Trade Knowledge Network

Series on Trade and Energy Security

Energy Security in South America

The Role of Brazil

Adilson de Oliveira

2010

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Abstract

South America has vast energy resources, but countries in the region are unable to guarantee adequate energy security levels for their consumers. The potential economic benefits from the process of regional energy integration are high, but national regulations impose strong barriers to such a process. Climate change policies open a window of opportunity for South America, which is particularly well placed in this regard, but also create challenges. Security of supply is fundamental, and regional energy cooperation is essential for removing the insecurity of energy supplies facing the region. A Multilateral Energy Security Reserve treaty can give countries access to the region's reserve supplies by providing regulations and pricing mechanisms to facilitate such access. Brazil's active participation in the formulation of such a treaty is essential, while its geographical position, market size, oil resources and leadership in renewable energy sources make it a sound candidate to take over the coordination of the competitive, secure integration of South America's energy markets. There are three important obstacles to integration: coordination of the output of the region's power plants, the environmental licensing of energy projects, and the legal deficit that adversely affects private investment in energy generation. An institutional mechanism to settle regional disputes is also needed.

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Energy Security in South America: The Role of Brazil

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This study is part of a larger, multi-region TKN project that seeks to understand better the impacts of trade policy on food security. It includes country case studies and regional analyses from Latin America, Southern Africa and Southeast Asia. It was made possible through the generous support of the Swedish Environment Secretariat for Asia (SENSA) and the Norwegian Agency for Development Cooperation (NORAD). The project outputs are available on the TKN website.

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Table of contents

Figures and tables

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Professor Adilson de Oliveira is a chemical engineer with a PhD in Economic Development from the University of Grenoble, France and a specialization degree in Energy Economics from the same university's Institute of Energy Economics and Politics. He has published several articles in national and international publications and is a member of the editorial board of the *International Journal of Energy Sector Management*.

He has been a consultant for international organizations such as the World Bank, the Latin American Energy Organization, the European Union and the Organization of American States. In Brazil, he has also been a consultant for several Brazilian energy companies, as well as ANEEL and the Ministry for Mines and Energy during the reform of the Brazilian energy industry.

An honorary professor at the Institute of Economy of the Federal University of Rio de Janeiro, he is also the director of the recently established Brazilian School of Advanced Studies. He is also an associate researcher for the University of Stanford's Energy and Sustainable Development Program.

Abbreviations and acronyms

BRL	Brazilian real
EPE	Empresa de Pesquisa Energética
EU	European Union
IEA	International Energy Agency
IIRSA	Initiative for the Integration of Regional Infrastructure in South America
LNG	liquid natural gas
MW	megawatt(s)
MWh	megawatt hour(s)
OECD	Organization for Economic Cooperation and Development
OLADE	Latin American Energy Organization
RMSE	Multilateral Energy Security Reserve
TWh	terawatt hour(s)
USD	U.S. dollar

Executive summary

South America has vast energy resources, both renewable and non-renewable. However, countries in the region are unable to guarantee adequate energy security levels for their consumers. The economic benefits that can be expected from the process of regional energy integration are high, but national regulations impose strong barriers to investments aimed at promoting energy integration. Low-cost energy resources remain idle and the cost of domestic energy supplies is increasing in all countries in the region. Climate change policies open a large window of opportunity for South America, but create challenges as well. The region has a privileged energy situation that should allow it to make the transition to a low-carbon economy based on renewable energy sources. Security of supply is fundamental for a successful energy transition that will do away with the region's economic dependency on the export of commodities, and regional energy cooperation is essential for removing the insecurity of energy supplies that periodically haunts countries of the region. To explore this opportunity, access to the energy reserves of the region whenever a particular country faces a threat to its energy supplies is needed. A Multilateral Energy Security Reserve treaty can grant such access, in particular by providing regulations and pricing mechanisms to facilitate access to the region's energy reserves. Brazil's active participation in the formulation of such a treaty is essential for the success of the South American energy security and integration process. Its geographical position, market size, oil resources and leadership in renewable energy sources make Brazil a sound candidate to take over the coordination of the competitive, secure integration of South American energy markets. Three obstacles to integration are particularly relevant: coordination of the output of the region's power plants; the environmental licensing of energy projects, especially in Amazonia; and, in particular, the legal deficit that adversely affects private investment in energy generation. It is also essential to have an institutional mechanism to settle regional disputes.

1. Introduction

South America is characterized by the vast availability of energy resources, both renewable and non-renewable. A net energy exporter, the region will play a relevant role in the area of global energy security during the next decades. Nonetheless, the countries in the region are not able to guarantee adequate energy security levels for their internal markets. Energy rationing, currently in place in Venezuela and Argentina, is commonplace in the region.[1]

Studies carried out by regional organizations indicate that the economic benefits that can be expected from regional energy integration, including energy security, are high (Moniz Ramos, 2004). However, the Initiative for the Integration of Regional Infrastructure in South America (IIRSA), which aims at developing the regional integration of transport, communication and energy infrastructure, largely neglects projects in the energy sector.[2] This reality is a result of the barriers imposed by national regulations to investments aimed at taking advantage of the benefits expected from regional energy integration.

Pineau *et al*. (2004) identify three types of barriers: (1) material infrastructure; (2) the regulation of energy flows; and (3) rules for trading these flows (prices). In the South American case, in the 1990s there was significant progress in the construction of the necessary infrastructure to make physical energy flows feasible, especially in the continent's Southern Cone. However, this progress was not followed by improvements in the regulation of regional energy flows or in mechanisms for its trade. The infrastructure that was built was based on bilateral agreements based on political and energy circumstances that were favourable to the exporting of energy excesses to meet the demands of a neighbouring country with a domestic supply deficit.

This pragmatic solution was unable to provide the necessary security for the physical flows of energy when the political and energy context of the 1990s changed in the first decade of the twenty-first century. The risk of cuts in the energy imported from neighbouring countries turned into a harsh reality. This reality rekindled the perception that energy security is fundamentally a matter to be dealt with in the domestic context, even though the economic cost of this approach is high. This factor, hardly debated in the region, is relevant insofar as the cost of energy is South America's main comparative advantage in the global economy.

Brazil, due to its geographical position and the size of its energy market, has a decisive role to play in the promotion of regional energy flows. During the 1990s heavy investments were made to develop the infrastructure needed to promote significant flows of electricity and natural gas from neighbouring countries to the Brazilian energy market. However, the bilateral agreements adopted to make use of this infrastructure proved unable to resist the changes in the regional energy and political context. This infrastructure therefore remains largely idle because energy imports from neighbouring countries are not perceived as safe and energy exports to neighbouring countries are seen as a source of insecurity for the domestic market. Low-cost energy resources therefore remain idle and the cost of domestic energy supplies is increasing in all the countries in the region.

1 Brazil was forced to ration electricity in 2001/02 and was on the brink of doing so again in 2008. Argentina adopted similar measures for its gas supply in 2004.

2 <http://www.iirsa.org>.

This report investigates Brazil's role in potentially increasing the energy supply security of its commercial partners. The next section reviews the issue of energy security, highlighting both its dimensions (reliability and supply security) and the role performed by geopolitical approaches (bilateral or multilateral) in the choice of governance mechanisms for the integration process. The following section presents the benefits that are expected from energy integration, as well as the obstacles that will have to be faced for it to take place. After this, the role that Brazil can take in the regional energy integration process is analyzed in the context of the transition to low-carbon energy generation systems.

2. Energy security and integration

South American socioeconomic integration began to have greater significance in the second half of the twentieth century. In order to induce this movement, regional organs were created that focused their efforts on the commercial integration process. In the energy sector, the Latin American Energy Organization (OLADE) was created with the objective of promoting regional trade in energy.[3] The limited extent of the physical infrastructure for the transport of energy proved to be the most important structural difficulty to overcome.

The IIRSA was launched with the objective of overcoming these structural hindrances that limit regional economic integration, but has not dedicated much effort to the development of energy infrastructure so far.

2.1 Energy security: Reliability and supply security

Energy is required for all human activities (UN, 2000), while continuity in its supply is crucial for the socioeconomic stability of modern economies. Energy security has two dimensions: reliability and supply security.

Reliability refers to the energy system's ability to avoid an abrupt cut in the energy supply to consumers. This type of situation can occur as a consequence of natural phenomena (such as storms or earthquakes) or as the result of a fault in the operation of energy supply logistics. Alternative routes for energy flows are essential to handle this kind of problem, so that when cuts become unavoidable energy can still be transmitted.[4] Compensation regimes for those who are harmed by these events can be adopted to minimize their costs to society.

Supply security refers to protection from events that require energy supply cuts for long periods of time. In this case, the issue is the risk of opportunistic behaviour of agents to benefit from a context that is favourable to them (moral risk). Under such circumstances, the risk of opportunistic behaviour increases the transaction costs, leading to poor/misguided selection in the choice of alternative projects. Lower cost solutions for the energy supply are neglected and higher cost solutions that eliminate risks of supply cuts are adopted instead.

This phenomenon became apparent in Brazil's decision to launch Plangás[5] and build terminals for liquid natural gas (LNG)[6] soon after Bolivia decided to nationalize Petrobras assets in that country. It also

3 <http://www.olade.org.ec>.

4 As energy integration grows, there is a risk of domestic reliability being adversely affected by problems in neighbouring countries. In this case, the way in which this issue is handled must account for this risk.

5 This plan aimed to rapidly increase the domestic supply of natural gas.

6 The Rio de Janeiro gas terminal required investments totalling BRL 850 million.

became apparent in Chile's decision to import LNG to meet its domestic demand when the natural gas supply crisis occurred in Argentina. In both cases, recognizably more expensive alternatives were selected to increase domestic energy supply security.

As a result of these developments, low-cost energy resources remain underutilized and investments made in infrastructure become idle. The frailty of regional institutional arrangements for the governance of energy flows (prices and regulation) is to blame for these situations.

2.2 Empire-regions or institutions-markets approach?

A NIIR study (2004) suggests two stylized approaches to the process of energy integration. In the *empire-regions approach*, integration aims to create a political bloc around a hegemonic country with the objective of creating competitive advantages for the members of the bloc. In this approach, geopolitics is the decisive factor in the offer of conditions for providing access to energy resources available in the region. Supply security is the object of political agreements, which are not necessarily based on market criteria. The presence of state-owned firms tends to be predominant in this approach.

In the *institution-markets approach*, integration also aims to obtain competitive advantages for the members of the bloc, but it is based on economic agreements and multilateral institutions. Access to resources is guaranteed to all countries that participate in the agreement and regulation is led primarily by market mechanisms (contracts). The presence of private investors in the energy market is significant. This approach has been followed by the European Union (EU) (Westphal, 2007), which established a multilateral treaty called the Energy Charter to give regulatory support to energy flows among countries.

The Energy Charter contains foreign investment protection clauses and mechanisms for conflict resolution.[7] The treaty's essential aim is to offer legal security to investors by limiting the risk of opportunistic behaviour when the nature of the energy market changes. Russia, despite being a signatory to the treaty, did not ratify its commitment to the Charter because the Russians wish to have long-term contracts for their exports in order to guarantee their gas market share in Europe. This type of contract eliminates market risk and reduces the financial costs of the construction of gas pipelines. Conversely, the Europeans prefer short-term contracts that allow for the adjustment of Russian natural gas supplies to the behaviour of the European market.

This example shows the difficulty in establishing rules for the trade of energy among countries. For exporting countries, energy is an important source of fiscal resources, which needs to be stabilized (quantity and prices) to allow for the formulation of sustainable macroeconomic policies. For consumer countries, the transition to a low-carbon economy requires movements in prices and quantities supplied that make the progressive substitution of fossil fuels for renewable energy sources feasible.

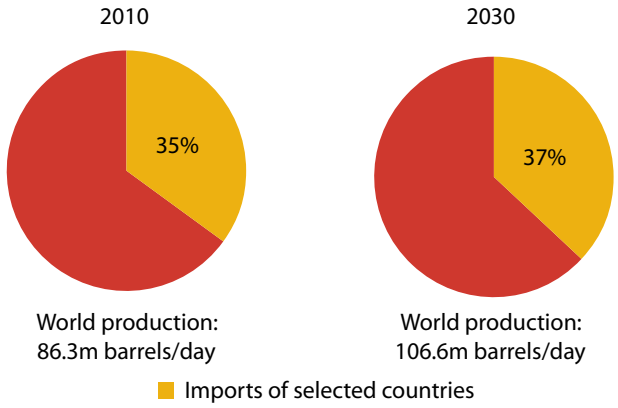
However, both exporters and consumers share an interest in avoiding volatility in prices of energy supplies. It is important to observe that supply security acts as a powerful factor reducing energy prices volatility. The difficulty resides in preserving market shares and price regimes that satisfy both exporting and consumer countries. This issue is particularly complex for oil-dependent economies that have to rely on supplies from politically unstable regions for decades to come (Figure 1).

7 It is interesting to note that the U.S. remained a mere observer in the Energy Charter.

In the 1990s South America adopted the institutions-market approach to promote regional energy integration. However, integration rested on bilateral agreements. The formulation of multilateral treaties to regulate the regional energy market was the object of studies, but nothing was done about actually drawing up such treaties. The European proposal that the countries in the region should adopt the EU Energy Charter was rejected by South American countries.[8]

In the first decade of the twenty-first century, escalating oil prices brought about the rebirth of the historical perception (Nore & Turner, 1980) that the terms of exchange were unfavourable to energy exporters. Governments and state firms began to take a central role in the South American energy integration process and supply security became perceived as an instrument for geopolitical policy. The energy integration process in the region returned to the empire-regions approach.

Figure 1: Imports of selected countries* as a proportion of global oil production, 2010 & 2030



* U.S., Japan, Europe (Organization for Economic Cooperation and Development, or OECD), China, India.

Source: Created from International Energy Agency (IEA) and OLADE data

3. Energy integration: Benefits and obstacles

The South American energy systems is the result of a historical process in which state-owned firms were the central organizing feature of the energy market under the economic policy of import substitution, and these firms structured domestic electricity markets in the industrialized economies in the region. However, the natural gas market is still being formed, except in Argentina. Little attention was given to energy integration before the economic liberalization of the 1990s.

Liberalization opened a wide window of opportunity for economic efficiency gains in the energy systems of the region. The state-owned energy firms were privatized and space for private investors in the energy markets was opened up. Agreements and bilateral contracts were used as institutional instruments to support the regional energy integration process. The development of the necessary infrastructure to allow energy flows among the region's countries received considerable support.

The opportunities for economic efficiency gains were largely associated with the convergence between the energy and fuel markets, induced by the increasing number of thermal power plants consuming

8 Venezuela is an observer in the Energy Charter.

natural gas (De Oliveira, 2007). Energy integration then appeared as a necessary mechanism for exploring these opportunities, as natural gas reserves were located in the regional economies with lower levels of industrialization and urbanization.

3.1 Benefits of energy integration

The cooperative use of the availability of electric resources in neighbouring countries began to be studied in the context of the Regional Energy Integration Commission in the 1960s. Two sources of significant economic efficiency gains were identified: the hydrological diversity of the river basins on the South American continent, on the supply side, and the diversity of the load curves of the various national electricity systems (depending on consumer behaviour in each country), on the demand side.

This hydrological diversity[9] offers opportunities to explore hydropower generation in the rainy season in certain river basins to compensate for the inability to generate power in other river basins that experience low rainfall. The cooperative generation of hydropower[10] reduces the need to burn fuel in thermal plants. The cost of electricity is reduced, the environment suffers lower impacts and the risk of power shortages diminishes.

The diversity in consumer behaviour leads to demand for power peaking at different times. The cooperative use of regional power generation capacity reduces the need for installed capacity to secure regional energy supplies. Investments are smaller and the cost of electricity is reduced.

The economic benefits expected from the integration of regional electricity systems have been studied quite extensively. It has been estimated that the integration of South America's electricity markets would lead to the saving of USD 529 million in operational costs alone in 2010 (Moniz Ramos, 2004). Additional benefits would be derived from the economies of scale provided by using larger power plants and the smaller investments needed to expand installed capacity. Aiming to take advantage of these opportunities, transmission lines were projected and built for the transportation of electricity among the countries in the region, both in the north and south of the continent (Table 1).

The integration of the natural gas industry began with the building of a gas pipeline to transport Bolivian gas to Argentina[11] and was fleshed out by the building of the Bolivia–Brazil gas pipeline and other gas pipelines to transport Argentinean gas to the Chilean market. Thermal power plants, perceived at the time as the anchors for the rapid development of the natural gas markets in the region, created a need to assess the economic feasibility of gas pipelines required for the transportation of significant natural reserves in South American countries.

A study prepared by OLADE indicated the existence of significant natural gas reserves with low opportunity costs in the Andean countries, most of which were unlikely to be used in these countries' domestic markets (WEC, 2007). Approximately 250 million m^3/day of gas could thus be offered to the markets in the south of the continent at competitive prices. The promotion of natural gas flows among the countries in South America is thus another opportunity for economic gains offered by the energy integration of the region.

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9 The Amazon basin, the largest in the world, occupies 7 million km^2. The Prata basin, the world's fourth largest, occupies 3.1 million km^2 and the São Francisco basin, the sixth largest, occupies 2.7 million km^2.

10 In the north: Magdalena, Cauca, Orinoco-Caroni, Marañon-Solimões and Trombetas; in the south: Xingu, Tocantins-Araguaia, São Francisco, Paraná-Paraguai and Uruguai.

11 The discovery of important natural gas reserves in Argentina after the gas pipeline was built limited its use for several years.

In order to give institutional support to the energy flows (electricity and natural gas) government agreements and bilateral agreements were established. These comprised rules to guarantee quantitative flows and formulas for the pricing of energy, based on international prices in the case of natural gas, but on domestic prices in the case of electricity.

Table 1: International electricity connections in South America

South	Countries	Location	Power (MW)
Operational	*Argentina–Paraguay	Central de Partidas Yacyretá	800/1,300
	*Argentina–Paraguay	Central Salto Grande (Colonia Elia [Arg]–San Javier [Par])	6,300
	*Brazil–Paraguay	Saídas da central Itaipú	1,000
	Brazil–Argentina	S.M. Ricón (Arg)–Garabi (Bra)	50
	Brazil–Argentina	Paso de los Libres (Arg)–Uruguaiana (Bra)	2,000
	Brazil–Argentina	Rincón (Arg)–Itá (Bra)	380
	Argentina–Chile	Central Termo Andes (Arg)–Norte Grande (Chi)	80
	Argentina–Paraguay	Clorinda (Arg)–Guaramaré (Par)	30
	Argentina–Paraguay	Eldorado (Arg)–Carlos Antonio Lopez (Par)	100
	Brazil–Paraguay	Foz do Iguaçú (Bra)–Acaray (Par)	70
Planned	*Brazil–Argentina	Yacyretá (Arg)–Foz do Iguaçú (Bra)	1,200
	Brazil–Argentina	Yacyretá (Arg)–Porto Alegre (Bra)	600
	Argentina–Chile	Mendoza (Arg)–Santiago (Chi)	150/200
	**Argentina–Paraguay	Argentina–Assunción (Par)	-
	Brazil–Uruguay	Livramento (Bra)–Rivera (Uru)	70
North	**Countries**	**Location**	**Power (MW)**
Operational	Brazil–Venezuela	Boa Vista (Bra)–El Guri (Ven)	60
	**Ecuador–Peru	El Alamor (Ecu)–Piura (Per)	-
	Colombia–Venezuela	Cuestecita (Col)–Cuatricentenario (Ven)	150
	Colombia–Venezuela	Tibú (Col)–La Fría (Ven)	80
	Colombia–Venezuela	San Mateo (Col)–Corozo (Ven)	150
	Colombia–Ecuador	Ipiales (Col)–Tucan/Ibarra (Ecu)	40
Planned	**Ecuador–Peru	Guayaquil (Ecu)–Piura (Per)	-
	Ecuador–Peru	San Ildefonso (Ecu)–Zorritos (Per)	70
	Colombia–Ecuador	Pasto (Col)–Quito (Ecu)	100

* Binational.
** No data available.

Source: Moniz Ramos (2004)

Studies were undertaken aimed at advancing the governance mechanisms in the regional electricity market (CIER, 1999; 2001) in terms of the institutions-market approach. A regional governance approach was suggested (in terms of operator, administrator and regulating commission), superimposed

on governance by national markets but subordinated to the subsidiarity principle.[12] The regional market would be operated according to the terms of bilateral agreements, but electricity flow markets would be created for eventual electricity flows (opportunity flows). These agreements would contain operational procedures that would guarantee adequate security levels for energy supplies in South American countries.

3.2 Obstacles to energy integration

Despite the fact that the potential economic benefits from regional energy integration are significant, this process has not progressed as expected. In principle, all countries gain in terms of improvements to their energy supply security. Consumers in importing countries have the additional gain of cheaper energy supplies and producers in exporting countries gain new business opportunities. However, energy becomes more expensive for consumers in exporting countries, while energy producers in importing countries face competition from providers with lower production costs. This tends to mobilize socio-political forces opposing the integration process. The clear identification of costs and benefits for the agents involved in the process of integration is thus a fundamental necessary step to make in order to adjust the various conflicting interests.

In the South American case, a large part of the costs and benefits of energy integration stems from the output of hydropower plants, as it determines the use of fossil fuels in thermal power plants. Thus, the output of hydropower plants plays a decisive role in the pricing of natural gas, as well as in the emissions of greenhouse gases. Given the differences in the technological composition (hydro and thermal) of generating capacity in the countries in the region, the coordination of hydropower plants' output is crucial to reaping the benefits of regional energy integration.

However, managing output requires a complex economic decision based on expectations regarding key factors (such as rainfall, electricity demand and natural gas prices). These expectations give shape to the opportunity cost for water saved in the hydropower reservoirs, and the power plants' output is based on this cost. Because water has alternative uses (irrigation, supplies to domestic users, leisure, etc.), its use follows differentiated economic criteria. Under these conditions, formulating supranational cooperative rules that lead to an agreed division of costs and benefits in terms of electricity output is a difficult task.

The difficulty in adopting cooperative rules for output also makes it difficult to formulate rules for dividing costs and benefits associated with the production and consumption of natural gas. As in the Russia–EU case, long-term contracts are considered essential by exporting countries in the region to secure their financial flows. However, contractual flexibility is necessary to allow for adaptation to changes in the energy and broader economic context.

In the present decade, the escalation of fossil fuel prices started a period of heightened disputes over economic revenues generated by energy systems. The political consensuses that allowed the elaboration of bilateral agreements in the 1990s have disintegrated, e.g. the Argentine government has decided to give priority to the domestic supply of natural gas, putting Chile's energy supplies at risk, while the Bolivian government decided to nationalize Petrobras's assets, putting Brazilian energy supplies at risk.

12 Introduced in the EU, this principle states that supranational rules take precedence over national rules.

Acknowledging the feebleness of the agreements made in the 1990s in securing the regional energy supply, the IIRSA (2002) prepared a study with the objective of establishing the basic conditions for structuring multilateral agreements that would make feasible the constitution of a regional energy market, with the fixing of prices based on opportunity costs (using the institutions-market approach). This study suggested advancing in carefully managed steps or stages.

In the first step, the agreements and contracts would not make significant alterations in national regulations, limiting themselves to the establishment of rules and norms for energy flows among the countries in the region. In other words, the coordination of the use of energy resources would remain in the domestic realm and any multilateral agreement would be limited to rules and mechanisms for energy trade governance in the region.

From this perspective, a group of South American countries (Argentina, Brazil, Chile, Paraguay, Peru and Uruguay[13]) promoted a study with the objective of reaching a preliminary consensus in regard to a legal and institutional regime for the interconnection of gas supplies in the region (Freyre & Asociados, 2005). The study suggested the creation of a multilateral treaty to institutionalize the gas pipelines network in the south of the continent. The difficulties in moving forward with this agreement arise from the formulation of tax rules, investment promotion mechanisms and dispute settlement arrangements. The study also identified the necessity of overcoming disputes over the geographical boundaries between Chile, Peru and Bolivia so that a multilateral approach can progress in the region. The proposals put forward by this study were forgotten.

It is important to note that the environmental issue, particularly relevant in the northern part of the continent, has not received the required attention in the debate over integration so far. The plans for expanding the energy supply indicate the problems of developing the energy potential of the Amazon region, where knowledge of local biomes is limited and the presence of various indigenous communities is an important factor. The controversy over the mitigation of the social and environmental impacts of projects in this region is enormous. The difficulties encountered in the environmental licensing process of the Belo Monte plant in Brazil illustrate the complexity of this issue.

4. The role of Brazil in South America's energy security

Brazil suffered intensely from the oil crisis of the 1970s because at the time the country imported around 80 percent of its oil consumption. Aggressive policies were therefore adopted with the objective of minimizing Brazil's dependency on imported oil (De Oliveira, 1988). Among these policies, the development of the large domestic potential for alternative renewable energy sources should be highlighted, as well as energy integration with the country's neighbours. Using alternative sources of energy, Brazil began a process of transition to a low-carbon economy, while the country sought to increase its supply security using integration.

Once historical suspicions were overcome, agreements and bilateral contracts were drawn up to make feasible the Itaipú power plant (12,600 MW), the Bolivia–Brazil gas pipeline (30 million m^3/day), and the Garabi converter station (2,000 MW) to allow electricity flows between Brazil and Argentina. The possibility of low opportunity cost energy supplies created by these projects made productive investments attractive, especially for energy-intensive activities.

13 Bolivia had observer status.

In the first decade of the twenty-first century, the escalation in oil prices gave a new dimension to the dispute over economic revenues associated with energy supplies. Political forces in South American exporting countries demanded the revision of contracts and agreements that made the above projects possible. This opportunistic behaviour rekindled suspicions regarding the supply security of energy imported from neighbouring countries and energy integration lost space in Brazil's energy policy.

However, escalating oil prices made it possible to identify large hydrocarbon resources in the Brazilian continental shelf. This oil potential radically changed the Brazilian energy scene. Traditionally a net energy importer, Brazil should become a substantial exporter at the end of the present decade (EPE, 2010). This new situation strengthened the indifference of Brazilian economic thinking to regional energy integration as a potential source of security for domestic energy supplies. However, in the context of global energy transition, energy integration continues to offer a wide window of economic benefits for Brazil and its neighbours.

4.1 Energy transition, security and competitiveness

In the last few years, scientific evidence that the accumulation of certain gases in the atmosphere causes the greenhouse effect and raises the risks of extreme climate phenomena at unacceptable levels has mounted. It is practically a scientific consensus that a change from energy generation through the burning of fossil fuels—launched by the Industrial Revolution—is needed. Although international negotiations are progressing slowly, the global transition to a low-carbon economic system is in play. In this environment, reducing dependency on oil, particularly when it is imported from geopolitically unstable regions, is at the centre of industrialized countries' energy policies.

Such an energy transition is a complex task that has high costs and uncertain benefits (Stern, 2006). If the transition is speeded up, the risks resulting from climate change will be minimized. However, on the one hand, a large part of fossil fuel reserves will remain underground without producing economic advantages for the countries holding these reserves. On the other hand, if the transition happens too slowly, there is the risk that the economic benefits derived from the use of these reserves will be largely neutralized by the environmental costs caused by the increase in the planet's temperature.

Security and flexibility are indispensable attributes of the energy supply system so that the transition to a low-carbon economy brings net economic benefits. Brazil, due to its abundance of fossil fuels and its leadership in the renewable energy field, possesses the structural conditions to give such attributes to its energy system. Its geographical position and the size of its market would allow it to extend these attributes to the rest of South America through regional energy integration. In this way, Brazil can give the region the necessary attributes to be an active participant in the creation of a low-carbon economy.

Table 2 shows the current situation and expected evolution of the regional energy system, highlighting the position occupied by Brazil in terms of regional energy supply ('Participation' indicates Brazil's share of the supply of each type of energy/energy source). Brazil's energy consumption will continue to rise and its natural gas consumption should double in ten years. During this period, Brazil will change from the position of importer to that of an exporter of approximately 2.1 million barrels of oil per day.

Table 2: Evolution of South America's energy production and consumption, 2008–18

Source		Production			Consumption		
		2008	2010	2018	2008	2010	2018
Oil (million barrels/day)	Brazil	1.8	3.5	4.9	1.8	2.3	2.8
	South America	7.0	9.6	12.0	4.4	5.2	6.0
	Participation (%)	26.0	36.5	41.3	40.3	44.4	46.7
Natural gas (m^3/day)	Brazil	59.2	92.6	129.0	73.5	93.5	127.8
	South America	214.7	278.2	353.2	216.7	279.6	355.9
	Participation (%)	27.5	32.2	36.5	33.9	33.4	35.9
Electricity (TWh)	Brazil	387.9	488.9	636.8	428.3	529.2	677.1
	South America	856.0	1,068.0	1,329.5	859.5	1,065.8	1,322.8
	Participation (%)	45.3	45.8	47.9	49.8	49.7	51.2
Coal (million tons)	Brazil	3.2	3.6	2.8	17.0	17.3	16.5
	South America	60.4	63.6	65.6	29.1	32.3	34.3
	Participation (%)	5.4	5.6	4.2	58.3	53.6	48.1

Source: Brazilian data supplied by Empresa de Pesquisa Energética (EPE) and South American data supplied by OLADE

In this scenario, South America will increase its share in supplying oil to the industrialized countries from 6 to 10 percent between 2010 and 2030 (Figure 2). To this volume should be added ethanol exports (estimated at 9.9 billion litres per year for 2019) and a growing surplus of natural gas in the Brazilian market that will also be available for export (EPE, 2010).

Figure 2: South America's share of oil imports of selected countries,* 2010 & 2030

* U.S., Japan, Europe (OECD), China, India.

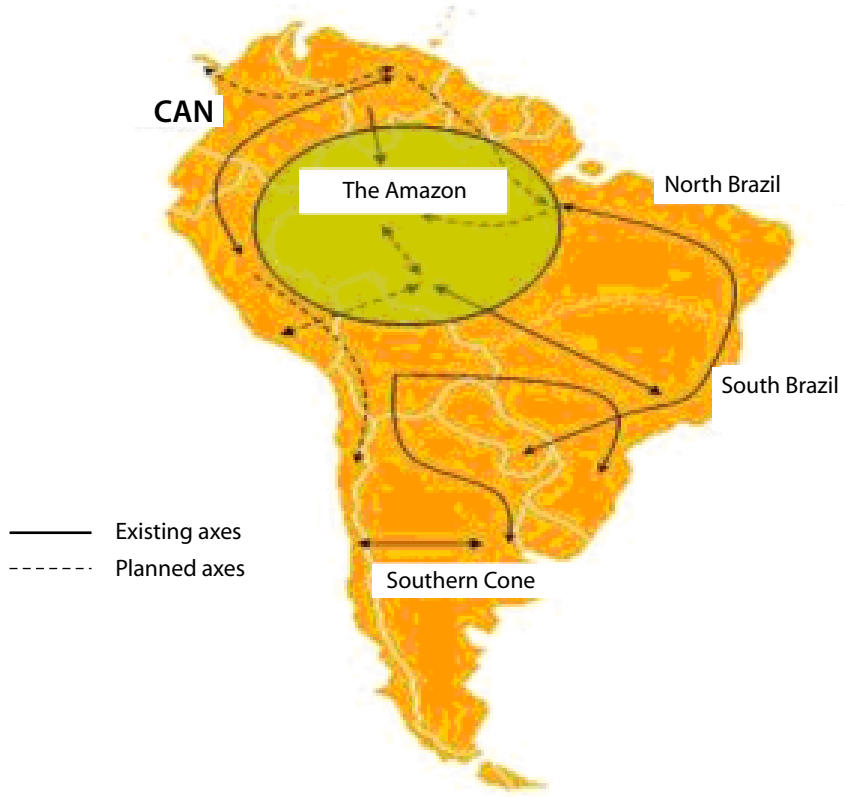
Source: Compiled from data supplied by IEA, OLADE and EPE

Figure 3 stylizes movement towards the integration of South America's energy transport infrastructure. This infrastructure is already in place in the southern part of the continent, where energy can flow from coast to coast. In the central part, transport infrastructure links the supply of the Jirau and Santo Antonio hydropower plants to the Brazilian main load centres. The development of the hydropower potential of Bolivian and Peruvian Amazonia is being planned, indicating that the logistical conditions for the flow of energy between the Atlantic and Pacific coasts should be available in the near future.

The energy transport infrastructure is still in its early stages in the north and between the north and the south of the continent. Political difficulties in the Andean north do not allow for optimism in regard to the integration of infrastructure in the short term, although it should be mentioned that there has been an advance in the integration of electricity supplies between the north and south of the continent through Brazilian territory. Brazil's ten-year plan (EPE, 2010) estimates a steady increase of natural gas supplies in Brazilian Amazonia, but gives no plans for a gas pipeline to transport this gas to the south of the continent.

The development of physical connections among regional energy markets has not been sufficient to allow South American economies to explore the window of opportunity presented by the energy transition, however. The energy transmission lines and gas pipelines that made physical energy flows feasible remain underutilized, the reliability of national energy systems remains inadequate and the cost of energy is growing in the region's countries.

Figure 3: South American energy integration axis



CAN = Andean Community of Nations.

To contain energy price increases for end consumers, subsidies have been used widely in the region. This practice hinders the development of regional energy flows, limiting these flows to responses to critical situations in the domestic supply of each country. The removal of subsidies in domestic markets is a complex process that will happen only gradually. This situation suggests that security of energy supplies must be the immediate focus of the regional energy integration agenda. An increase in commercial energy flows should be a subsequent step.

4.2 Multilateral Energy Security Reserve (RMSE)

Energy supply security became the central focus of Brazil's energy policy after the energy rationing crisis that occurred at the beginning of the twenty-first century. The harmful effects (social, political and economic) of this crisis generated a consensus on the need to minimize the risks of similar events taking place in the future.

To avoid rationing in the future, the Electricity Sector Monitoring Committee was created. From a regulatory point of view, risk aversion curves that limit the use of accumulated energy in hydroelectric reservoirs were adopted. Moreover, the requirement that thermal plants sign contracts for their fuel supplies that will allow them to deliver their maximum output at any given moment was introduced.[14]

These new regulations were adopted without giving the necessary attention to their costs (De Oliveira, 2010). Significant investments in the expansion of infrastructure for electricity and natural gas supplies remain low and the system remains idle for long periods of time, being activated only in situations of unfavourable rainfall. These measures had as a corollary an increase in electricity (Figure 4) and natural gas costs in Brazil's domestic market.

The escalation of electricity prices is one of the relevant factors in the Brazilian economy's loss of competitiveness (Kanto Filho, 2009). Aiming to contain this escalation, the government has offered subsidies in different forms for the building of new hydropower plants (Werneck, 2010) and has been studying a proposal to renew hydropower plants concessions at prices much lower than their opportunity costs, as a mechanism to achieve the average tariff considered to be economically competitive.[15] This development causes distortions in energy prices without solving the structural problem of energy supply security.

Energy integration remains the best economic alternative for the competitive increment of Brazil's energy supply security. It offers access to energy resources from neighbouring countries at low opportunity costs, especially from the Andean countries situated in the centre of the continent. As for the other countries in the region, energy integration offers the opportunity to improve their energy security and access to the Brazilian market for their energy resources that would otherwise remain idle, and would allow them to participate in the productive chain of the Brazilian energy system.[16] The region as a whole would gain in providing a competitive, secure supply of energy to investors.

It is important to note that bilateral agreements limit the scope for energy integration. The institutions-market approach, based on multilateral agreements, is able to prevent opportunistic behaviour of governments and energy market agents. To explore its main comparative advantage (i.e. the large regional availability of energy resources with low carbon content and low opportunity costs), South America needs to establish rules and multilateral mechanisms that minimize the risk of unilateral changes in agreements and contracts. However, it is necessary to accept that the diversity of the nature

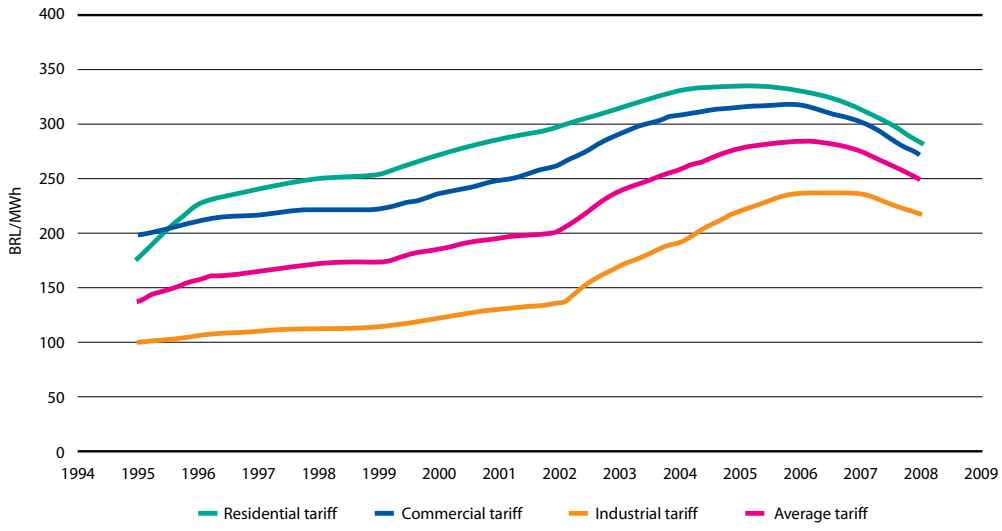
14 The Electricity System Monitoring Committee has the responsibility of monitoring the energy supply situation monthly.

15 Low prices below opportunity cost for energy offered by plants whose concessions will be renewed, with prices in line with the opportunity costs in other plants.

16 The Brazilian market offers the necessary scale to make feasible the expansion of the regional offer of goods and services required by the productive chains in the energy system. In this way, the region will no longer be in the vulnerable position of commodities exporter and will be able to offer the goods and services required by the energy sector to the global market.

and regulation regimes of the region's energy systems imposes the need for integration to progress in stages, as the IIRSA study (2002) suggests. Access to neighbouring countries' reserves in situations of energy supply insecurity could be the initial aim of such integration efforts.[17] A treaty that provides the legal base for contracts for the use of the RMSE can remove risks associated with imports of energy in such situations.

Figure 4: Evolution of Brazil's electricity tariffs, 1994–2008 (BRL/MWh*)



* At 2008 prices deflated according to the consumer price index (Índice Nacional de Preços ao Consumidor Amplo or IPCA).

Source: Based on data from the Instituto Brasileiro de Geografia e Estatística

An RMSE treaty should offer free access, in terms of the economic and technical conditions established in the treaty, to the required infrastructure and reserves needed to overcome the insecurity of energy supply in any country in the region whenever necessary. Economic access to the energy resources from the RMSE (energy price) and the transport logistics (tariffs for the use of networks) would be set based on the long-term supply costs of the various domestic markets. Therefore, the energy prices in the energy security flows between countries of the region would not be linked to the prices currently set in these domestic markets. Since the use of RMSE energy should only occur in situations of difficulty in the domestic supply of energy, its supply costs should offer a price signal for investors of the opportunity costs of energy supply in the region. In this way, the RMSE treaty would work as a fundamental pillar for the coordination of regional energy security and integration.

5. Conclusion

The need for radical changes in the world energy scene induced by climate change policies opens a large window of opportunity for South America, but creates challenges as well. The region has a privileged energy situation in terms of the transition to a low-carbon economy based on renewable energy sources. Security of supply is fundamental for a successful energy transition that will remove the region's economic dependency on the export of commodities, and regional energy cooperation is essential for removing the insecurity of energy supply that periodically haunt the countries of the region.

17 It is important to note that secure energy supplies in South America would create favourable conditions for the improvement of secure energy supplies for other parts of the world, as the region will remain a net energy exporter.

South America's place in the process of energy transition will be largely determined by two elements: its capacity to secure its energy supplies and its ability to promote safe energy supplies, especially of hydrocarbons, to energy-importing countries during the transition period. The provision of energy security will create a favourable economic context for attracting investments to the region, thus adding value to its energy resources, whether renewable or not. To develop its capacity to provide energy security, South America needs to proceed with its energy integration process using the institutions-market approach.

So far, energy integration policies have been focused on the construction of the infrastructure needed to increase energy flows among the countries of the region, and there have been no significant efforts either to develop regulations for these flows or to establish trading mechanisms for them. This situation can be largely attributed to the difficulties that the region is facing in achieving economic integration beyond a customs union. Unfortunately, a common agenda for integration is becoming increasingly difficult to draw up as a result of radically different political approaches among the countries of the region. Nevertheless, it is possible to move energy integration a step forward within the current economic integration process.

There is strong evidence that energy integration will provide large economic benefits for the region, but it is very hard to identify a fair method of sharing its costs and benefits. Among these benefits, regional energy security is one that will provide economic gains to every single country of the region; furthermore, it has costs and benefits that can be easily identified (and eventually shared) by each country. To explore this opportunity, access to the region's reserves whenever a country faces an energy supply risk is needed. An RMSE treaty can both grant such access and establish the required regulations and pricing mechanisms that would govern this process.

Brazil's active participation in the formulation of the RMSE treaty is essential for South American energy security and the success of regional energy integration. Its geographical position, market size, oil resources and leadership in the development of renewable energy sources make Brazil the best candidate to take over the coordination of the competitive, secure integration of the South American energy markets. For the countries in the region, Brazil can offer access to its market and leadership in the restructuring of Latin American economies for the supply of low-carbon goods and services to the world economy.

It is essential to recognize that the integration process faces significant obstacles, however. Three are particularly relevant: the coordination of the electricity output of the various power plants in the region; the environmental licensing of energy projects, especially in Amazonia; and, in particular, the deficit in terms of a legal system to facilitate private investment. The European Energy Charter sought to solve this last problem by providing conditions and protection for private investments, but it has not been accepted in South America, mostly because it removes the dispute settlement process from the region itself. However, it is essential to have an institutional mechanism to settle regional disputes, and the RMSE treaty therefore needs to address this issue.

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