

REGIONAL ELECTRICITY COOPERATION AND INTEGRATION IN THE AMERICAS: POTENTIAL ENVIRONMENTAL, SOCIAL AND ECONOMIC BENEFITS

Francisco J. Burgos

Department of Sustainable Development
Organization of the American States

ABSTRACT

Regional electricity cooperation and integration is accelerating in the Western Hemisphere. The process of electricity integration differs both within and between countries, and processes are underway at different stages, and within different objectives, in North America, Central America, the MERCOSUR¹ countries and elsewhere. In general, electricity integration comprises a long-term process which comprises of integration electric-generation and transmission grids, as well as supporting policy-related harmonization of electricity regulations, and the accelerated integration of technology sharing.

Integration also entails a common strategy to attract financing, with returns on investment changing and increasing because of integration-related advances. For instance, experience demonstrates that diversifying the source of electric-power generation to least-cost production for both peak and non-peak power options has the potential to lower overall costs, promote more efficient use of resources, increase the reliability of power generating sources, and through efficiency related gains; improve the business opportunities to attract foreign investments within the sector. In turn, the expansion of capital and operational investments can lead to positive spin-offs in human health and environmental performance, including the acquisition of end-of-pipe pollution abatement equipment, improved design and maintenance of hydro-power, and other benefits.

However, the possible social and environmental benefits associated with electricity integration are neither simple nor automatic. Instead, they require additional policy attention to ensure a complementary policy approach in which energy security works in tandem with environmental protection and the climate change agenda.

¹ Mercado Común del Sur (MERCOSUR) translated *Common Market of the South* is a Regional Trade Agreement (RTA) among Argentina, Brazil, Paraguay and Uruguay founded in 1991 by the Treaty of Asunción, which was later amended and updated by the 1994 Treaty of Ouro Preto. Its purpose is to promote free trade and the fluid movement of goods, people, and currency. Bolivia, Chile, Colombia, Ecuador and Peru currently have associate member status. Mexico has observer status. Venezuela signed a membership agreement on 17 June 2006, but before becoming a full member its entry has to be ratified by the Paraguayan and the Brazilian parliaments.

One example of the attention countries of the region are placing on complementary policies is set out in the communiqué of the leaders of Canada, Mexico and the United States in August 2007, in which they agreed to increase cooperation in energy security and environmental protection, including the adoption of a formal framework of collaboration to address issues such as bilateral and trilateral cooperation in mutually beneficial research, development and deployment on a wide range of energy technologies for peaceful uses, including renewable energy, energy efficiency, nuclear energy, fossil fuels and electricity. The three countries also agreed to increase cooperation in the development of low and zero-emission energy production and end-use technologies; low carbon fuels; carbon dioxide capture and storage; hydrogen and fuel cell technologies; and technologies to enhance the security of energy infrastructure².

1. INTRODUCTION

Regional electricity cooperation and integration is a long term process that involves the combined operation of power systems, the interconnection and the harmonized management of infrastructure services, including the design and operation criteria. In addition, it entails a common strategy around policy harmonization, as well as comparable approaches related to financing. At the aggregate level, the countries of the Americas possess sufficient energy capacity to meet the energy demand. However, there are asymmetric capacities within individual countries (Weintraub, 2007). Electricity cooperation and integration not only increases the access of operators and consumers to modern electricity services and products, but also provide greater security and reliability to the power sector, and contribute to improvement of technical operation.

Energy integration has the potential to support and complement environmental policies, including increasing the potential of countries to expand renewable energy generating capacity within countries, as well as contribute to climate change mitigation both by achieving efficiency gains associated with integration and economies of scale from the production perspective, and increasing conservation due to price formation of electricity services. In addition, regional integration has the potential to accelerate the transfer of modern electricity generating technologies among countries, leading to an upwards harmonization of performance-based generating capacities.

At the same time, the potential environmental benefits of electricity integration are neither automatic nor easily achieved. Indeed, experience from electricity integration within the United States, through the liberalization of generating capacities, suggests that integration can exacerbate environmental pressures, by providing a preference to the least cost electricity producer (which in the case of the United States is coal-fired plants in the mid-west). Moreover, the policy lessons of market liberalization and integration at the North American level (in particular involving integration of the United States and Canada

² See North American Leaders' Summit, Montebello, Quebec, Canada, August 21, 2007
<http://www.state.gov/p/wha/rls/prsr/07/q3/91320.htm>

electricity markets) is that liberalization is accompanied by more, not less, regulatory oversight by government authorities, as electricity services as unbundled and risks of price manipulation increases).

This paper provides an introduction to some issues related to electricity market integration. Section 2 presents a brief coverage of the trends for electricity –energy– integration and cooperation within the countries of the Americas. Section 3 shows the principal barriers for greater electricity cooperation and integration in the Western Hemisphere with regard to the most relevant environmental, social, economic and policy issues. This section is specially focused on the challenges faced by Latin American and Caribbean countries. Section 4 explores the potential benefits that can be obtained from greater electricity cooperation and integration. A conclusion is offered in section 5.

2. THE HEMISPHERIC REALITY AT A GLANCE

Energy infrastructures, understood as consisting of power plants for electricity generation and transmission systems using both renewable and non-renewable energy sources, pipelines, grids, refineries and storage stations; are essential for development due to the role they play in the energy sector as well as for its strategic value to facilitate and enhance economic and social benefits. The development of these infrastructures in the Western Hemisphere has been remarkably differentiated. North America has the most integrated and dynamic experience, followed by the MERCOSUR countries where the electricity market is greatly integrated, and the emerging Central American Electric Interconnection System (SIEPAC).

In general, energy infrastructures in the hemisphere were state-owned and managed as a monopoly within the public sector. In the case of Latin American and the Caribbean (LAC), it was during the mid 1980s and early 1990s that state-owned utilities in most of the countries of the region started a reform process –capitalization and/or privatization– motivated by the worsening financial and operational situation faced by the energy sector, and more specifically the electricity industry, that was affected by, among others, inflation problems, currency devaluation, high interest rates, and the oil crisis of the 1970's (Bacon and Besant-Jones, 2001; Dussan, 1996; Fisher and Serra, 2000; Matos, 1996), and this as part of a global situation (Dubash, 2002). In consequence, the power sector in LAC demanded major public financing interventions that resulted in deteriorating the development of most countries national economies due to the lack of proper design and operational planning; low technological development, inadequate policies, and the lack of transparency in the management of the power sector activities³.

³ Corruption seems to have been a major problem for national and regional development, particularly, in efforts to fighting poverty. According to the 2006 Corruption Perception Index survey done by Transparency International, 25 of 30 countries studied in the Americas indicated serious perceived levels of domestic corruption, and 11 countries indicated a perception of rampant corruption. For more details see http://www.transparency.org/policy_research/surveys_indices/cpi/2006

In LAC, the accumulation of these and other related situations led to a decline in the annual rate of growth of electricity demand which, according to Dussan (1996), downgraded from 9.8% in the period 1975-1980 to 4.6% during 1985-1990. In short, these problems and needs pushed for more strategic reforms of the power sector, including the necessary development and update of the physical facilities in the electricity industry and encouraging the energy dialogue, cooperation and interconnections within the countries in the region⁴.

During the 1990s, the electricity sector in the Western Hemisphere experienced major improvements toward national and regional interconnections which increased the electricity trade by 99.3 percent during the years 1988 and 1996. Additionally, the residential electricity consumption rose by 50 percent between 1988 and 1999, and the electric power coverage expanded from 75.1 percent in 1988 to 87.9 percent in 1998 (Appendix A presents the net electricity generation in the Americas by type during the year 2004). According to the World Bank, this development of the hemispheric electricity sector demanded an increment in investment from US\$2 billion to US\$46 billion during the first half of the 1990s, from this amount 23 billion were allocated in LAC countries (Coordinating Secretariat of the Hemispheric Energy Initiative (HEI), 2001⁵; Ruiz-Caro, 2006).

The political motivation behind this progress could be represented by the adoption of the HEI in the First Summit of the Americas in 1994 in which the Heads of States of the Americas defined a plan that promoted integration and sustainable development in the region while encouraging the definition and adoption of transparent regulatory frameworks to secure energy markets that meet the investment and sustainable development needs. The Declaration behind the HEI strongly stated that the sustainable economic development of the region required major energy cooperation and the political will to increase investment in the energy sector. Also, its Action Plan (Appendix B) outlined various strategies for promoting energy efficiency, the development of environmentally sound technology, and the promotion of renewable energy.⁶

Despite the afore-mentioned advances, it can be argued that the energy infrastructure in the Americas is nearing capacity and inadequate to meet the requirements of a sustainable energy system (Pineau et al., 2004; Weintraub, 2007). For instance, LAC has only used 26 percent of its energy potential, although it is estimated that its overall energy consumption in relation to GDP growth in this sub-region has increased by 2 percent since 1970 (Weintraub, 2007). Additionally, the average investments in infrastructure do not reach 2 percent of GDP when 3 to 6 percent is needed to meet LAC development needs (Fay and Morrison, 2007).

⁴ It is important to mention that the formation of the Latin American Energy Organization (OALDE) in 1973 and the Regional Association of Oil and Gas Companies in Latin America and the Caribbean (ARPEL) in 1976, reveals that the issue of energy market integration in LAC has a long history in the regional negotiations.

⁵ More information about the Summit of the Americas can be found at <http://www.summit-americas.org/>

⁶ First Summit of the Americas, Action Plan signed by the Heads of States and Governments, Miami, Florida, December 9-11, 1994. Available online at <http://www.summit-americas.org/miamiplan.htm>

Currently, there are various initiatives involving political and economic reforms toward energy cooperation in the hemisphere which include not only the required energy policy dialogue within the countries but also the implementation of activities such as cross-country electricity projects, sub-regional grid interconnections, as well as collaboration in the development of financial opportunities and technical expertise. Currently, electricity infrastructure and cooperation/integration trends in the hemisphere are determined by regional agreements, and these have followed a geopolitical and economic path that is further explained below.

2.1 North America

As was stated before, North America has the most active and integrated electricity market in the hemisphere, with 51 multinational electricity transmission lines connecting North America to Canada and Mexico (Weintraub, 2007). However, electricity trade within the three countries is remarkably differentiated by the amount of transactions between Canada and the United States, and the trade between Mexico and the United States. According to the Energy Information Administration (EIA), in 2005 the United States imports reached 44.5 billion kilowatt-hours (kWh), and from that amount 42.9 billion kWh were purchased from Canada (EIA, 2006). The small transactions between Mexico and the United States are limited due to short cross-grid interconnection, market harmonization and grid compatibility issues. According to the North American Energy Working Group (NAEWG), a body created under the North American Free Trade Agreement (NAFTA), there is a real need for a more comprehensive grid, which requires the development and update of current infrastructure to ensure supply reliability.

Another significant difference among North American countries has to do with the use of energy sources for electricity generation. Power generation in the United States mainly relies on coal, which accounted for 52 percent of the total generation in 2004. Canada's electricity generation was dominated by hydroelectricity totaling 60 percent during the same year, and Mexico's electricity generation was based on the use of oil products and natural gas which accounted for 66 percent of the power generation (EIA, 2007). In general, it is affirmed that trilateral electricity cooperation and integration within North America's countries is at its early phase and requires major improvement to make the grid more comprehensive and to coordinate action toward infrastructure financing (Pineau et al., 2004).

2.2 Central America

Diverse projects have been taking place in Central America in order to address electricity/energy needs. These activities go from a policy framework such as the 1996 Framework Treaty for the Central American Electricity Market⁷, to the implementation of physical interconnection projects such as the 2001 Puebla-Panama Plan (PPP), a multi-

⁷ The Governments of the Republics of Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama agreed to initiate a gradual process of electrical integration by developing a competitive regional electricity market through transmission lines interconnecting their national grids and by promoting regional generation projects.

billion dollar development plan intended to "promote the regional integration and development" of the nine southern states of Mexico with all of Central America and Colombia. Two of the major projects that reflect the countries' commitment are the Sistema de Interconexion Electrica para America Central or *Central American Electrical Interconnection System* (SIEPAC) and the Mexico-Guatemala interconnection project.

SIEPAC was initially conceived in 1987 by the cooperation between the governments of Central America and Spain, to have transmission lines with an extension greater than 1,800 kilometers, to enhance the regional access to electricity while facilitating the reliability of electricity services, energy security and energy efficiency. This US\$320 million project entails the construction of 1137-miles (1830-km) of 230 kV energy distribution line between southern Mexico and Panama, connecting 37 million consumers in Panama, Costa Rica, Honduras, Nicaragua, El Salvador, and Guatemala. Proponents of SIEPAC expect that interconnecting the nations' electrical transmission grids will alleviate periodic power shortages in the region, reduce operating costs, create a competitive energy market in the region, and attract foreign investment in power generation and transmission systems. They estimate that the cost of energy for consumers could go down as much as 20% from US\$0.11 per kWh to US\$ 0.09 per kWh as a result of the project. While there is controversy about the benefits and indirect environmental impacts of the project, it is expected to be completed in 2009.

For its part, the Mexico-Guatemala interconnection project aims to facilitate the connection of the Central American Electricity Market with the Mexican Electricity System. The financial resources for this project reach an estimated US\$40 million and will have a grid extension of 103 km.

The other two integration projects being studied to enhance the Central American regional electricity market are the interconnections between Guatemala and Belize which will have a longitude of 195 km, and the cross-borders electricity project between Panama and Colombia with 614 km of grid lines. The estimated costs for these projects are US\$24 and US\$207 million, respectively. In 2005, the six Central American countries plus Belize, the Dominican Republic, Mexico and Colombia adopted the Mesoamerican Energy Integration Program to support the region's energy market integration and to increase the electricity generation (Ruiz-Caro, 2006).

2.3 South America

In general, the electricity systems of South American countries have developed in response to national strategies; often with the participation of the private sector. Most of these have been binational projects, including the Salto Grande, Itaipú and Yacyretá hydroelectric plants, as well as the cross-countries interconnections between Venezuela, Colombia and Brazil. In 2003, there were a total of 15 electricity interconnections projects among the countries of this region, which constitutes a significant step in the Initiative for the Integration of Regional Infrastructure in South America (IIRSA). Table 1 shows the binational hydroelectric projects in this region.

Table 1
Binational Hydroelectric Projects in South America

Project	Countries	Installed Capacity (MW)	Generation (Year)
Yacyretá	Argentina-Paraguay	3,200	12,275 GWh (2002) ⁱ
Itaipú	Brazil-Paraguay	14,000	92,689,963 MWh (2006) ⁱⁱ
Salto Grande	Argentina-Uruguay	1,890	4,326,399 MWh (2006) ⁱⁱⁱ
Sources: i- www.eby.gov.ar ; ii- www.itaipu.gov.br ; iii- http://www.saltogrande.org/			

MERCOSUR was established in 1991 with the objectives of integrating the economies of Argentina, Brazil, Paraguay and Uruguay. Since its beginnings, MERCOSUR advocated for common energy policies within its member states under the premise that energy cooperation constitutes an essential step for the economic development and the integration process. In this regard, the market framework defined by MERCOSUR for the integration and cooperation of its electricity sector includes not only financial stipulations but also energy efficiency, environmental protection and legal harmonization.⁸ In 1998, the group decided to strengthen its efforts for electricity integration, and two years ago advocated for a more efficient coordination of the regulatory rules and technical activities in support of energy trade. It is projected that by 2025 this group of nations will have a completed integrated electricity grid (Weintraub, 2007). However, regulatory differences and the state's role in each system still appear as the major constraints for integration in MERCOSUR (Pineau et al., 2004).

The Commission of the Andean Community (CAN's)⁹ Decision 536 of December 2002 defined a general framework for the regional electricity systems interconnections. This political initiative supported the cross-border electricity grids between Ecuador and Colombia, Colombia and Venezuela, and between Ecuador and Peru. Most recently, during the XVI Andean Presidential Council, the four member states of the CAN agreed to facilitate the interconnection of grids and systems by pooling energy and financing resources. In this regard, the CAN envisions energy integration as a significant driving force for its interdependence and regional economic development.¹⁰

2.4 The Caribbean

The Caribbean experience presents a different scenario when considering electricity integration. This is because the region is composed primarily of a large number of isolated and widely dispersed small island states with low energy demand that creates great physical barriers and challenges for designing and installing electricity interconnection infrastructure.

⁸ MERCOSUR Decision No. 1/93 called for the definition of basic guidelines for the energy policy in the common market and the Resolution GCM No. 57/93 constitutes the fundamentals for energy cooperation, including the electricity sector.

⁹ CAN is a trade bloc comprising the South American nations of Bolivia, Colombia, Ecuador and Peru. Associate members are Argentina, Brazil, Paraguay and Uruguay. Mexico and Panama has observer status.

¹⁰ Andean Energy Alliance: http://intranet.comunidadandina.org/Documentos/DTrabajo/SGdt256_R1.doc

Nevertheless one can consider recent initiatives such as the PetroCaribe Treaty (2005), as an attempt to create a virtual energy supply interconnection/integration. In this agreement, Venezuela takes the role of supplying subsidized petroleum products to the several islands in the Caribbean at a reduced price to help the islands reduce their energy production costs. Also Trinidad and Tobago, in cooperation with Venezuela, is contemplating the development of a gas-pipe line interconnecting several Eastern Caribbean islands (Appendix B). On Dominica, activities have started for the development of a geothermal plant that will be interconnected with the French islands of Guadeloupe and Martinique. Additionally, the Dominican Republic is signatory of the Mesoamerican Energy Integration Program.

In most LAC countries the reforms of the power sector were motivated by the lack of funds to improve and expand the electricity infrastructure, as well as electricity services and products. These reforms created a singular climate for private participation in energy activities –generation, transport and distribution–, characterizing the trends for electricity development and integration as a process of market liberalization that involved greater competition and private capital inputs (Dussan, 1996). In fact, in LAC during the period between 1990 and 1997 a total of US\$ 45 billion was invested in 169 private electricity projects (Izaguirre, 1998), which in 2003 represented 60 percent of the total electricity connections (Fay and Morrison, 2007). However, in some cases such as Mexico and Venezuela, the state's role in energy/electricity activities is strongly supported as a key component for the regional cooperation and integration process.

Today, the current trends for electricity cooperation and integration in the Americas are focused on the development of regional grids interconnections that are supported by bilateral and regional agreements (ECLAC, 2006) (See Appendix C). These initiatives present a mix of public and private participation, including joint investments and sharing of technical resources, in activities that comprise infrastructure development, projects management and operation, and electricity services. However, despite substantial advances made during the last three decades, the Americas energy/electricity integration is still far away from optimal. There is a real need for new physical facilities and improvement of the existing ones to meet electricity demand.

The barriers to promote and develop efficient regional electrical cooperation and integration in the hemisphere include economic limitations consisting of non-compatible electricity markets. Also, this process is affected by the lack of political commitments to foster a greater energy mix, to develop and use renewable energy sources, to support the articulation of harmonized regulatory regimes, as well as financial constraints that are aligned with the lack of or weak common goals and planning.

The following section highlights some of these barriers and their complexities.

3. UNBUNDLING THE OBSTACLES

3.1 Environmental and Social Issues

Energy cooperation in the Americas has been seen as a key opportunity to address Climate Change issues, including the environmental and social matters that these entail. In this regard, the HEI that was signed by the Head of States of the Americas' in 1994 constitutes a concrete recognition of the special link between energy/electricity and sustainable development. Furthermore, in the context of the Latin American and Caribbean Initiative for Sustainable Development, the countries of the region agreed to increase renewable energy use to at least 10% of their total primary energy supply by the year 2010, which demanded a substantial change of the regional energy infrastructure, and in particular, a stronger definition and enforcement of the environmental regulations (Perkins, 2003). All of this required major action from policy makers, understanding that for the years to come cleaner production will be a key issue for international trade (Rosenberg, 2000) and power integration will be a necessary step for securing sustainable development and for mitigating negative environmental impacts. In fact, from a policy perspective, in today's world it is inappropriate to conceive economic growth without environmental quality measures (Seymour et al., 2005).

Regional integrated systems within the countries of the Americas have the potential to achieve multiple environmental benefits through the optimization of the use of energy sources. The pooling of technical expertise (know-how), the development of coordinated electricity market, and the strengthening of environmental regulations are essential to foster sustainable and environmentally favorable energy resources for power generation.

In relation to greenhouse gas (GHG) emissions which contribute to climate change, there is a big difference among the countries of the Western Hemisphere, which is further illustrated in Table 2. For example, while CO₂ emissions in North American countries accounted for 6.9 billion metric tons in 2004, Central and South American nations only emitted 1 billion metric tons during the same period (EIA, 2007). Despite these discrepancies, CO₂ emissions during the period of 1990-2004, have increased by 3.1% annually in Central and South America compared to an annual average of 1.3% in North America (EIA, 2007). These statistics demonstrate the significance of achieving regional electricity integration through the use of sustainable means, by regulating the use of fossil fuels and encouraging the expansion of renewable energy uses, specifically in consideration of the increased energy demand.

The pooling of resources can offer electricity development options that allow countries to mitigate the use of the highly polluting energy sources and structure electricity production in a way that prioritizes environmental concerns.

Table 2
Greenhouse Gas Emissions per country in the Americas

<i>Greenhouse gas emissions per country in the Americas</i>				
	Latest year available	Total GHG emissions	% change since 1990	GHG emissions per capita
		<i>Million Tonnes of CO₂ equivalent</i>	<i>%</i>	<i>Tonnes of CO₂ equivalent / person</i>
Antigua and Barbuda	1990	0.39	0.0	6.19
Argentina	1997	279.68	20.6	7.84
Bahamas	1994	2.20	14.9	7.91
Barbados	1997	4.06	24.8	15.34
Belize	1994	6.34	...	30.50
Bolivia	2000	21.46	40.1	2.58
Brazil	1994	658.98	11.1	4.16
Canada	2004	758.07	26.6	23.72
Chile	1994	54.66	...	3.91
Colombia	1994	137.49	22.8	3.64
Costa Rica	1996	10.50	72.2	2.95
Cuba	1996	40.13	-36.9	3.64
Dominica	1994	0.15	-98.8	2.02
Dominican Republic	1994	20.44	...	2.71
Ecuador	1990	30.77	0.0	3.00
El Salvador	1994	11.92	...	2.15
Guatemala	1990	14.74	0.0	1.68
Guinea	1994	5.06	...	0.71
Guyana	1998	3.07	40.8	4.08
Haiti	1994	5.13	...	0.70
Honduras	1995	10.83	...	1.92
Jamaica	1994	116.23	...	47.44
Mexico	1990	383.08	0.0	4.60
Nicaragua	1994	7.65	...	1.78
Panama	1994	10.69	...	4.09
Paraguay	1994	140.46	114.6	29.85
Peru	1994	57.58	...	2.46
Saint Kitts and Nevis	1994	0.16	...	3.71
Saint Lucia	1994	0.89	...	6.42
Trinidad and Tobago	1990	16.39	0.0	13.49
United States	2004	7067.57	15.8	23.92
Uruguay	1998	33.57	21.4	10.20
Venezuela	1999	192.19	...	8.08
Source: Adapted from United Nations Statistics Division (2007). Available at http://unstats.un.org/unsd/ENVIRONMENT/air_greenhouse_emissions.htm				

The success of environmental policies is highly related to the existence of strong institutions and well defined regulatory regimes (Perkins, 2003). In this regard, the coordination of local, national and regional environmental legislations, as well as the harmonization of economic incentives for less-polluting energy activities is critical to cooperation initiatives. In the electricity sector, environmental provisions to support clean generation appear as one relevant motivation for cooperation and integration, in particular for the economic opportunities offered by the CO₂ emission trading market (Tsikalakis and Hatziaargyriou, 2007), which constitutes a potential source for financing.

Poverty alleviation issues are also strongly aligned with environmental policies (Altomonte et al., 2003), particularly because improving environmental conditions can benefit poverty mitigation. Regional cooperation to promote renewable energy means, and fairness in the electricity market, contributes to the expansion of electricity services, which have huge positive social impacts, including improvement in education and health, and in opening up economic opportunities, especially in rural communities. It is recognized by the international community that increasing electricity access and services is a strategic way to improve quality of life through the provision of better medical care, shelter, education services, food and water, and access to information (Johansson and Goldenberg, 2005; UNDP, 2005).

As was previously mentioned social policies in the electricity sector require a well designed legal framework to facilitate the access of electricity services for the poor. This entails the definition of special price mechanisms that are socially oriented and economically sustainable. Therefore, regional electricity cooperation represents a real opportunity for poverty alleviation and environmental protection in the Americas, and very specifically for LAC countries, where, according to the Pan American Health Organization, more than 100 million people are exposed to high levels of air pollution.

3.2 Economic: Market Trends

The introduction of market competition in any sector is expected to improve the quality of services, lower prices, and secure the freedom of choice for consumer's benefits (Beder, 2005). In the case of the electricity sector this involves a complex institutional and regulatory definition process (Altomonte et al., 2003) to facilitate the effective management of price risks (Tomiak and Millan, 2002), and to prevent the harmful causes from market failures and/or weak performance (Wolak, 2004).

In regard to market harmonization, different experiences within the region show poorly designed pricing mechanisms tied to sector reforms that happened during the last two decades, and in particular, where these reforms responded mainly to financial restrictions (Fischer and Serra, 2000). Additionally, in many cases, social oriented mechanisms to secure affordable services to the poor were defectively designed, creating a situation where many people benefitted from electricity prices that were so defined to secure energy services for the poor. For example, in Guatemala and Honduras, 95 and 85 percent of the population, respectively, benefit from social tariffs for electricity originally meant for the poor.

In general, past experiences in electricity markets reforms in the Americas have shown different outcomes and have been perceived from dissimilar perspectives. NAFTA, for example, stipulated initial reforms in the regulation of the energy market at the same time more private participation in energy activities began to emerge. Under these reforms, Mexico's energy market permitted capital investment for electricity infrastructure and limited private electricity generation in a power market controlled mainly by the country's Federal Electricity Commission, which produces 92 percent of the Mexican electricity generation.

In LAC, the reform process was initiated in 1982 when Chile separated its power sector activities –mainly generation and distribution– by setting up an open market approach with privatization, deregulation and competition measures. Later on, Argentina, Colombia and Peru developed a similar approach based on the Chilean experience (Dussan, 1996). It can be argued that market liberalization, driven by economic considerations, represents an expansion for business opportunities and retail competition that improve efficiency and generate great positive externalities for consumers, namely, quality and reliability of services, economic efficiency and long-run development of operation and services (Beato and Fuente, 1999; Beder, 2005; Dussan, 1996). However, there are some reservations regarding the national benefits from these kinds of reforms, and it is advocated that states participation is more than necessary for regional energy integration (Ruiz-Caro, 2006). Table 3 reflects a summary of electricity reforms and market size in LAC.

Table 3
Electricity Reforms and Market Size in Latin America and the Caribbean

Electricity Reforms and Market Size in LAC								
Installed generating capacity (MW)	Central Control		Regulated Integrated System		Sole Purchaser		Open Market	
	Integral part of State	Some commercial freedom	Single integrated structure	Different business units	Integrated distribution	Disintegrated distribution	Vertical integration allowed	Vertical segmentation required
0-500		Haiti	Barbados Granada		Suriname Guyana		Nicaragua	
500-1000					Jamaica Honduras		Panama El Salvador	Bolivia
1001-2000	Cuba	Uruguay		Costa Rica	Trinidad & Tobago			Guatemala
2000-5000		Paraguay		Ecuador ^a			Peru Dominican Republic	
5000-10000							Chile	
10000-20000							Colombia	Argentina
>20000				Brazil ^a Venezuela ^a	Mexico			

^a On the basis of the approach embodied in their regulation, these countries ought to be included in the open market coordination method. Their position on the table reflects the situation during the current stage of transition.

Source: Altomonte et al., (2003)

Despite these discrepancies in support for or against a more sound market approach, it has been proven that facilitating the diversification of electricity providers and enabling consumers to purchase power from their preferred retail company are two of the major gains that the electricity industry has made upon improving its productivity, efficiency and services, including cost reduction (Beato, 1997; Beato and Fuente, 1999). Basic economic theories demonstrate that the mix of resources among two or more countries constitutes a positive experience for mutual cooperation, including the power sector. In this sense, economic policies designed with fairness considerations and representing a common path for reciprocal growth are relevant to the promotion of international trade of electricity. In the context of cross-countries cooperation and integration initiatives, efficient and harmonization measures are essential for the market to generate such benefits. This involves several issues that are related to the identification of common goals and priorities; the development of uniform policies and procedures to prevent discrimination; the promotion of transparency; and as was discussed above, the establishment of a regulatory structure to follow up on these matters.

The trends for electricity markets cooperation and integration necessarily begin with the interconnection of infrastructure facilities among the countries in which those markets function (Pierce et al., 2006; Wolak, 2004). The interconnection of systems and the merging of generation resources facilitate a better trade of electricity services, making markets more reliable and functional, at the same time, they secure more efficient use of energy sources and electricity services. In fact, one of the benefits of electricity market cooperation is the reduction of the total cost of electricity due to a more efficient use of generation and transmission means. In addition to this, Pierce et al. (2006) affirm that greater market integration not only increases competition in the electricity sector but also prevents market power and makes electricity prices more transparent to investors and consumers.

Regional electricity markets integration does imply a coordinated pricing policy which can improve the efficiency of electricity products and services, which benefit consumers (Forster and Yepes, 2006). With this purpose, market integration requires the coordination of regulatory bodies and policies that will facilitate the monitoring of electricity market operations, securing consumers' protection and promoting the development of environmentally friendly technologies (Pierce et al., 2006), while preventing price manipulation.

Other issues to be considered as market drivers for electricity cooperation and integration in the Americas are energy security, economic development and climate change. As was stated earlier, the pooling and efficient use of energy sources, the appropriate operational management including reserves provisions, and the generation of financial recourses for the expansion and improvement of electricity infrastructure contribute to the achievement of national and regional energy security goals. The improvement of the regional capacity for raising investments into a shared electricity market can stimulate the economic development of the region by facilitating the implementation of national and regional strategies for poverty alleviation such as better social services and job opportunities, both in the public and private sectors.

This requires the definition of social policies that promote the efficiency and expansion of electricity services which will necessarily lead to rural electrification and the improvement of electricity products. In the short term, this generates local employment opportunities, and in the long-term, through the reliability of service, it will facilitate action toward poverty alleviation such as better provision of health and education services, and wealth production activities.

3.3 Policy Issues

The identification of national and regional goals and objectives in the electricity sector constitutes an essential element for policymakers, and has a special place in the strong linkage between economy and electricity growth. In this sense, market regulation, management of infrastructure services and public and private financing are central concerns for policymakers for the potential role that regulatory and standards harmonization could play in support of increased integration. In the hemisphere, particularly in LAC, some of the policy constraints to facilitate electricity cooperation and integration within the countries are described below.

Lack of measures to ensure long-term energy security by improving electricity operations still remains one of the most needed steps toward electricity trade in the region. This implies not only the definition of development plans with common objectives but also carefully designed regulatory approaches to effectively address issues such as technology and clean production, competition, access to electricity services including rural electrification, and transparency in reporting business operations and services. Additionally, a resource planning process for energy efficiency needs to take place in order to foster the cooperation and integration of cross-borders electricity sector. Aspects such as technical development, renewable and non-renewable energy sources assessments, and financing projections need to be evaluated as part of this process.

The dialogue in support of cooperation within the Americas has encountered the incompatibility of legal frameworks. Despite emerging practices that are increasingly promising, the region demands a deeper and decisive negotiation process for stimulating efficient cooperation through the institution of legal frameworks. These should include clear terms related to the autonomy of regulatory bodies, minimal provisions of how regulation will be implemented and minimum definitions of market rules and participants' role.

The creation of regulatory institutions is a key issue for national and regional coordination which could be strongly supported by the determination of the authority, jurisdictions and independence that will govern these regulatory bodies. The functions of these organisms necessarily include procedures for anticorruption actions, mechanisms for supporting the standardization of markets operations, and prevention of pollution through the establishment of pollution taxes.

In the Americas, differences in states' functions and regulatory policies are two of the main barriers for systems integration (Pineau et al., 2004). The fact that North American countries do not have a completed comprehensive grid, and that regulatory standards in Latin America and the Caribbean are still at the beginning stages constitute two strong reasons to advocate for the establishment or improvement of regulatory institutions and the definition of policies and standards harmonization for better cooperation and integration within the Western Hemisphere. Table 4 illustrates the integration continuum for regional electricity markets in the Americas considering infrastructure, regulatory and commercial aspects.

Table 4
Integration Continuum for Regional Electricity Markets in the Americas

Infrastructure integration			Regulatory integration		Commercial integration	
No regional integration	Isolated national power systems		Independent national regulation	MERCOSUR	National markets with local ownership	
↓	Cross-border transmission capabilities	MERCOSUR NAFTA	Compatible regulation	NAFTA	Cross-border trade and ownership	MERCOSUR
	Coordinated efforts in transmission investment		Coordination of regulatory agencies		Regional spot market (unique price reference) ^a	NAFTA
Full regional integration	Fully integrated regional system operation		Regional regulatory agency		Regional secondary / future markets	
^a It is recognized that long distance may affect local prices at different transmission nodes. Source: Adapted from Pineau et al. (2004)						

The constitution of efficient regional regulatory bodies enables an effective monitoring process of the electricity markets, which can identify and prevent unilateral market power by promoting and putting in place adequate mechanisms for the release of public data (Wolak, 2004). Another important role of regulatory institutions is to ensure that operational and market rules and environmental regulations are not breached (Pierce et al., 2006), to make certain the social, economic, and environmental goals are realized through the financial and green benefits generated by the power sector's activities (Perkins, 2003). All of these require the definition and strengthening of legal frameworks, including comprehensive environmental rules that support and encourage power generation from renewable sources and the use of environmentally sound technologies. In this case, electricity cooperation and integration in the Americas not only demands the improvement of regional infrastructure but also requires major progresses in institutional capacity, comprising regulatory agencies' functions and the coordination of policies and technical standards. Table 5 presents the principal characteristics of coordination processes and resulting regulation. In general, a successful

regulatory regime will create a reliable climate for the public and for investors, while promoting sustainable economic growth and environmental protection (Berg, 1998).

Table 5
Characteristics of Coordination Methods and Ensuing Regulation

	Central Control	Sole Purchaser	Regulated Integrated Market	Open Market
Characteristics	All decisions taken by the State on the basis of normative centralized planning and political prioritization of implementation by State enterprises.	Leaves room (within an energy production chain) for outside private companies to produce and deliver energy to the integrated State enterprise, which acts as the sole purchaser. This system is also known as partial liberalization.	Provides greater autonomy for privately owned or mixed companies and public organizations overseen by provinces or municipalities. The State acts as regulator and can give priority to technical and economic considerations, but always with a quantum of political judgment. The characteristic of this method is the lack of market competition. The State is closely involved in investment decision and pricing.	Method that seeks to realize the benefits of market competition. For this, regulatory principles and changes in the organization of production and institutions need to generate potential competition.
Regulations	Confined to creating institutional barriers to entry, laying down certain technical characteristics for sectoral products and services and apportioning responsibilities within the State apparatus itself.	Investment characteristics may vary in accordance with the terms of reference laid down by the State. In cases where outside involvement is based on bidding, there is an element of competition for a specific market. The State can set business terms, and usually provides some guarantee to make the business attractive. Regulations lay down entry conditions and the rights and obligations of new entrants as regards their participation in the relevant energy production chain.	They may be technical or negotiated nature and the rationality prevailing in the system will be primarily development –or profit- driven depending on the institutional nature of enterprises. Although enterprises are public, however, their activities are likely to be more commercially oriented than the previous stage.	In the case of energy types that are transported and distributed over networks (electricity and natural gas), strict separation and demarcation of functions is required, as is the principle of unrestricted access to installations to avoid discrimination. In some cases vertical integration may be allowed to continue, subject to virtual (accounting) separation and bidding mechanisms for transactions. In the case of links that have natural monopoly characteristics (transport, distribution), regulation is based on technical and economic criteria and there are certain rules that promote competition as far as possible (commercial bypass, competition by market, competition by comparison reference).

Source: Altomonte et al. (2003)

Other policy issues to be considered for fostering international cross-lines connections in the Americas include the expansion and maintenance of physical facilities, which represent a key element for the attainment of economic, social and environmental objectives. This requires an adequate coordination process for the optimization of the technical and financial resources that will increase the electricity trade among the different regions (Matos, 1996), and the harmonization of legal codes and environmental regulations (Pineau, 2004) to meet the electricity needs.

Annual growth in electricity generation in the Americas is forecasted to continue increasing during the years between 2004 and 2030. During that period, it is estimated that power generation in Central and South America will increase from 882 billion kWh in 2004 to 1,838 billion kWh in 2030, representing an increase of 2.9 percent per year. In North America the annual growth in electricity generation is expected to change by 1.5 percent per year during this period (EIA, 2007). This increase in electricity generation will involve substantial capital investment, both from the public and private sectors. In fact, it is estimated that US 40 billion per year will be required to meet LAC countries' energy demand. In addition, the increase in energy costs due to volatile oil prices will have tremendous impacts in the local and regional economies particularly in the electricity industry, in countries such as the Caribbean where electricity almost exclusively is produced from oil/diesel generators.

The cost of physical facilities and systems constitutes one of the main barriers to cooperation and interconnection projects. In the LAC region, this is one of the main issues stifling economic growth, competitiveness and poverty alleviation (Fay and Morrison, 2007). Activities for electricity cooperation and integration represent a great opportunity to minimize the cost of power projects as well as for the generation of investment, enabling different countries to share the benefits that such activities produce. It is projected that nearly US\$1,250 million is needed for grid interconnections and for the consolidation of a Latin American electricity market which, at the same time, will produce annual returns equal to US\$1,000 million (OLADE, 2007). Electricity integration projects will make it possible to have large scale generation to respond to the expansion of the electricity market, which can facilitate regional economic growth. The grid connection between Colombia and Ecuador represents an example of positive economic externalities from electricity trade. In financial terms, Colombia receives US\$ 115 million per year for conduit of electricity services to Ecuador, which saves around US\$ 70 in production and distribution costs (Ruiz-Caro, 2006).

Finally, the policy framework for regional electricity cooperation and integration involves the identification of national and regional goals for energy efficiency, which entail specific objectives for energy security, climate change and economic growth issues. There is a variety of economic trends related to energy policy in the power sector; this can include the establishment of tax incentives and emissions taxes, the requirement of Renewable Portfolio Standards and feed-in law schemes, among others.

4. POTENTIAL BENEFITS OF REGIONAL ELECTRICITY COOPERATION AND INTEGRATION

Regional electricity grid interconnections can generate a variety of benefits (Zhu et al., 2004) including environmental, social and economic gains. For the countries of the Americas', it can be argued that more political willingness is needed for regional energy integration (Pineau et al., 2004). In the case of LAC this reality seems to demand more attention for the strong link between energy, poverty alleviation, and environmental policies (UNDP, 2005). This section of the paper reflects some of the potential benefits of regional electricity cooperation and integration activities, with special focus on the environmental, social and economic dimensions.

4.1 Environmental Benefits

Regional electricity cooperation has the potential for better exploitation of natural resources, which in many ways can significantly reduce the consumption of non-renewable primary energy sources. In the case of LAC, the total primary energy supply during the year 2000 accounted for 456 million tones, of which 127 million tones corresponded to renewable energy (Karekezi et al., 2004).

In relation to climate change, power sector emissions can be substantially reduced by better management of energy sources and by the exploration and development of renewable energy technologies. In this regard, infrastructure electricity integration, specifically in LAC, could lead to mitigate GHG pollution and to improve the capacity to access, monitor and manage environmental and pollution data in the region, especially the emissions associated with electricity generation (Burtraw et al., 2000). Additionally, a significant portion of deforestation in the rural areas can be avoided by expanding electricity services to rural areas as part of a regional electricity cooperation approach.

Other environmental benefits that accrues from increased electricity integration is the mitigation of negative environmental impacts generated by new power sector facilities, which can be avoided through the interconnection of the existent power infrastructures (Zhu et al., 2004) and by the adequate operational management of these facilities, which entails the harmonization of technical and legal standards (Seymour et al., 2005).

In general, regional electricity cooperation and integration can constitute a singular opportunity for environmental protection in the sense that any trends for cooperation in the electricity sector will be measured for its optimal potential outcomes, including environmental protection and climate change mitigation.

4.2 Social Benefits

The expansion of electricity services, and very specifically the increase in rural electrification, is one of the principal gains from regional electricity cooperation. This will facilitate a better response to local needs, including sanitation, job opportunities, and education. The increase in availability of electricity services contributes to poverty

alleviation by improving access to better education and health care. For instance, according to data from the Pan-American Health Organization there is a positive correlation between energy use, including electricity, and sociological indicators such as infant mortality, life expectancy at birth and analphabetism (illiteracy) (Audisio, 2006). Electricity cooperation can also contribute to the expansion of information services, which potentially creates opportunities for public participation, facilitating the promotion and strengthening of democracy and gender balance at the local, national and regional level (Dubash, 2002).

The technical harmonization from regional electricity cooperation can lead to better performance of utilities ensuing greater access and quality of services. In the case of the urban poor, particularly, this can represent a substantial improvement to their living condition, including better shelter and employment/entrepreneurship opportunities which constitute a crucial element for LAC considering that 70 percent of the poor live in cities.¹¹ In that regard, electricity cooperation represents a relevant factor for potential income generation as a consequence of the improvement in services and the expansion of the market.

Electricity cooperation may foster greater national and regional security by providing reliable services and by contributing to the access and management of strategic information systems that can benefit activities such as natural disaster mitigation and general security issues. Also, it can create a regional climate for corporate social responsibility and stimulate greater technological contributions to society, including in academies, industry and government.

4.3 Economic Benefits

Regional electricity cooperation and integration will facilitate an optimum use of available energy sources in an environmentally sound scheme resulting in lower production costs, which can represent an important reduction in electricity prices and other commodities. As well, this constitutes a unique opportunity for economic growth for expansion and improvement within the services sector and the upgrading of productivity.

An increase in cross-border grid interconnections will improve power systems reliability and sustainability making possible better conditions for electricity trade and bolstering energy interdependence in the region. Also, this will reduce the cost of electricity projects in the sense that it will allow large scale generation and pooling of resources to respond to the expanded electricity market. In addition, increased cross-countries interconnected systems can foster more energy efficiency practices that will result in cash saving, for both the power industries and final consumers.

Electricity cooperation will create more opportunities to take advantage of the emerging global and regional carbon market. The potential emission GHG offsets from electricity

¹¹ Detailed information about urban poverty in LAC can be found in the Socio-Economic Database for Latin America and the Caribbean (SEDLAC) at <http://www.depeco.econo.unlp.edu.ar/cedlas/sedlac/>

cooperation and integration projects can constitute additional financial resources if they are considered as part of carbon trading schemes such as the Clean Development Mechanism under the Kyoto Protocol to the United Nations Framework Convention on Climate Change.

Finally, regional electricity integration entails greater harmonization of environmental, finance and legal frameworks which will contribute to the expansion of multilateral cooperation within the countries of the Americas'. This can have a huge impact in reducing the risk of investments not only for projects in the power sector but in other national and regional production activities.

5. CONCLUSION

Regional electricity cooperation and integration is not a new phenomenon for countries of the Americas' but it is still far from optimal. A variety of experiences are taking place in the Western Hemisphere and these comprise regional cooperation activities that are divided by the following geographical blokes: North America –NAFTA/NAEWG–, Central America –SIEPAC, PPP–, and South America –MERCOSUR, CAN, IIRSA–. Cross border grid interconnection appears impossible for the Caribbean region as a consequence of the region's geographical characteristics. However, there is not doubt about the potential gains that this region can obtain from the policy dialogue and activities on energy/electricity cooperation within the Americas.

The hydrological resources in Latin America represent a valuable advantage for electricity integration and for cross national cooperation to facilitate greater efficient management of natural resources and environmental protection. Similar experiences with alternative sources of energy, especially renewable sources, can be stimulated by following the cooperation scheme of the existent binational hydroelectric projects in South America.

The interconnection of multinational transmission networks requires a resource planning process for energy efficiency and the definition of long term energy security objectives that will be accrued by improving electricity operation. As well, it demands the establishment or reinforcement of regulatory institutions, the harmonization of legal, market and technical frameworks, and environmental regulations.

Greater environmental, social and economic benefits from regional electricity cooperation and integration can be obtained if there is enough political willingness to carry out the activities that such a process requires. For LAC, major cooperation in electricity policy and trade constitutes a unique opportunity for sustainable development considering the social, environmental and economic dimensions that such development entails; including its contribution to climate change mitigation by electricity generation from the use of low carbon intensity technologies and renewable sources. Furthermore, regional electricity cooperation and integration can lead to major improvements in the quality of life through better access to services that positively affect health care,

employment and education activities. Finally, regional and national sustainable economic growth can be stimulated by multinational electricity cooperation by fostering a safe climate for investment, lowering the generation costs and electricity prices, and by creating a more reliable environment for business activities.

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APPENDIX

ANNEX A

Net Electricity Generation by Type in the Americas (2004)

(Billion Kilowatthours)					
Country	Conventional Thermal	Hydroelectric	Nuclear	Geothermal, Solar, Wind, Wood and Waste	Total
Antigua and Barbuda	0.11	0	0	0	0.11
Argentina	55.15	30.22	7.31	1.26	93.94
Bahamas, The	1.79	0	0	0	1.79
Barbados	0.90	0	0	0	0.90
Belize	0.07	0.11	0	0	0.18
Bolivia	2.25	2.13	0	0.10	4.47
Brazil	34.54	317.59	11.60	17.20	380.93
Canada	142.85	334.25	85.87	10.02	572.99
Chile	27.46	21.69	0	1.76	50.91
Colombia	9.41	37.00	0	0.52	46.93
Costa Rica	0.06	6.44	0	1.90	8.40
Cuba	14.30	0.09	0	0.78	15.16
Dominica	0.05	0.03	0	0	0.08
Dominican Republic	13.34	1.62	0	0.05	15.02
Ecuador	4.86	7.34	0	0	12.20
El Salvador	1.83	1.38	0	0.97	4.17
Grenada	0.17	0	0	0	0.17
Guatemala	4.28	2.52	0	0.81	7.60
Guyana	0.81	0.01	0	0	0.82
Haiti	0.26	0.28	0	0	0.54
Honduras	3.03	1.75	0	0.02	4.80
Jamaica	6.69	0.12	0	0.10	6.91
Mexico	199.92	24.95	8.73	8.79	242.39
Nicaragua	1.98	0.32	0	0.46	2.77
Panama	3.74	3.78	0	0.02	7.54
Paraguay	0.01	51.76	0	0	51.77
Peru	4.56	19.22	0	0.21	23.99
Saint Kitts and Nevis	0.13	0	0	0	0.13
Saint Lucia	0.29	0	0	0	0.29
Saint Vincent/Grenadines	0.08	0.03	0	0	0.11
Suriname	0.14	1.37	0	0	1.51
Trinidad and Tobago	6.04	0	0	0.01	6.05
Uruguay	0.07	8.09	0	0.03	8.18
United States	2,849.00	268.42	788.53	97.09	4,003.03
Venezuela	30.97	62.06	0	0	93.03
Source: Adapted from EIA (2007). International Electricity Generation Tables. Available at http://www.eia.doe.gov/emeu/international/electricitygeneration.html					

ANNEX B

Action Plan for the Hemispheric Energy Cooperation¹²

Energy Cooperation

The nations of the Hemisphere have begun a new era of economic growth. This new era is based on greater economic cooperation, freer trade, and open markets. Sustainable economic development requires hemispheric cooperation in the field of energy.

Governments will:

Convene a follow-up hemispheric officials' meeting in the first semester of 1995 to encourage cooperation to study ways to develop the energy industry within the Hemisphere, consistent with the least cost national energy strategies and the activities described in the "Partnership for Sustainable Energy use" in the following areas:

Consideration of ways to use the energy sector to promote sustainable economic growth.

Cooperation to study ways to optimize and facilitate the financing mechanisms of international financial institutions to support the development of projects in the energy sector, especially including those pertaining to the enhancement of efficiency in the use of energy and to non-conventional renewable energy.

Cooperation to promote capital investment and to foster the use of innovative financial mechanisms to increase investment in the energy sector and the enhancement of efficiency in the use of energy and non-conventional renewable energy, in accordance with each country's legislation and developmental needs.

Promotion of the use of efficient and non-polluting energy technologies, conventional and renewable, leading to a higher degree of knowledge and technical expertise in this area.

Consideration of the enhancement of ongoing efforts to establish electric and other energy facilities in accordance with domestic regulatory frameworks and, where appropriate, under sub-regional agreements.

¹² Organization of American States, Office of Summit Follow-Up (1998). First Summit of the Americas Plan of Action. Available at <http://www.summit-americas.org/miamiplan.htm#12>

ANNEX C
Projected Gas Pipeline in the Caribbean Region



Source: EIA, (2002)

ANNEX D
Projected Electric Interconnection in Latin America and the Caribbean (2018)



Source: Center for Strategic and International Studies. (2007). Available from http://www.csis.org/media/csis/events/070206_oladepowerpoint.pdf