope. Methodologically there is the consideration of deterministic indicators, such as: project costs, installed capacities, financing sectors and politics strategy. These results in quantitative evidences that less developed countries from Latin America (LA) are precisely the ones that consume less electric power per capita and that have large reserves of energy resources, available to be commercialized with countries that have high demands and lack of reserves. Results also demonstrate that EI carries factors of development (national and regional) that ensure supply, reliability and efficiency in this region, which minimizes the dependency for only one energy source and reduces store costs. A conclusive element refers to relevant economic gains for countries that commercialize their energy resources or electricity surplus, which includes the possibility of development of other structural areas. Once established the region's physical integration, the enhancement of trade, political, social and cultural relations between their members are greatly expanded.

Key words: energy integration; transboundary projects; energy planning; South America; integrated resource planning; supranational bodies

JEL codes: F020, O210

1. Introduction

South America (SA), see Figure 1, is a subcontinent that comprehends the southern portion of America. Its surface corresponds to 17.819.100 km², representing 13.7% of Earth's surface. Its natural boundaries are the Caribbean Sea to the north; Atlantic Ocean to the east; northeast, southeast and Pacific Ocean to the west. It concentrates a population of approximately 407 million inhabitants, 6% of world population, which 84% lives in urban areas and 16% in rural areas. It has a population density of 22.8 inhabitants per km², Gross Domestic Product (GDP) of 4.368 billion (currently US$), about 6% of world GDP (WDI, 2014) and Human Development Index (HDI) of 0.740, see Table 1, which, according to UN, is a high human development index (HDR, 2014).

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Figure 1 South American Projection

SA has abundant natural resources but still presents serious socioeconomic problems. Since the beginning of its colonization, the continent has served as raw material supplier, at first for its metropolis and currently for developed countries and China, staying at the sideline of technological and social development.

The economy is concentrated in beneficiation of agricultural products, in production of consumer goods, mining, steel mill, extraction and petroleum refining.

Regarding the energy sector, SA has big petroleum reserves, with 322.4 billion of bbl, highlighting Venezuela with 92% from the total, and natural gas reserves, with 7,097 Gm^3, highlighting Venezuela and Bolivia (Olade, 2011). Besides that, SA has the biggest water system in the world, in which the mainly basins are the Amazon, Orinoco and Plata systems. These three systems, together, drain an area of 9,583 MM km^2 (54% of SA territory), and big lakes like Titicaca and Poopó, Andes region, and Maracaibo lake, in Venezuela. This characteristic ensures this region a great hydroelectric potential (583 GW), which only 25% (144 GW) of the total is used nowadays (IEA, 2012), see Figures 2-4.

Table 1 Countries and Dependencies in South America

Country	Area km^2	Population (2013)	GDP ($x10^3$ current US$ 2013)	HDI (2013)
Argentina	2,791.810	41,446.246	611.755	0.808
Bolivia	1,098.581	10,671.200	30.601	0.667
Brazil	8,514.877	200,361.925	2,245.673	0.744
Chile	756.950	17,619.708	277.199	0.822
Colombia	1,141.748	48,321.405	378.148	0.711
Equator	256.370	15,737.878	90.023	0.711
Guyana	214.970	799.613	3.076	0.638
French Guyana[1]	86.504	209.000	-	-
Paraguay	406.750	6,802.295	29.949	0.676
Peru	1,285.220	30,375.603	202.296	0.737
Suriname	163.270	539.276	5.231	0.705
Uruguay	176.220	3,407.062	55.708	0.790
Venezuela	916.445	30,405.207	438.284	0.764
AS	17,809.715	406,696.418	4,367.942	0.740
World	129,733.917	7,124,543.962	74,909.811	0.702
SA/W Rel	13.7%	5.7%	5.8%	-

Note: [1]Territory entirely integrated to France

Source: own elaboration, data from WDI, 2014, HDR, 2014.

In the current context of increased demand for mineral and energy resources in Brazil and SA, caused by economic growth and expanded access to electricity by poorest and geographically isolated populations, which, economically, expand the need for energy and raw material for companies to extract and process their products and, socially, improve people's lives by adding lighting, heat and transportation. So, it is inherent the need of energetically integrating the region, since lots of these resources are exhaustible and not distributed in a homogeneous way in that space. Energy planning becomes important in a way to guarantee security and energy efficiency, in a long term, in the whole area.

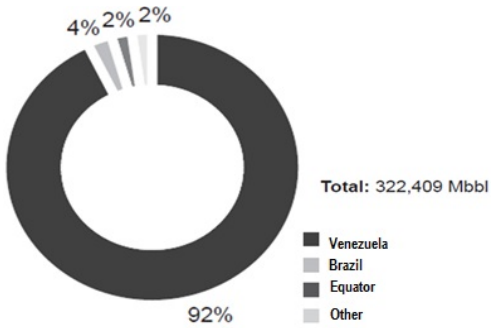

Figure 2 Distribution of SA Petroleum Reserves (Olade, 2011)

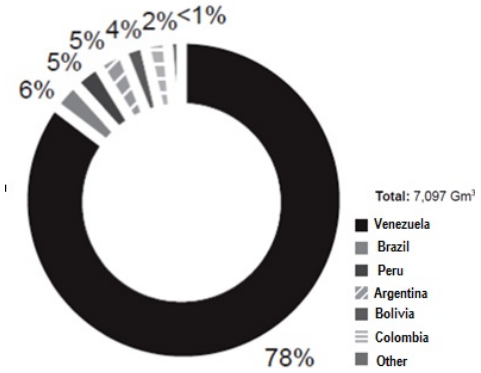

Figure 3 Distribution of SA Natural Gas Reserves (Olade, 2011)

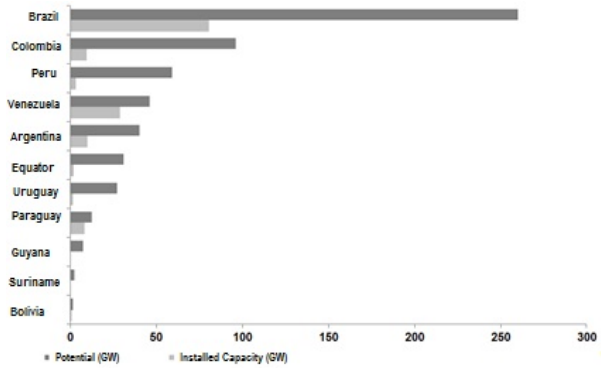

Figure 4 South American Hydroelectric Potential (Olade, 2011)

In EI it is necessary to discuss and understand specific and regional needs of the nations, as well as diplomatic history between them, because the current political conjuncture of SA overlaps its economics facilities, since energy is one of the foundations of economic integration in the globalized world. Therefore, EI aims to determine what the

energy sector, characteristic of each country, can offer to the process of social and economic development in national policies and regional integration scope.

Within Latin America (LA) context, the dynamics of SA integration will be presented with more emphasis since it is the study focus and many times these relations will occur with Central America and North America countries, because they have historical, political, economic and social similarities.

2. Methodology

This work consists in the analysis of SA integration, through bibliographic and historic survey of bilateral and regional agreements, identifying:

- Main involved agents (public and private);
- Supranational Organisms;
- Existing, implanted and planned integrations.

From this survey, analyze EI studies and projects in South America, considering the kind of project, involved countries, funding source, investment amount and implantation area, and, thus, identify the future perspective of SA integration.

The projects selection goes after the following criteria:

(1) Projects linked to IIRSA (Initiative for the Integration of the Regional Infrastructure of South America);

(2) Having the purpose of EI;

(3) Binational or Multinational;

(4) Having physical infrastructure of electricity generation or transmission;

(5) Being concluded or in an execution phase.

3. Supranational actors involved in South America Integration

Throughout history several regional organisms in SA were suggested, at first for defense and arbitration cooperation of external policies, like the ABC pact 1915, formed by Argentina, Brazil and Chile, with the aim of minimizing United States' influence at the region and establishing consultation mechanisms. Posteriorly, these agreements had the feature of promoting trades and regional production and, after that, of South America integration.

In Latin America, nowadays, there are several supranational organisms linked to regional integration, like Andean Community of Nations (CAN) and Southern Commom Market (Mercosur), which are small regional blocs formed, mainly, by Andean countries and Southern countries, respectively. There are even bigger blocs, like Union of South American Nations (UNASUR) and Latin American Integration Association (ALADI), the biggest bloc in LA, formed by thirteen countries. In truth, all blocs aim internal and regional development of their societies.

Regarding EI process, as well as the regional integration, there are several supranational organisms, like ARPEL, ECLAC (United Nations Economic Commission for Latin America and the Caribbean), CIER (in Spanish *Comisión de Integración Energética Regional*), OLADE (Latin American Energy Organization) and IIRSA. These organisms have the role of contributing to the integration process as a whole, since they can represent a support in regional countries decision making through studies, debates promotion, standards setting, regulatory framework and information handling, thus ensuring energy markets integration with the purpose of achieving efficiency in resources utilization, infrastructure functioning of transportation network, regulatory and contractual framework.

Establishment and good functioning of these three assumptions are extremely important, since petroleum and natural gas reserves, as well as watersheds are not distributed uniformly, hydrological regimes between the north and south of the continent are complementary. Therefore, common regulatory framework establishments between all the areas guarantee a good functioning of all energy chain, enhancing resources and energy flow and favoring all integration chain.

EI in LA occurs through uni-bilateral investments between countries of the region, like the cases of binational hydroelectric power plants case, gas pipeline construction connecting two or more countries case or simply energy exportation from one country to another, because it is usual an area of the country having a specific energy resource, but not funds to develop an energy generation and/or transmission project. On the other hand, there are countries that need energy and have capital to invest, but that have no energy reserves to explore, so they need the surplus of their neighbors. Because of this complexity, several agents, in all dimensions, are involved in negotiations, like political (national and supranational states) agents, economical (banks and development agencies) agents, companies (public, private, national and multinational) and civil society.

3.1 Latin American Regional Blocs

(a) Andean Community of Nations (CAN)

CAN is a South American economic bloc formed by Bolivia, Colombia, Equator and Peru. Chile left the bloc in 1977 due to political issues linked to Augusto Pinochet dictatorial period and Venezuela left it in 2006 due to an agreement firmed by the bloc and the USA without the presence of Bolivia and Venezuela, which changed the *266 article* about the free trade in medicines. One month after Venezuela had left the bloc, Chile was reincorporated as an associate member.

The area has big reserves of hydrocarbon, petroleum and natural gas, besides a huge and underexplored hydroelectric potential. Countries like Venezuela, Equator and Colombia, being the first two members of OPEC (Organization of the Petroleum Exporting Countries), have big petroleum reserves. Regarding natural gas, there is Bolivia and, once again, Venezuela with big reserves. This factor permits these countries to be big hydrocarbon suppliers in the area, since their productions surpass the domestic consumption and let the excess of their reserves to be exported. Argentina, Brazil, Chile and Peru are big regional importers of these hydrocarbons, highlighting Chile, for it demands lots of energy quantity and has small reserves. Such dependence makes Chile search for a bigger stimulation of regional interconnections, focusing on them with Colombia to access lines from Central America region (ME, 2012).

Regarding the electrical interconnections, CAN has the biggest advancement between SA blocs, which, through the Decision n°536, adopts the general framework for sub regional interconnection of electrical systems and intercommunity exchange of electricity, ensuring legal and regulatory conditions of electricity commercial transactions between member countries and leading harmonization and utilization of energy resources of the region (OLADE, 2010). Despite the big advance in regional context of SA, the bloc was suspended due to internal political factors of CAN members.

(b) Southern Common Market (Mercosur)

Mercosur, see Figure 5, is a customs union, i.e., a free trade zone formed by five countries of SA, Argentina, Brazil, Uruguay and Paraguay. The last one returned to the bloc after April 2013 elections, after its suspension due to the coup d'état that toppled the president Fernando Lugo in June 2012. Venezuela was the last country to join the bloc, in July 2012, which occurred right after Paraguay been suspended, for this country had vetoed Venezuela's admission. Bolivia is in accession process as a full state and integrated to the bloc.

Beside those five countries, the bloc has associated members like Chile, Colombia, Equator, Guiana, Peru and Suriname. Chile is currently in a process to become a full member, but before it the country is in diplomatical discussions on territorial problems with Argentina.

Mercosur is seen as a weapon against the American influence, because it has a large sales and diplomatic force in the region. It is easy to see its extension when analyzing numbers: in 2011, Brazil had exported US$ 256.04 billion, of which US$ 27.9 billion (with a balance of US$ 8.5 billion) were exported only to Mercosur (MDIC, 2012).

Besides free trade agreements between members and associated countries, Mercosur has agreements with Israel and Egypt.

The big market asymmetry has been causing misunderstandings inside the bloc. The Brazilian GDP representing 63% of bloc's GDP, this hampers commercial relationships and the creation of a single currency for the bloc, among other issues. Several misunderstandings have been happening along the bloc's history, for example, Paraguay and Uruguay claiming economic concessions since commercial exchange in the bloc were twenty times lower than the one conducted by Argentina.

Brazil is the leading economy of the bloc, which has been causing some friction and diplomatic struggle between its members, for every year this country has a surplus trade when comparing to the other member countries.

Brazil-Uruguay: In 2007, Brazil had exported to Uruguay US$ 1.5 billion; products were diesel oil, cars, auto parts and cellphones. On the other hand, Uruguay had exported US$ 818 million and the products were agricultural commodities and plastic bottles.

Brazil-Argentina: In 2007, Brazil had exported US$ 14.7 billion to Argentina; products were white line, cars, auto parts and cellphones. On the other hand, Argentina had exported US$ 9.55 billion and the products were agricultural commodities (mainly wheat) and naphtha.

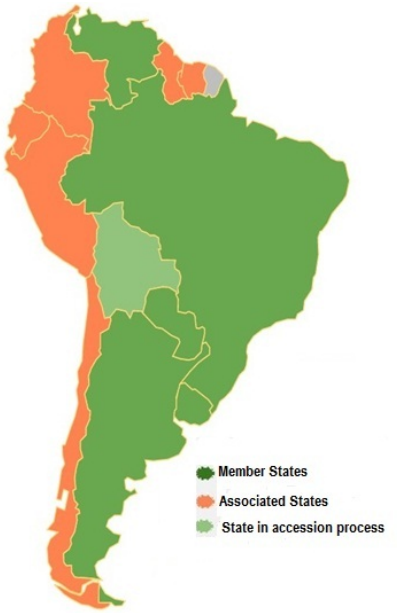

Figure 5 Mercosur Countries (Mercosul, 2014)

Brazil-Venezuela: In 2007, exports reached US$ 4.96 billion and Brazil had the surplus of US$ 3 billion. Brazilian exports to Venezuela are basically manufactured products, chicken meat and sugar. Products that lead the

Brazilian importation are 28% jet fuel, 23% petrochemical naphthas and 11% diesel oil.

Brazil-Paraguay: the commercial unbalance between these two countries are even bigger, with exports reaching US$ 1.92 billion and Brazil with a surplus higher than US$ 1 billion. Brazilian exports are based on diesel oil, fertilizers, tires and charge cars. Paraguay exports agricultural commodities as wheat, corn, cotton and soy. In this context, Itaipu's energy is not recorded, since the energy purchase is not linked to Mercosur agreements (Mdic, 2012).

Bloc's EI started with resolution N32/98, which stimulates the parts to extend the electricity exchange in order to complement their energy resources, optimize the supply security, realocate energy surplus and rationalize the installed capacity of its members. This resolution did not make any progress, for it was beneath the ANC integration, normative number 536.

(c) Union of South American Nations (UNASUR)

UNASUR is the intergovernmental union between Mercosur and CAN. This union is part of the South American process integration and is formed by all independent countries of South America plus Mexico and Panama as observer countries, see Figure 6.

The integration of these two blocs was signed in 2008 with UNASUR Constitutive Treaty. The bloc intends to structure the community in a European Union way, i.e., adopt unique passports, parliament and currency.

The integration mark is based (Unasul, 2010) on common market and elimination of rates for products considered non-sensitive until 2014 and for sensitive products until 2019, in infrastructure cooperation through IIRSA (Initiative for the Integration of the Regional Infrastructure of South America), a program that aims to promote the South American integration through physical integration with the modernization of transportation, energy and telecommunication infrastructure with estimated investments of US$ 38 billion. Financing agents of this program are Inter-American Development Bank (IDB), Development Bank of Latin America (CAF), The Brazilian Development Bank (BNDES) and Financing Fund for the Development of the Rio de la Plata Basin (FONPLATA).

Bloc's monetary policy is ruled by South Bank, created by the bloc itself, and one of its goals is to establish a single currency. Defense policy includes the creation of a military integration between members of the bloc as a way of protecting the area, as well as creating an arms industry exchange of these countries. The bloc is committed to democracy through defense mechanisms of member countries against coups to the civil power legitimately constituted. In occurrence of such violations, the bloc provides political and diplomatic sanctions as suspension of the right to participate in UNASUR and partial or total closure of land borders of the state that caused the conflict.

The bloc provides free circulation of people, ensuring freedom to member countries citizens to stay until 90 days with the presentation of nothing but the identity card.

Obstacles in the bloc consolidation are due to individuality and rivalry between some countries. Argentina suffers from the loss of regional power to Brazil due to aggravation of its economic crisis. Brazil, on the other hand, has increased its partnerships with neighbor countries due to commercial dynamics practiced in recent years by current government that aim to reduce economic dependence of the USA, searching for new partners and signing new agreements with old partners. Chile has some political differences with Argentina, Bolivia and Peru due to past wars that resulted in a loss of territory for Argentina, take of Bolivia and Peru territories and, more recently, due to gas crisis between Argentina and Chile — thanks to cancellation of natural gas supply by Argentina that needed it for intern consumption. Besides that, there is a big political problem between Colombia and Venezuela due to Colombia's military alliance with USA ("Colombia Plan") to fight drug traffic and to disrupt the country guerrilla. In the last years, this caused some diplomatic dispute due to Colombian trops invasion of Venezuelan territory to

fight the Revolutionary Armed Forces of Colombia (FARC).

Figure 6 UNASUR Member States (UNASUL, 2012)

(d) Latin American Integration Association (LAIA)

LAIA, the biggest Latin American bloc, is an intergovernmental organism with head office in Montevideo, Uruguay, that aims the promotion of Latin American region integration and the guarantee of the social and economic development of its members (ALADI, 2012).

Initially, LAIA was called LAAFT, Latin American Association of Free Trade, which was an unsuccessful attempt of Latin American integration in the 60's.

The first members were Argentina, Brazil, Chile, Mexico, Paraguay, Peru and Uruguay. Already in the 70's, LAAFT expanded with new members adhesion: Bolivia, Colombia, Equator and Venezuela. In 1980, LAAFT became LAIA; in 1999, Cuba affiliated and, in 2012, Panama affiliated, totalizing thirteen member countries, see Figure 7.

Inside the vision of integration process, the bloc provides gradual elimination of obstacles to reciprocal trade from member countries, impulsion of solidarity bonds and cooperation between Latin American people, promotion of economic and social development of the region in a harmonious and balanced way to ensure a better life level for its people, renovation of Latin American integration process and establishment of mechanisms applicable to regional reality, creation of an area of economic preferences that has as an ultimate goal the establishment of Latin America common market through three mechanisms: regional tariff preferences applied to products originated in the member countries against tariffs in force for third countries, agreements of regional range common to all member countries and agreements of partial range with the participation of two or more countries from the region.

Figure 7 LAIA Member Countries

Bloc's agreements cover various economic, social and environmental niches, such as: trade promotion, economic complementation, agricultural trade, financial, tax, customs and health cooperation, environment preservation, scientific and technological cooperation, tourism promotion and technical standards.

3.2 Economic Agents Linked to Latin American Integration

Economic actors in LA and SA act like economic enablers of infrastructure implantation of region integration, since these works are expensive, making projects not viable for economically smaller countries in the region. Main economic agents that operate in the area are public entities of its countries or blocs, as BNDES, FONPLATA and CAF, or international agents as IDB and World Bank (WB).

(a) Banco del Sur

It's a monetary fund linked to UNASUR and developed to lend money to social and infrastructure programs of nations from South America. This bank is an alternative to IMF, WB and IDB, because they have a bad image among the region countries. They performed loans to these countries and contracted debts to develop projects linked exclusively to multinational companies.

This bank creation intends to cultivate a bigger integration between UNASUR countries, helping companies and member states to borrow money to develop projects without having to be victims of perverse conditions of international banks. Besides that, of course, the intention is also to become the central bank in case UNASUR integration comes true.

(b) Development Bank of Latin America (CAF)

CAF is a financial organism that encourages and foments the Andean region integration. It is an Andean foment bank founded in 1968 after Constitutive Agreement signature, giving the entity the role of a multilateral bank that promotes development and Andean integration, but only in 1970 its operations were formally started.

Nowadays, CAF is formed by 18 countries from Latin America, Caribbean and Europe, see Table 2, in addition to 14 private banks from Andean region. Its investments are based by credit operations, aids and support in financial and technical structure of projects from LA public and private sector with investments in infrastructure area, social development, environment, public policy, research, financial and corporate sector.

Table 2 CAF Member Countries (CAF, 2012)

Country	Member/Stocks
Argentina	2011/6.9% (U$ 643 MM)
Bolivia	Founder 1970/6.1% (U$ 511 MM)
Brazil	2006/6.3% (U$ 907 MM)
Chile	2009/0.9%
Colombia	Founder 1970/6.2% (U$ 2.05 bi)
Costa Rica	2002/0.5%
Equator	Founder 1970/6.2% (U$ 873 MM)
Spain	2002/2.5%
Jamaica	1999/0.03%
Mexico	1990/0.8%
Panama	1997/1.2% (US$ 198 MM)
Paraguay	1997/0.5% (US$ 199 MM)
Peru	Founder 1970/21.6% (US$ 2.29 bi)
Portugal	2009
Dominican Republic	2007/0.9%
Trinidad and Tobago	1994/0.1%
Uruguay	2001/2.1% (US$ 241.2 MM)
Venezuela	Founder 1970/21.6% (US$ 627 MM)

(c) Financing Fund for the Development of the Rio de la Plata Basin (FONPLATA)

FONPLATA was founded in 1974 by its current members, Argentina, Bolivia, Brazil, Paraguay and Uruguay, that joined by the need to increase efforts and reach development and integration among them. FONPLATA defrays studies, projects and programs executions that develop physical integration of *Rio de la Plata Basin* and its influence area. This way, the fund acts in different programs in the region, as intergovernmental committee Paraguay-Parana waterway and IIRSA. The capital structure of member countries is presented in Table 3.

Fund investments stand out with infrastructure works of social welfare, as programs against floods, warning and disaster preparedness, urban infrastructure, public housing, besides road, shipping and rain transport infrastructure and studies about Guarani aquifer and Paraguay-Parana waterway.

Table 3 FONPLATA Capital Structure in US$ (FONPLATA, 2010)

Countries	Integrated capital	Executable capital	Capital total	Participation %
Argentina	149,743.812	13,334.000	163,077.812	33
Bolivia	49,904.126	4,444.000	54,348.126	11
Brazil	149,743.812	13,334.000	163,077.812	33
Paraguay	49,904.126	4,444.000	54,348.126	11
Uruguay	49,904.126	4,444.000	54,348.126	11
Total	449,200.000	40,000.000	489,200.000	1000

(d) The Brazilian Development Bank (BNDES)

BNDES is a Brazilian federal public company. Currently is the main instrument of long-term financing for investments realization in all economic segments, covering a policy of social, regional and environmental dimensions (BNDES, 2012).

Founded in 1952 to support agriculture, industry, infrastructure, commerce and services, nowadays it offers conditions to micro, small and medium companies, besides owning lines of social investments directed to education,

health, family agriculture, sanitation and urban transportation.

Financing is based on projects investments, purchasing of equipment and exports of goods and services. In addition, the bank has a modality called non-reimbursable funding, that consists on making financial investments without requiring refund, it is about social, cultural (teaching and research), environmental, scientific and technological investments. The bank acts like a Brazilian company's provider in projects inside Brazil or abroad, as long as it is destined for Brazilian companies.

BNDES disbursed R$ 94.6 billion between January and September of 2012, an increase of 3% regarding the same period in 2011. Industry and infrastructure were responsible, together, for 68% of total, highlighting paper and cellulose, chemical, petrochemical, mechanics and transport material (BNDES, 2012).

Therefore, BNDES invests in organizations and individuals enterprises following criteria that prioritize development with social inclusion, job and income creation and generating foreign exchange.

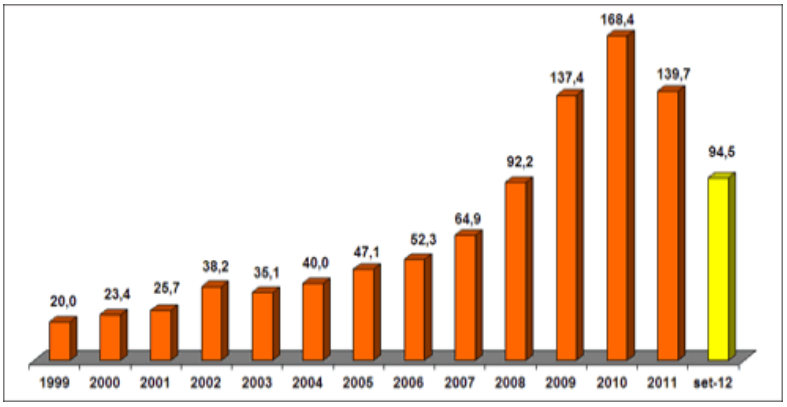

Figure 8 Evolution of BNDES Disbursement in R$ Billion (BNDES, 2012)

(e) Inter-American Development Bank (IDB)

IDB is a bank created in 1959 to finance development projects of Latin America and Caribbean countries. The bank's shareholder picture is formed by 48 countries, in which 26 are from Latin America and Caribbean and have majority share.

Besides making loans, IDB provides donations, technical assistance and researches in the area. Due to its shareholder base, IDB is able to borrow from international markets with competitive rates and transfer this benefit to 26 Latin American and Caribbean countries (BID, 2012).

Besides that, IDB has a fund to special operations (FSO), which provides subsidized financing for more vulnerable member countries as: Bolivia, Guyana, Honduras and Nicaragua. Haiti receives donations from IDB Donations Fund. Due to democratic criteria, Guatemala and Paraguay receive a smaller part from FSO financing, because of the coup d'etat that these countries suffered. Traditionally, IDB finances projects in LA region, and since its foundation it invested more than US$ 40 billion (McElhinny, 2008), but this participation has decreased due to appearance of other financing agents in the region, as CAF and FONPLATA, and of national banks as BNDES. This reduction reflects economic growth and fortification of countries from this area.

3.3 Actors Involved in Latin America Energy Integration

Just as political and economic actors, LA and SA have organisms directly linked to energy market. These organisms aim to provide favorable market and regulation conditions to energy companies that desire to invest in the region, in addition to conducting studies and to assist EI's infrastructure implementation.

(a) Regional Association of Oil, Gas and Biofuels Sector Companies in Latin America and Caribbean (ARPEL)

ARPEL was created in 1965 and is formed by 35 companies and institutions from hydrocarbons sector that operate in LA, holding more than 90% of region sector. It is an interactive forum for ideas, experiences and knowledge exchange in order to identify issues that may affect the development of hydrocarbon industry, i.e., it is an association developed to perform lobby with region governments.

ARPEL includes EI, environment, security and regulation as themes, elaborating proposals of its demands for governments' formal analysis. In 2003, ARPEL promoted a symposium that highlighted the importance of Regional Organisms coordination and boosted the creation of EI Regional Forum. The second symposium was held in 2004 and it consolidated EI Permanent Regional Forum, with the participation of all organisms linked to EI of this region (ARPEL, LAIA, OLADE, CIER, ECLAC), highlighting that none of these actors could be protagonist and their contributions should be considered keys. However, the leadership of the integration process should be of governments.

(b) United Nations Economic Commission for Latin America and the Caribbean (ECLAC)

ECLAC was created in 1948 by United Nations Economic and Social Council and it is one of five UN commissions with head office in Santiago do Chile. This commission cooperates to collaborate and coordinate along with other organisms, regional and sub regional, working in the energy sector of LA and offering advice to governments in regulation (water and energy), electricity laws, hydrocarbons, natural gas, rational use of energy and new and renewable sources. Posteriorly, its work expanded to Caribbean countries and it incorporated the goal of promoting social and sustainable development. Currently, this commission monitors policies aimed at promoting economic development of LA, advices actions directed to its promotion and contributes to strengthen and support area countries relations and economic growth, between each other and with other world nations, considering the social policy rule, treatment of environmental and demographic aspects, educational strategy, need of technical progress to insert itself in a competitive way in the global context. It consolidates the stability of the region economies (CEPAL, 2012).

(c) Latin American Energy Organization (OLADE)

OLADE was created in 1973, in the context of the international energy crisis of the 70's, due to the big increase in the oil barrel prices, strongly affecting LA and Caribbean countries, that lack energy policies; given the need to face this crisis, OLADE initiated a political mobilization in this region, with the creation of that organization.

OLADE is formed by 27 member countries, twelve from South America (Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay, and Venezuela), six from Caribbean (Barbados, Cuba, Granada, Haiti, Jamaica, Trinidad and Tobago, and Dominican Republic), seven from Central America (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama), one from North America (Mexico), and one participant country (Algeria). Algeria is a participant country because it is not on the Latin America and Caribbean region, having access to the products and services provided by the organization, and being allowed to show its voice, but not voting (OLADE, 2012), see Figure 8.

OLADE is a political and technically supportive organization, in which its member States take common efforts to the EI of the region, always seeking sustainable development with advice and cooperation of all the members.

(a) (b)

Figure 9 (a) Member countries and (b) participant country in the OLADE

(d) Comisión de Integración Energética Regional (CIER)

CIER was created in 1965 with the support of South American companies from the power sector. Currently, it is a non-governmental organization that includes power companies and non-profit organizations united with the bodies of the electricity sector of the member States. That commission is formed by 10 members (Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela) and by the CECACIER (Regional CIERs Committee to Central America and Caribbean) formed by Costa Rica, El Salvador, Guatemala, Dominican Republic and Panama, totaling 263 companies related to the power sector. Moreover, it possesses an associated member, the UNESA (Spanish association of electric industry). Each member country has a national committee formed by representatives of electric companies from each country.

Currently, there are five areas that cover the electric power companies in the commission (generation, transmission, distribution, commercialization, and corporate area).

The products and services the CIER provides are database, technical work, memorials and articles of the commission events and electric bills, training courses, development projects, information and technology exchange, but all connected to the electric industry. The projects developed by CIER are financed by the foundation and in some cases are supported by WB, CAF and the European Community.

(e) South American Council of Infrastructure and Planning (COSIPLAN)/Initiative for Integration of Regional Infrastructure in South America (IIRSA)

COSIPLAN is a UNASUR body created in 2009 during a presidential meeting of UNASUR, when it was defined the substitution of the IIRSA Executive Direction Committee for a Council at ministry level. With this measure, the member countries sought to give greater political support to the activities developed in the infrastructure integration area, to ensure the necessary investments for the execution of priority projects defined in a Strategic Action Plan for the next 10 years in the Priority Projects Calendar that functions as a promoter of regional infrastructure integration, strategic for the South American development.

The COSIPLAN replaced IIRSA, designed as a forum for coordination and exchange of information about infrastructure among the twelve countries of the region (Ministry of Planning, 2012).

IIRSA, in order to promote the development of transport, energy and communication infrastructure within the regional context through intergovernmental actions, arises from the meeting of the twelve heads of state of South America in 2000; at the time, joint initiatives were approved to boost the political, economic and social integration process in the region, including the modernization of regional infrastructure, and the development of isolated regions (MP, 2012).

The idea of its foundation stemmed from the Brazilian experience in territorial planning, known as Axis Study,

conducted by the Ministry of Planning (MP) with BNDES in 2000, that planned the country from regions identified by their economic inter-relationship.

IIRSA not only performs coordination mechanisms through strategic designs, but seeks to promote the exchange of information between the governments involved to boost development. The initiative has certain principles involving the approach between the countries that are based on open regionalism, contemplating the need to minimize internal barriers to commerce, bottlenecks in infrastructure and regulatory systems and operation, in the Integration and Development Axis (IDA) which are distributed on the South American space in multinational groups that concentrate current and potential trade flows to promote the development of business and productive chains, the economic, social, environmental and political-institutional sustainability (MP, 2012).

IDA is a special division of the South American territory organized into 10 axes (Andean, Amazon, Peru-Brazil-Bolivia, Capricorn, Guyanese Shield, South Andean, Central Interoceanic, MERCOSUR-Chile, Parana-Paraguay Waterway and South), see Figure 10.

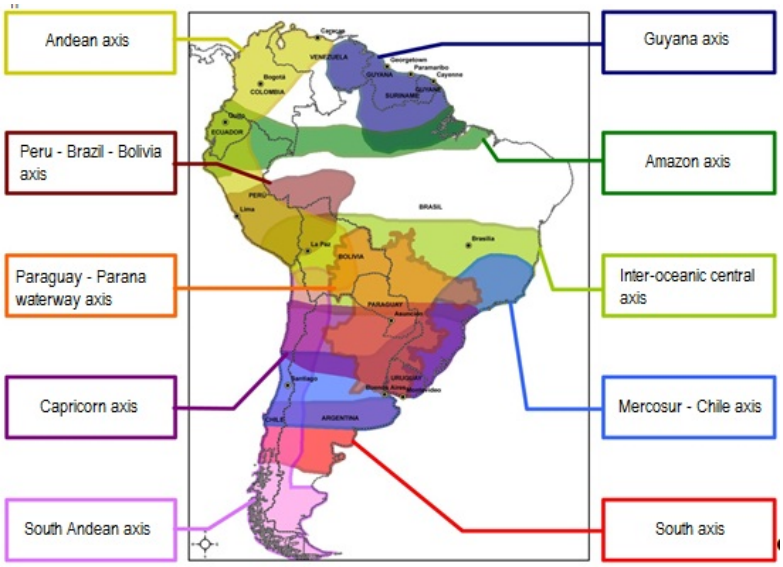

Figure 10 Integration and Development Axis (IIRSA, 2012)

IIRSA, over ten years, and currently the COSIPLAN, developed important projects, with a portfolio of 579 projects, see Table 4, in study (23.5%), pre-running (28.8%), running (29.2%) and completed (18.5%), with an approximate investment of US$ 163.069 billion (IIRSA, 2014). According to the latest report of COSIPLANs projects portfolio (2013), the energy sector concentrated 59 projects, of which 27 (46% of the total) are aimed at generating, representing 75% of the total investment, and 32 interconnections projects. These projects receive investment especially from public/private partnerships (68% of total investments) followed by the public sector (25%), see Table 5; this characteristic is due to the high value of the individual projects and the fact that they are structuring, with market opening bias, creating conditions for businesses and society to have access to new regions and can dispose their productions. Projects in the energy sector are mainly based on the construction of new interconnections, 52.5% of the total projects and 25.1% of investments. Hydroelectric plants, because they are characterized as large enterprises of electricity generation, hold 27.1% of the projects portfolio and 63.8% of investments see Table 6.

Table 4 Projects Portfolio of COSIPLAN (IIRSA, 2014)

Year	Number of projects	Estimated investment (x10³ US$)
2004	335	37.425
2007	349	60.523
2008	514	69.000
2009	510	74.542
2010	524	96.119
2011	531	116.121
2012	544	130.139
2013	583	157.731
2014	579	163.069

Table 5 Characteristics of the Type of Financing (COSIPLAN, 2013)

Energy sector	Projects		Investment	
	Number	%	(MM US$)	%
Private	7	12%	3.435	7%
Public	38	64%	12.871	25%
Public/ Private	14	24%	34.524	68%
Total	59	100%	50.830	100%

Table 6 Kinds of projects from Energy Sector (COSIPLAN, 2013)

Energy sector	Projects		Investment	
	Number	%	(MM US$)	%
Generation	27	45.8%	37.965	74.7%
Hydropower	16	27.1%	32.418	63.8%
Thermoelectric	5	8.5%	2.476	4.9%
Nuclear	2	3.4%	1.740	3.4%
Other	4	6.8%	1.332	2.6%
Interconnections	32	54.2%	12.865	25.3%
New	31	52.5%	12.740	25.1%
Adaptation	1	1.7%	125	0.2%
Total	59	100%	50.830	100%

4. Electrical Integration in South America

Interconnections are physical unions, a set of equipment to link the power systems, allowing the exchange of energy between the interconnected electrical systems through plants and transmission lines, containing equipment such as control of substations (with or without transformation), voltage regulation equipment and frequency converters.

Cross-border interconnections are no different from the internal transmission system of a country, such as the National Interconnected System (SIN) in Brazil, see Figure 10, that due to its large size, ensures the complementation of energy resources distributed throughout the country, improving security of supply to users through access to a more efficient electrical service, by providing energy surpluses and use of installed capacity to the neighboring countries. SIN, if replicated to the South America, would ensure the hydrothermal and hydro geographic complementarity due to the dispersion of water basins and natural gas reserves in the region, in addition to the non-simultaneity of maximum demands for hourly and seasonal difference of four time zones. For these

interconnections to occur, it is necessary to grant authorizations, permits and concessions for the construction, operation and exploration of interconnections that join the electrical systems of different countries. Ideally, the rules would reach to facilitate free trade of electricity between power companies between countries, respecting the technical and environmental regulatory standards as well as the principles of non-discrimination and reciprocity, to ensure the support of the projects.

Currently, the distribution of cross-border interconnections in South America, see Figure 11, can be divided into two regions: the Andean countries (Colombia, Ecuador, Peru and Venezuela), and MERCOSUR countries plus Chile. Apart from these two regions, it is worth highlighting the interconnection between Brazil and Venezuela that links Guri (Venezuela) to Boa Vista (Brazil). These interconnections provide the purchase and sale of energy, improving of the use of generation resources, increase the reliability of electrical systems and, especially, enable the promotion of infrastructure in economically in deficit countries.

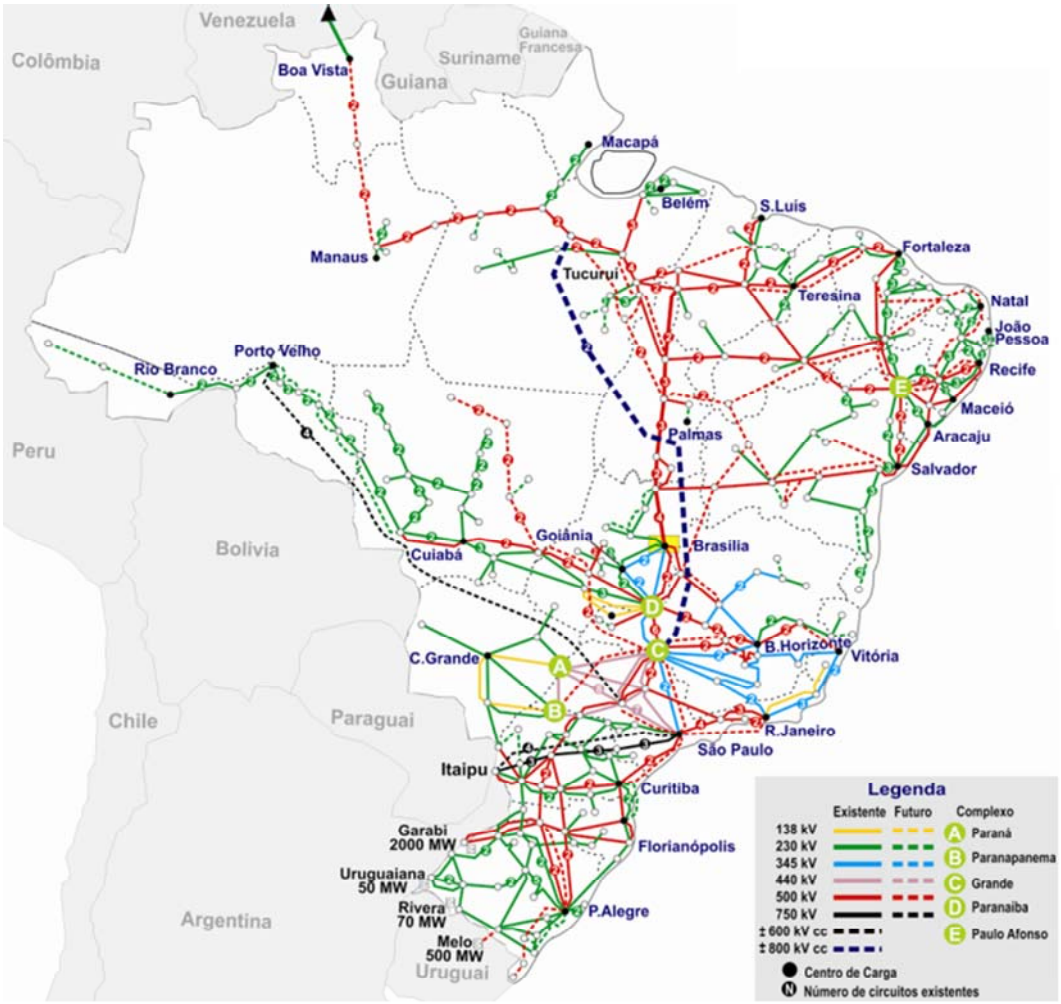

Figure 11 SIN (ONS, 2014).

The interconnections of the Andean region are characterized by service on an emergency basis, mainly due to network stability problems; in the MERCOSUR region, because it has large electrical links with large hydroelectric binational power plants (Itaipu, Yacyreta and Salto Grande) and their lines of transmission, energy trading operations are constant.

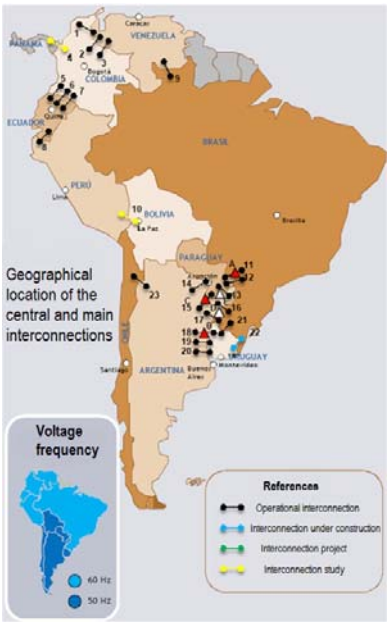

Figure 12 Cross-border Interconnections in South America (CIER, 2010)

4.1 Underway Projects

According to the database COSIPLAN (2014), there are 12 EI projects in progress, totaling $27.327 billion, of which three are consistent with the criteria established in the methodology, the others being primarily related to plant electricity generation.

(a) Electrical Interconnection Ecuador-Peru

This implemented bi-national project is intended to carry out the electricity exchange synchronously to harmonize regulations, ensure energy supply, and develop mechanisms to importation and exportation between Ecuador and Peru through this construction, with 500 kV voltage level.

The type of funding is public, with the participation of the two countries through their national treasures; studies on the interconnection were made by CELEC EP, electric corporation of Ecuador which covered all costs. This structure will be part of the framework of the initiative of the Andean Electrical Interconnection System (AEIS) (COSIPLAN, 2014).

(b) Electrical Interconnection Colombia-Venezuela

This bi-national scope project involves the construction of an electrical interconnection of 34.5/13.8 kV between San Fernando de Atabapo in Venezuela until Inírida, Guainía department in Colombia.

This line will provide the electricity produced by the power plant of Inírida, Colombia, by offsetting the costs generated by the supply of Venezuelan fuel for the domestic price of San Fernando de Atabapo, since the energy will serve to feed this city (COSIPLAN, 2014).

(c) Electrical Interconnection Uruguay-Brazil

This ongoing project is a binational project to build an electricity interconnection line between Uruguay and Brazil which aims to diversify the electricity trade as much uninterrupted as through firm contracts tied with Argentina.

This project enables more export markets for any surplus of Uruguayan plants, and stops the Brazilian secondary energy at times of surplus hydroelectric and thermal generation associated with unused plants. The

holding companies of this line are the Brazilian companies Eletrobras and the Uruguayan ETE.

The type of funding is public with the amount of US$ 349 million, and the stakeholders are:

- CAF, with US$ 30 million approved;
- The National Treasury of the two countries, with US$236 million in progress;
- FOCEM, fund tied to MERCOSUR, with approved US$ 83 million.

The project includes the construction of a 500 kV network; totaling 60 km from San Carlos, in Uruguay, until the frequency conversion station, since the two countries operate with frequency of 50 (Uruguay) and 60 (Brazil) Hz, and another network of 230 kV with 9 km to the substation President Medici in Brazil.

ELETROBRAS is responsible for the work and has received authorization from ANEEL to import and export electricity through this line by Authorizing Resolution No. 2,280/2010.

The National Coordination (CN) of the project are the Ministry of Transport and Public Works (Uruguay) and the Ministry of Planning (Brazil).

4.2 Completed Projects

According to the database of COSIPLAN (2014) of EI, we have completed 21 projects, totaling US$22.617 billion; only two of these projects are consistent with the criteria established in the methodology, since two of them are dams already built, pre-formation of IIRSA (Itaipú and Yacyretá), and the third, because it is a pipeline (Nor-Peruano) between Ecuador and Peru.

(a) Electrical Interconnection Project Colombia-Ecuador

The bi-national scope project to build a 230 kV transmission line between the substations Pasto (Colombia) and Quito (Ecuador) came into operation in 2007. The project goal was to provide energy to Ecuador in times of rationing and replace the generation of electricity from fossil fuels, and in the rainy season export power to Colombia.

The line is 213 km long with an initial capacity of 200 MW; in 2009 energy exports to Ecuador totaled 1,076 GWh.

Project funding came from the National Treasury of both countries, providing US$ 45.400 million (IIRSA, 2012).

The export of electricity to Ecuador in 2009, even with water scarcity in Colombia, was 1,077 GWh, a figure higher than the first two years of line operation, when there was no shortage of water.

The responsible for the project are the Ministry of Transport and Public Works (Colombia) and the National Planning Department (Ecuador).

(b) Electrical Interconnection Project Colombia-Venezuela

The bi-national scope project consisted on the adequacy of the interconnection line Cuestecitas y El Corozo - San Mateo, with 230kV.

Funding for this project was public, with the participation of national treasures of both countries, with invested amount of US$ 125.2 million.

Exports to Venezuela through this interconnection amounted to 222.25 GWh in 2009; in 2010 there was no exchange of energy because of water scarcity in the period; in 2012 ISAGEN, Colombian electric company, and CORPOELEC, Venezuelan Electric Corporation, established a monthly supply contract of 30 GWh from Colombia to Venezuela.

(c) 500 kV Transmission Line (Itaipu - Asuncion)

The bi-national scope project consisted of the construction of a line of electricity transmission between Brazil

and Paraguay, to improve the quality of service and reliability of supply, correcting the low system voltage, and reducing the high transmission technical losses, which reach 10% during peak hours.

Transmission lines are already operating at 85% capacity, and interconnection transformers Itaipu are already operating on the edge since 2011.

The construction consisted in a transmission line of 500 kV from Itaipu to Villa Hayes, station area of Asuncion, and the expansion of the Villa Hayes station. The additional transmission capacity will increase the exchange of energy with Argentina through the 220kV interconnection. The system has a length of approximately 345 km.

The project financing was public and investments amounted to US$ 555 million distributed among (IIRSA, 2012):

- The National Treasure of the two countries, with US$155 million in implementation;
- FOCEM, with US$ 400 million running.

The completion of the project took place in 2013 and the responsible for the project are the Ministry of Public Works and Communications (Paraguay) and the Ministry of Planning (Brazil).

4.3 Future Projects

In this context, we will cover construction projects for future hydroelectric facilities and transmission lines in South America.

(a) Construction of Hydroelectric Plant Corpus Christi

The project aims to build a binational hydroelectric plant. This plant will be built in the Paraná River, the natural border between Argentina and Paraguay. The estimated cost for this construction will be US$4.200 billion and will be funded by the national treasure of the two countries.

The discussion of its construction dates back to the same period as the construction of Itaipu and Yacyreta, but Paraguay and Argentina chose to carry forward the signing of the Treaty of Yacyretá and not of Corpus Christi, because at the time that construction would cripple the Itaipu project. To reach a diplomatic agreement the three countries signed a tripartite diplomatic agreement in 1979 (Oxilia, 2007).

Study completed in 1984 estimated that the installed capacity of the plant will be 4,608 MW generating annual average of 20,100 GWh. This project added to Itaipú, Yacyretá and Itacorá-Itatí, will achieve a generation of energy greater than 123,000 GWh/year. This project is a big step for MERCOSUR's EI.

Until today the two countries are completing the basic studies and preparing the treaty for the execution of the project. The environmental impact study has already been done.

(b) Hydroelectric Binational Garabi-Panambi - Argentina-Brazil

Hydroelectric plants Garabi and Panambi, see Figure 13, of binational level, aims to harness the potential of the Uruguay River, with a total installed capacity of 2,200 MW at a cost of US$ 5,202 million.

The hydroelectric plant Garabi, has 1,152 MW of installed capacity and generation capacity of 5,970 GWh/year, with total investment of US$ 2,728 billion; Hydroelectric power plant Panambi, on the other hand, will have 1.1048 MW of installed power generating capacity of 5,475 GWh/year, requiring investment of US$ 2,474 million. These two projects will be funded by the public sector of both countries, in which case the Brazilian side the work is part of the GAP 2 (growth acceleration program) being financed by BNDES (COSIPLAN, 2014).

In November 2012, the governments of Argentina and Brazil showed the feasibility study schedule of hydroelectric exploitations of Garabi and Panambi that began in 2013, and is expected to start operation in 2020 (Eletrobras, 2012).

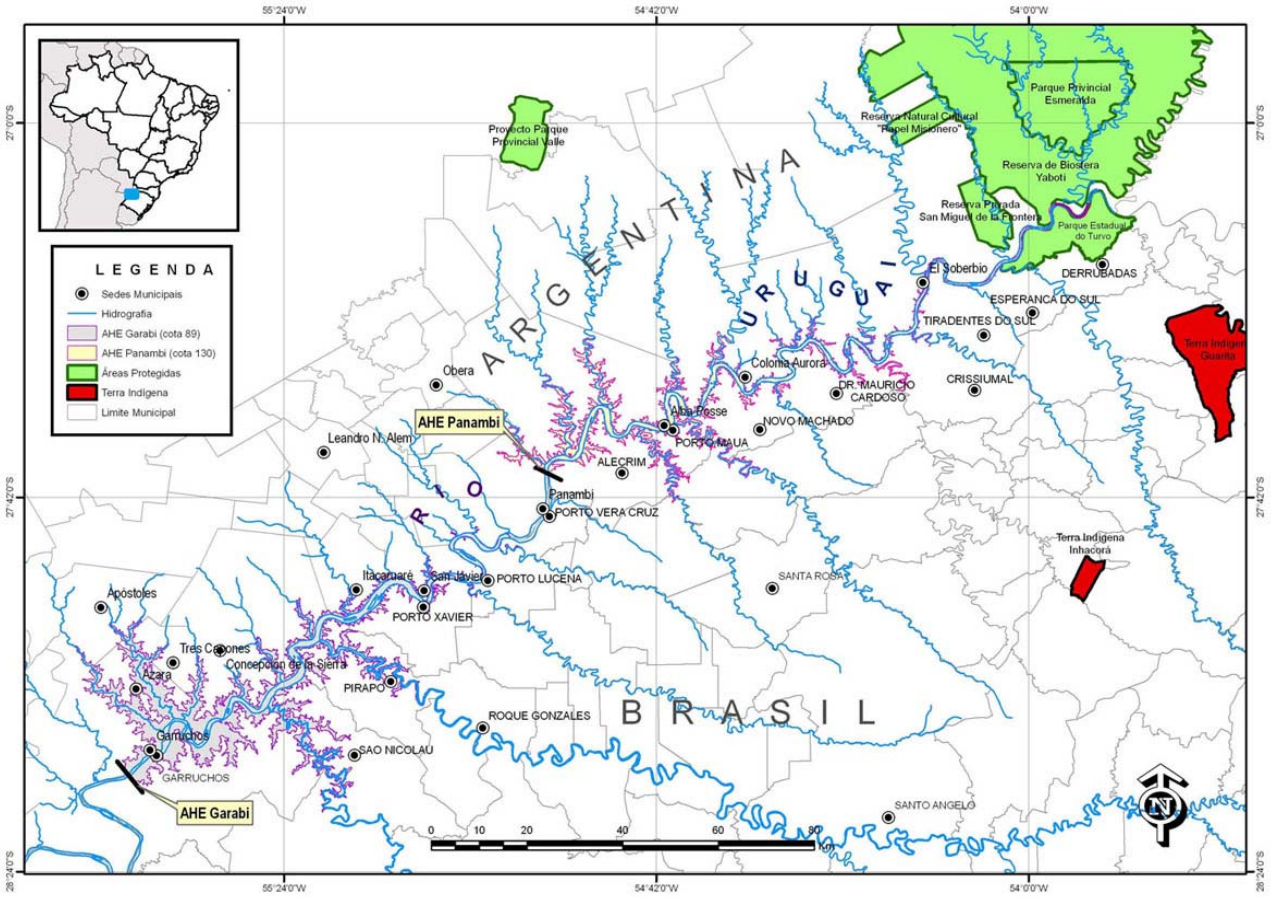

Figure 13 Hydroelectric Plants Garabi and Panambi (Eletrobras, 2012)

The project has the Joint Technical Committee (CTM), responsible for feasibility studies and basic designs, environmental studies and social communication.

(c) Project Peru-Brazil

Currently the Brazilian government is studying the feasibility of building hydroelectric plants in seven countries in South America: Argentina, Bolivia, Colombia, Guyana, Peru, Suriname and Venezuela. The plants would generate about 12,000 MW and would be built by local contractors to supply both the domestic market of the country as well as the Brazilian. Eletrobras will be responsible for the construction and financing would come from BNDES.

Among the projects, six plants are in Peru: Inambari (2,000 MW), Sumabeni (1,740 MW), Paquitzapango (2000 MW), Urubamba (940 MW), Vizcatán (750 MW) and Cuquipampa (800 MW); together these plants would total approximately 9,000 MW of installed capacity (Eletrobras, 2009).

In 2010, the presidents of both countries signed an agreement for the construction of these plants with US$15 billion investment. However, Peru has canceled the provisional license of the Inambari consortium, earlier design, due to protests in Puno department claiming that the plants would be more beneficial to Brazil than to Peru, since the environmental cost would be borne only by Peru.

The Inambari power plant, in terms of power generation, will be the largest dam in Peru and the fifth largest in Brazil, with a reservoir of 413 square kilometers. It is not yet set, but it is estimated that 80% of the energy produced

will be exported to Brazil and much of the resources used for its construction would come from the BNDES.

This plant is strategic for Brazil, not only for its energy supplies, but to be upstream of the Madeira river, damming water to promote the best hydroelectric utilization Jirau and Santo Antônio during periods of drought (Furnas, 2010).

Companies involved in this building are: Odebrech Peru, and Andrade Gutierrez, OAS, Eletrobras, Eletrobras Furnas.

(d) Other projects via Eletrobras (Brazil)

Eletrobras, a public company controlled by the Brazilian government operates in the generation, transmission and distribution of electricity (Furnas, 2010).

This company is important in the EI scenario because holds half the capital of Itaipu Binational.

In the six countries cited in the text, Eletrobras studies (Eletrobras, 2012):

- Bolivia: implementation of hydroelectric waterfall Hope with 800 MW and the Binational Guajará-Mirim 3,000 MW, with an estimated investment of US$ 5,000 million;
- Guyana: feasibility of a plant with 1,500 MW, and be mapping the hydroelectric potential the country, estimated at 8,000 MW;
- Suriname, Venezuela, and Colombia: are still in studies on the hydroelectric potential.

The generation provided by energy produced in Guyana would be imported into Brazil to the state of Roraima, to supply the state that uses mainly electric thermal fuel oil and imports from Venezuela. This state is an isolated system, so it is not connected to the SIN.

5. Conclusions

After the various data provided, it was observed that the integration of South America will be a difficult task, given that over the last 60 years various bodies of regional cooperation were created. These organizations held numerous agreements and political, economic and social treaties as a means of integration of the region, and over time many of these initiatives ended due to diplomatic problems or the annexation by larger supranational bodies.

UNASUR, the greatest organism in South America, has a great convergence among member countries, such as Argentina, Brazil, Bolivia, Ecuador, Uruguay and Venezuela, protectionist countries in the bloc, as Chile and Colombia are more aligned to the neoliberal line.

UNASUR, due to legacy and annexation of IIRSA, an institution that through technical work together with the 12 member countries has a portfolio of 579 integration projects for the region; it allowed the countries to discuss and structure in a common language. On the one hand its technical nature can create such resources, on the other hand, it cannot give sequence to the implementation of projects, despite the large inflow of encouragements agencies and regional banks such as the IDB, CAF and BNDES for the preparation of projects, because it does not have financial support for feasibility of the projects.

EI in the region, specifically in the implementation of binational hydroelectric, the negotiation process between countries is very complex, because it touches on issues related to environmental impacts, sovereignty and funding. Large binational plants were only built thanks to a convergence of political ideals present in South America between the 60’s and the 80’s. These ideals approached countries as they were aligned with the US, which facilitated the sources of financing (via WB and IDB), technical and diplomatic support. Another very important factor of the season was the emergence of large public companies that took the lead of large projects, thus enabling the

negotiations and borrowing.

Today, large EI projects related to hydropower belong to Eletrobras, as part of the international expansion plan of the company, for the supply of electricity from the Southeast and isolated northern states of the country. Most studies on potential energy and construction of transmission networks are being made in countries such as Suriname, Venezuela, Bolivia and Peru, with planned capacity of over 20 GW.

The South America EI is an extremely important factor as it ensures energy security of the region. For countries with limited access to loans and low domestic demand in the short and medium term, EI provides investment and construction of the project, and in the long run makes possible the sale of energy to other countries in the region and/or domestic consumption. In this matter, Brazil has a strong political and economic clout in the region, a fact proven only with the analysis of the number of projects and investment in the project presented by the BNDES and Eletrobras, and the trade surplus of the country in relation to neighboring countries.

There is quantitative evidence that the least developed countries in South America, with the lowest HDI, which consume less electricity per capita, are precisely those that have large energy reserves. This feature allows the marketing of its resources with the countries of the region with high energy demand and lack of reserves, thus ensuring the reliable and efficient supply for energy consumers, reducing the dependence on a single energy source and reducing supply costs. The economic gains for countries that sell their energy resources or their excess electricity enable the development of other structural areas, and once established the physical integration in the region, the enhancement of trade relations, political, social and cultural relations between its members are enlarged.

Therefore, the EI needs articulation of rules and congruent policies, such as agreements, frameworks and regulations aimed at opening markets and supply assurance. This congruence appears with the creation of common rules to the region's countries, facilitating transactions and investment of state capital, private national and multinational, through the reduction of differing interests among States and stakeholders.

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