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The Potential of Regional Power Sector Integration

Central American Electric Interconnection System (SIEPAC) | Transmission & Trading Case Study

Submitted to ESMAP by:

Economic Consulting Associates

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Abbreviations and acronyms

BCIE	Central American Bank for Economic Integration
CAF	Corporación Andina de Fomento (multilateral financial institution focused on Latin America)
CEAC	Central American Electrification Council
CEPAL	Comisión Económica para América Latina y el Caribe
CRIE	Comisión Regional de Interconexión Eléctrica
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EOR	Ente Operador Regional (SIEPAC regional system and market operator)
EPR	La Empresa Propietaria de la Red (SIEPAC Regional Transmission Company)
GWh	Gigawatt-hour (measure of electrical energy = 10^9 watt-hours)
IADB	Inter-American Development Bank
kWh	Kilowatt-hour (basic unit of electrical energy = 10^3 watt-hours)
MER	Mercado Eléctrico Regional (Central American Regional Electricity Market)
MO	Market Operator
MW	Megawatt (unit of electrical power = 10^6 watts)
PIEM	Programa de Integración Energética Mesoamericana—Mesoamerican Energy Integration Programme
PPA	Power Purchase Agreement
PPP	Plan Puebla-Panama
RTR	Red de Transmisión Regional (regional transmission network)
SIEPAC	Sistema de Interconexion Electrica para America Central
SO	System Operator

Preface

This case study is part of an Energy Sector Management Assistance Program (ESMAP) project on Regional Power System Integration (RPSI). The objective of the project is to facilitate and accelerate RPSI projects in developing countries around the world. The project will draw on international experience and theoretical analysis in this area to provide a framework to assess:

- the economic, financial and environmental benefits that can accrue to regional power trading;
- the institutional and regulatory arrangements needed to sustain and optimize regional projects; and
- the ways in which obstacles to integration have been successfully overcome.

The final output of the project will be an umbrella report, *Regional Power Sector Integration – Lessons from Global Case Studies and a Literature Review*. This review will summarize the 12 case studies and literature review undertaken and analyze common themes on barriers to RPSI and solutions to overcome them.

Economic Consulting Associates was contracted to execute the project. In doing so, we are working closely with ESMAP and World Bank staff, as well as government officials, utility, power pool, and regional economic community personnel, and others directly involved in implementing regional power schemes.

This and other 11 Case Studies are prepared as clear, factual presentations of the selected projects. The intent is to provide a direct, easily digestible description of each of the selected projects without imposing an analytic framework or making judgments about the degree of success. Such analysis will be undertaken at the global level, considering the entirety of experiences from the Case Studies, in the aforementioned umbrella report.

All 12 Case Studies follow a uniform structure to facilitate ease of comparison and reference from one Study to the next. Some sections are longer than others, depending on the specifics of the Study. Additionally, there is some cross-referencing within each Study.

1 Executive summary

1.1 Background and motivations for trade

The Central American Electrical Interconnection System (SIEPAC)[1] project is an initiative to create an integrated regional electricity market among six Central American countries: Guatemala, El Salvador, Honduras, Costa Rica, Nicaragua and Panama.

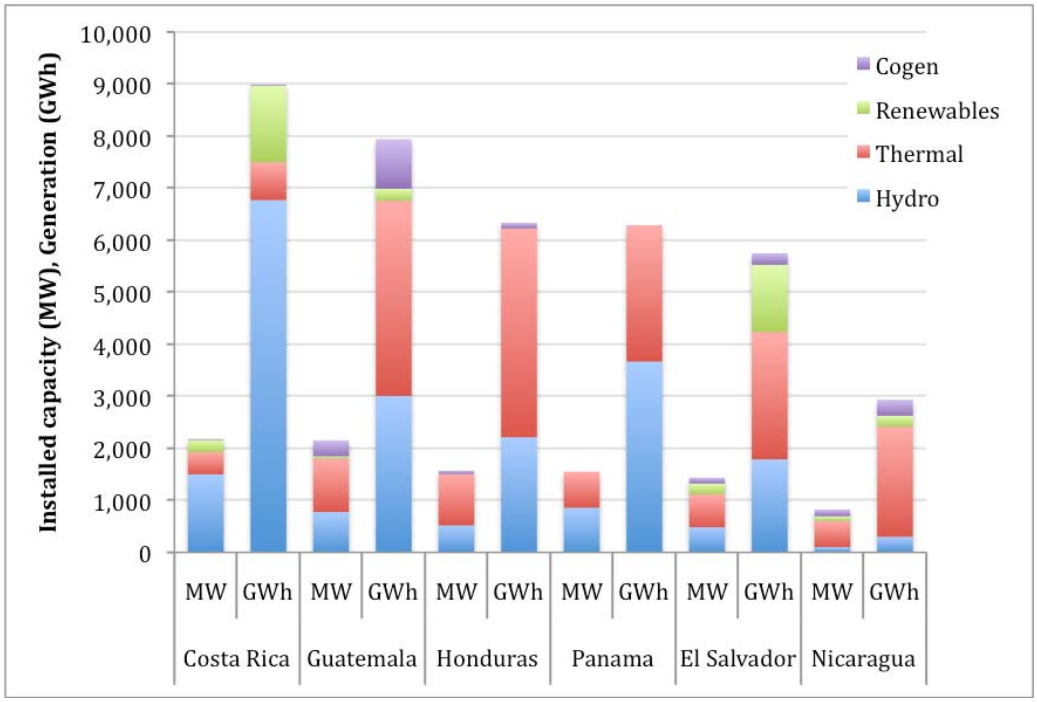
The region contains untapped energy reserves, particularly in hydropower. However, large-scale development is hamstrung by small markets at the individual country level and a lack of sufficient market integration. Achieving economies of scale in generation is only possible in the context of a multinational market. Trade at the regional level would also open the potential for trade with large neighboring systems in Mexico and Colombia. SIEPAC would also bring efficiency gains through economic dispatch, shared reserve margins and exploitation of complementarities in demand and supply.

The objective of the SIEPAC project is to enable these potential gains from integration. To this end it includes a new regional transmission line and institutions to support a regional electricity market.

The existing transmission system interconnections are weak, with several unable to operate above 50 MW despite higher ratings, and no direct interconnection is in place between Honduras and Guatemala. After peaking at 5.5% of total generation in 2000, trade in the region fell to less than 1% in 2007. While the region's existing capacity is mainly hydro and thermal in equal shares, generation is dominated by hydro, although this share has been declining. Installed capacity and generation by country are shown in Figure 1.

[1] SIEPAC is the acronym for the Spanish title: Sistema de Interconexión Eléctrica para los Países de América Central.

Figure 1 Installed Capacity (MW) and Generation (GWh) by Country, 2007



Source: CEPAL (2007)

Electricity sector and market structure vary among the six countries from fully competitive wholesale markets to monopoly integrated utilities acting as single buyers. Some countries have attracted a high level of private participation throughout the sector, while in other countries the private sector role remains limited to investments in generating stations which hold power purchase agreements. The retail markets have been opened in some countries but remain tightly regulated in others. All countries have some cross-subsidization of end-user tariffs.

1.2 The regional trade solution

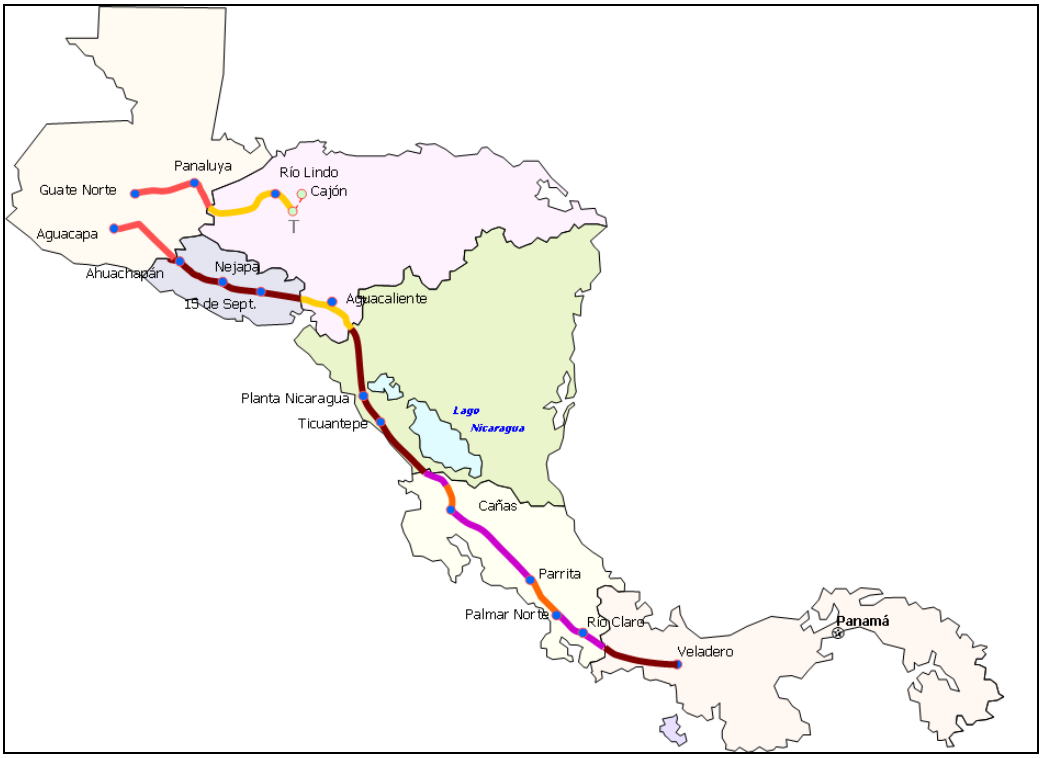
SIEPAC consists of two interdependent projects:

- The development of a **regional electricity market (MER)** based on a standard set of trading rules at the regional (supranational) level. Part of the MER initiative is the creation of a regional institutional structure, including regional regulator and a regional transmission operator.

- The development and completion of a new 1,800 km **international transmission line**, running from Panama in the south to Guatemala in the north, that will increase transfer capacity at all borders in the region to 300 MW.

The geography of the region and the route of the SIEPAC line are shown in Figure 2.

Figure 2 Route of the SIEPAC Line Through Central America



Source: EPR

The SIEPAC transmission line will physically enable a market at the regional level, and the regional market in turn will provide the economic basis for an integrated transmission investment.

SIEPAC was formalized in an intergovernmental framework agreement, known as the Marco Treaty. This agreement is fundamental to the project and provides the legal foundation on which the regional market and the supporting institutional and physical infrastructure are being built.

The institutional design and development have been carried out by the regional planning organization that represents the six national utilities. A series of planning, advisory and steering groups have been set up within this entity.

The range of institutional development and capacity in the national electricity sectors was recognized as an important element affecting the design of the regional market. To accommodate the differences, the MER is designed to be a seventh market that connects the six national markets while remaining separate from them. The design deliberately seeks to allow the individual countries to develop their sectors at their own pace while also enabling trade within the region. The focus on gradualism is explicitly required in the Marco Treaty.

The regional market is supported by two new institutions created at the regional level. These are a regional market and system operator and a regional regulator. These institutions, provided for in the Marco Treaty, have supranational legal status which grants them independence from any of the six national legal systems.

The SIEPAC transmission line is being built and will be owned and operated by a project company formed for this role. This company is owned in equal shares by each of the six state-owned national transmission companies, the dominant state-owned utilities of two neighboring countries (Mexico and Colombia) and one private-sector partner. The private partner is leading the transmission project management and overseeing the private contractors.

The total transmission investment of US$405 million is funded primarily by loans from the Inter-American Development Bank (IADB, approximately 59%) and the Central American Bank for Economic Integration (25%). Corporación Andina de Fomento has also financed slightly under 4% of the cost. Equity financing makes up around 12%.

The IADB has played an important facilitating and governance role in the overall project development and management. Its loan agreement made release of funds conditional on a set of project design and implementation milestones being met. The project has also received high-level political support through the Plan Puebla-Panama, renamed the Mesoamerican Project, which is a broader regional integration initiative.

1.3 Current state of development

SIEPAC has had a long gestation from the initial feasibility study in 1987. The Marco Treaty was signed in 1996 and came into effect in 1999. Construction of the transmission line did not begin until 2006. The intervening period saw the design, development and creation of the regional market institutions, as well as preparation of the design and financing for the physical infrastructure.

The regional market and supporting institutions have now been established and are operating. Trade in the MER using the existing interconnectors is underway at a low level.

Construction of the line has met with delays, and the 2008 commissioning date originally targeted for the line has been missed. It is now hoped that the line will be operational in the first quarter of 2010.

In addition to the main SIEPAC line, an interconnector between Mexico and Guatemala that will link the SIEPAC region to its far larger northern neighbor is under construction. A southern extension of the SIEPAC line is also under study, which would interconnect the Central American market with Colombia.

The major future challenge is to capitalize on the potential of the line and regional market by attracting regional-level energy projects. To date no such project exists or is underway in the region.

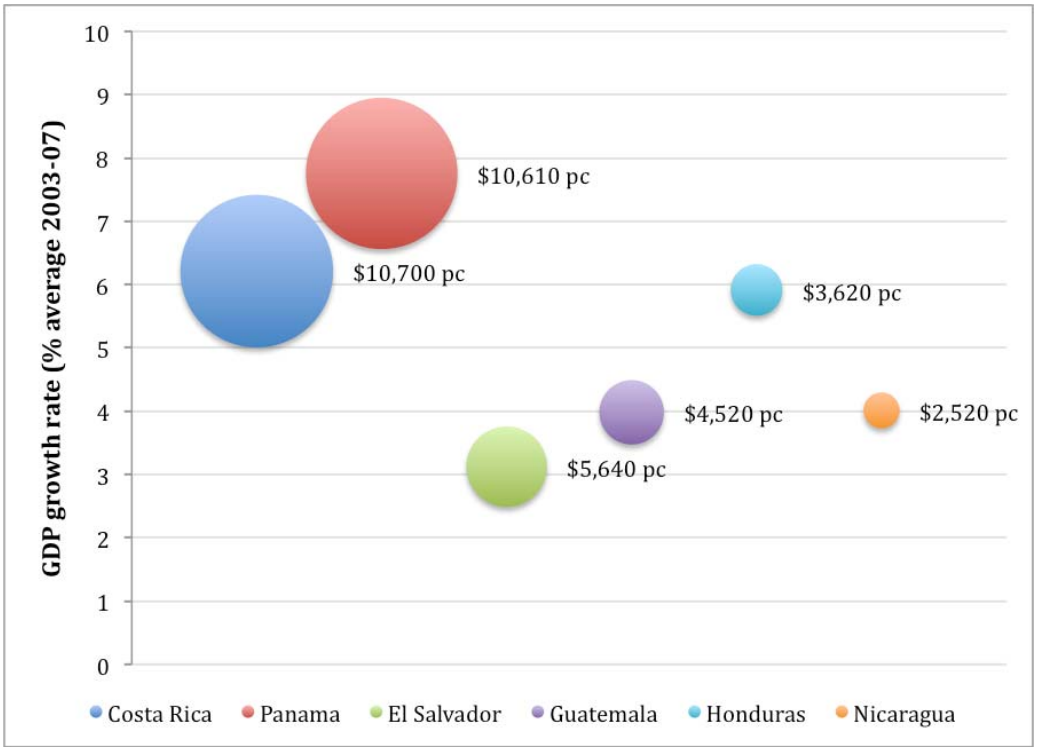
2 Context for trade

2.1 Economic and political context

The Central American Region covers the isthmus connecting southern Mexico to South America at Colombia. It is made up of seven countries with a combined population of around 40 million people. These are Guatemala, El Salvador, Honduras, Costa Rica, Nicaragua, Panama and Belize. The seventh country, Belize, is not part of SIEPAC. For the purposes of this study "Central America" and "the region" are used to refer to the six SIEPAC countries together unless stated otherwise.

In 2007, average GNI per capital (PPP basis) for the region was US$6,268. GDP growth averaged 6.3%. There are, however, large variations in income levels, growth rates and stages of economic development. GDP growth rates and relative incomes in the region are illustrated in Figure 3. A selection of leading indicators follows in Table 1.

Figure 3 GDP Growth Rates and Relative Per Capita Incomes



Source: World Development Indicators, World Bank, 2007; Bubble sizes correspond to relative GNI per capita on PPP basis; Bubbles are centered on the 2007 GDP growth rates.

Table 1 Central America Leading Indicators, 2007

	GNI Per Capita (PPP, 2007)	GDP Growth (average 2003-07)	Population (millions)	Electricity Consumption (kWh/capita)[a]	Population with Access to Electricity (%)[b]
Costa Rica	10,700	6.2%	4.5	1,816	99.2
Panama	10,610	7.8%	3.3	1,606	87.8
El Salvador	5,640	3.1%	6.9	709	84.4
Guatemala	4,520	4.0%	13.3	491	83.7
Honduras	3,620	5.9%	7.1	701	71.4
Nicaragua	2,520	4.0%	5.6	374	61.2

Source: World Development Indicators, World Bank; [a]ECA calculations; [b]CEPAL
Gross national income (GNI) in purchasing power parity (PPP) terms is expressed in international dollars (equivalent purchasing power to same US$ amount in the United States).

Costa Rica is the largest electricity consumer and the largest purchaser of imported electricity. Guatemala and Panama are the main exporters. However, international trade within the region remains low due, in the first instance, to lack of physical capacity in international interconnections. In 2007, total regional trade was less than 1% of total generation (see Section 3.5 for more details of trade and interconnections).

Significant advances have been made over the past 15 years in extending access to electricity to rural areas. Costa Rica has achieved near universal electricity access, and Guatemala and El Salvador have made large gains from a low base. However, progress has been slow in Nicaragua and Honduras. In 2007, nearly 8 million people in the region were still without an electricity connection.

2.1.1 Electricity sector structure and reform

Electricity market reform and development have progressed at varying speeds among the six countries. As a result, the region is characterized by a range of market structures and uneven market development. Differences among countries' generation markets are particularly relevant in the context of the regional market design.

Broadly, the stage of reform in the region can be characterized into two groups:

- Guatemala, El Salvador, Nicaragua, and Panama have reformed their generation, transmission and distribution sectors and have competitive generation markets in place.
- Honduras and Costa Rica retain a vertically integrated utility, and competition is limited to contracts for generation with the single buyer.

All six countries have established an electricity sector regulator and have retained state ownership of their transmission companies.

The timeline of reform has been:

- In 1990, Costa Rica was the first to move away from the state-owned, vertically integrated utility model to a single-buyer model. Guatemala followed in 1991.
- By 1996 all six countries had reformed to at least the level of a single-buyer model.
- In 1996 Guatemala implemented regulated wholesale competition (a cost-based pool). El Salvador also introduced a wholesale market and passed a law to begin the implementation of retail competition.
- During the second half of the 1990s Nicaragua and Panama took steps toward introducing wholesale competition.
- In 2000 Nicaragua launched its electricity market.

Among the more active reform group, Panama has had the most success in terms of attracting private investment (nearly all existing generation was privatized in 2000) and improving operational efficiency. El Salvador implemented a highly deregulated structure which has met with difficulties in the context of a small sector. Nicaragua has also had difficulties, with private operators unable to reduce electricity losses from high levels.

Guatemala, El Salvador, Nicaragua and Panama all have active participation from the private sector in the generation and distribution activities (see Table 7 in annex A1). Nicaragua has a large private-sector presence in generation. Many of the private investors are large multinational energy companies, primarily from the United States and Europe. The ability of these countries to attract and retain private investors indicates their success in creating credible investor protections.

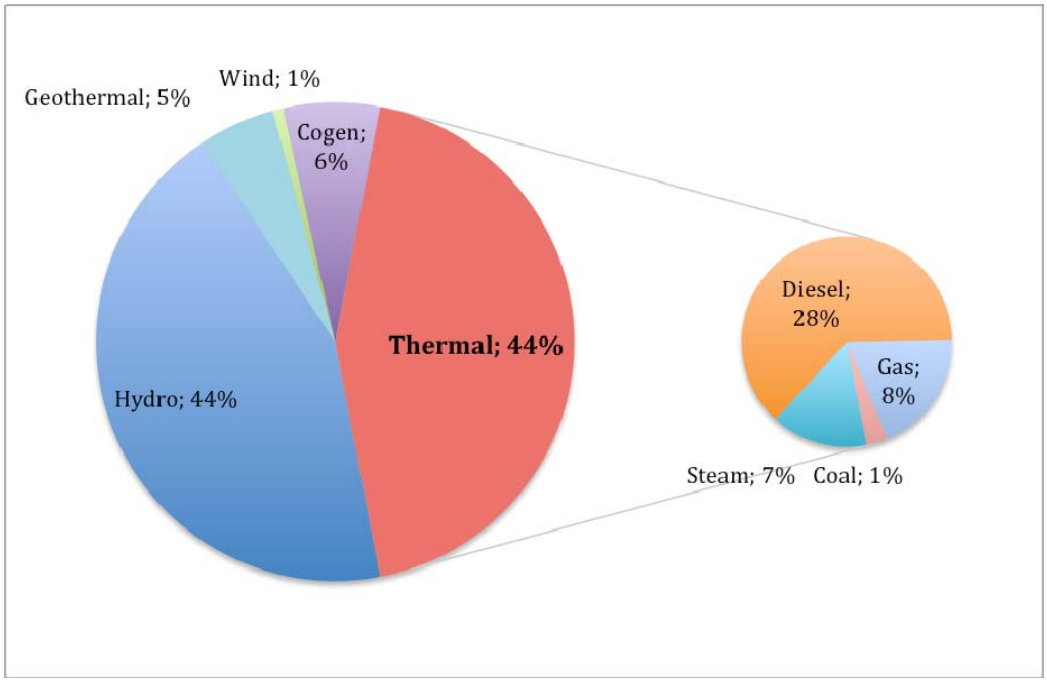
Honduras and Costa Rica continue to operate centrally planned systems with the private sector participating in generation primarily through power purchase agreements (PPAs).

2.2 Supply options

The region's generation fuel mix is dominated by hydroelectricity. In 2007, 46% of electricity was from hydropower and only 9% from fossil fuels, with the remainder from cogeneration, geothermal and other renewables. Imports made up less than 1% of total supply in 2007 (see Section 3.5). Costa Rica is considered to have particularly good potential for new hydro to serve the regional market.

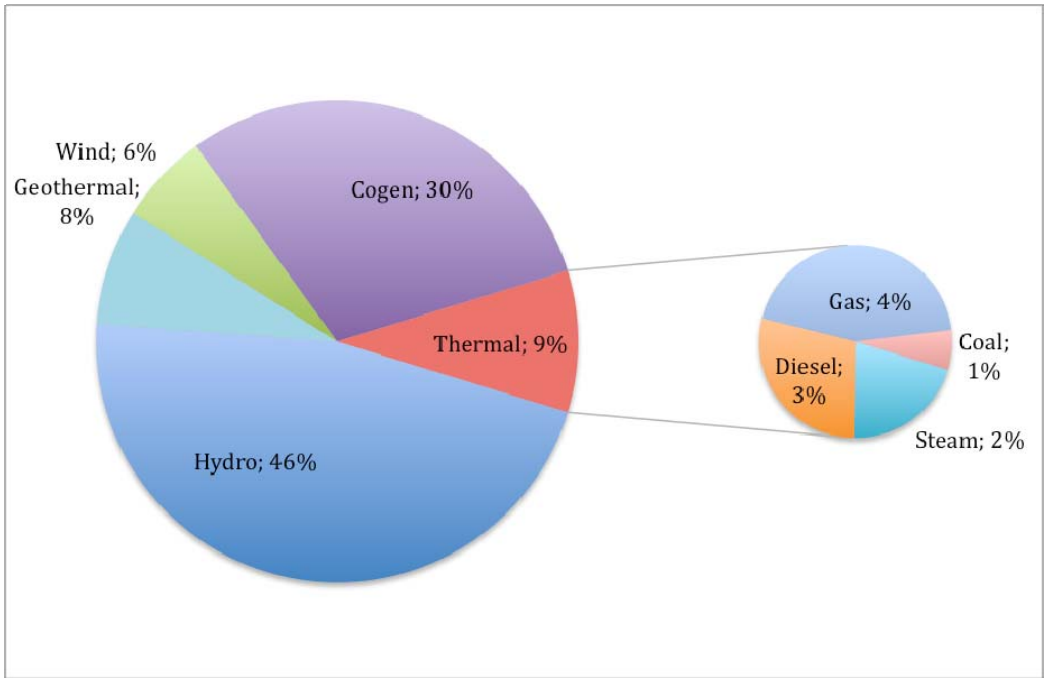
Figure 4 and Figure 5 illustrate the capacity and generation mix in 2007. The region has a large surplus of name-plate installed capacity relative to peak demand. Much of the thermal capacity is not dispatched (average load factor on gas-fired plants is only 10%), with the result that wind and cogen take proportionately larger shares of actual generation (wind and cogen load factors are 39% and 29%, respectively).

Figure 4 Installed Capacity by Fuel Type, Central America Total



Source: CEPAL (2007)

Figure 5 Generations by Fuel Type, Central America Total



Source: CEPAL (2007)

Annex A1 contains the data tables for these graphs.

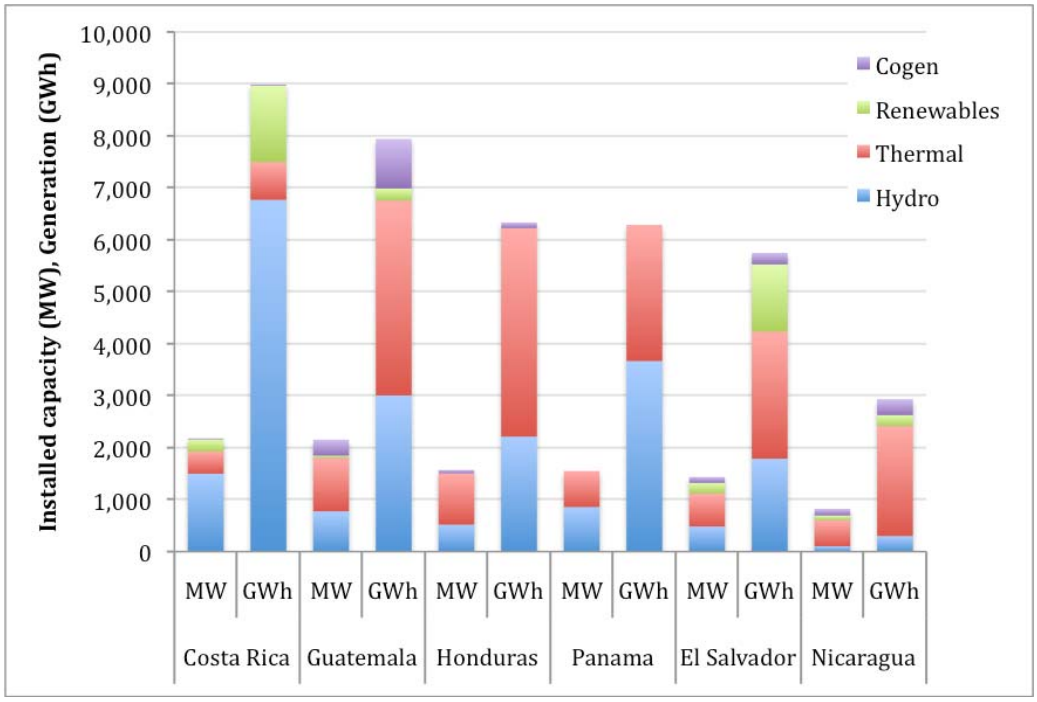
The relative importance of hydro has been falling in favor of thermal generation since 1990 as the technology preference for new plants has shifted toward petroleum fuelling. This has prompted a more recent emphasis on diversifying away from oil, with coal starting to enter the fuel mix (although it remains at a low level).

Costa Rica has the largest installed capacity and is the largest producer in the region. Nicaragua is the smallest. The distribution of generation by fuel source is characterized by:

- Costa Rica has the largest hydro capacity, both in absolute terms and as a proportion of its overall total, followed by Panama.
- By contrast, thermal makes up more than half of installed capacity in Honduras and Nicaragua.
- Cogeneration, which has grown in relative importance in recent years, is concentrated in Guatemala, Nicaragua, and El Salvador.
- Geothermal is the primary renewable fuel in the region (after hydro). Costa Rica is the only country with installed wind power.

Installed capacities (MW) and generation (GWh) by fuel mix for each country in 2007 are illustrated in Figure 6.

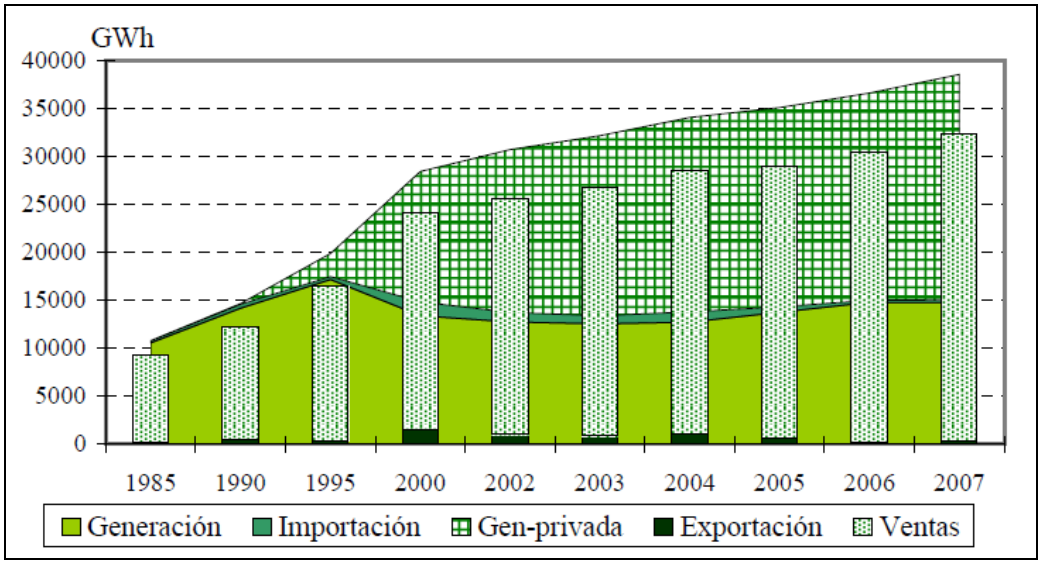
Figure 6 Installed Capacity (MW) and Generation (GWh) by Country



Source: CEPAL (2007)

Figure 7 shows the evolution of the electricity balance in the region over the past two decades. The figure shows clearly the increase in generation from privately owned plants since 1990, both in absolute terms and as a proportion of the total.

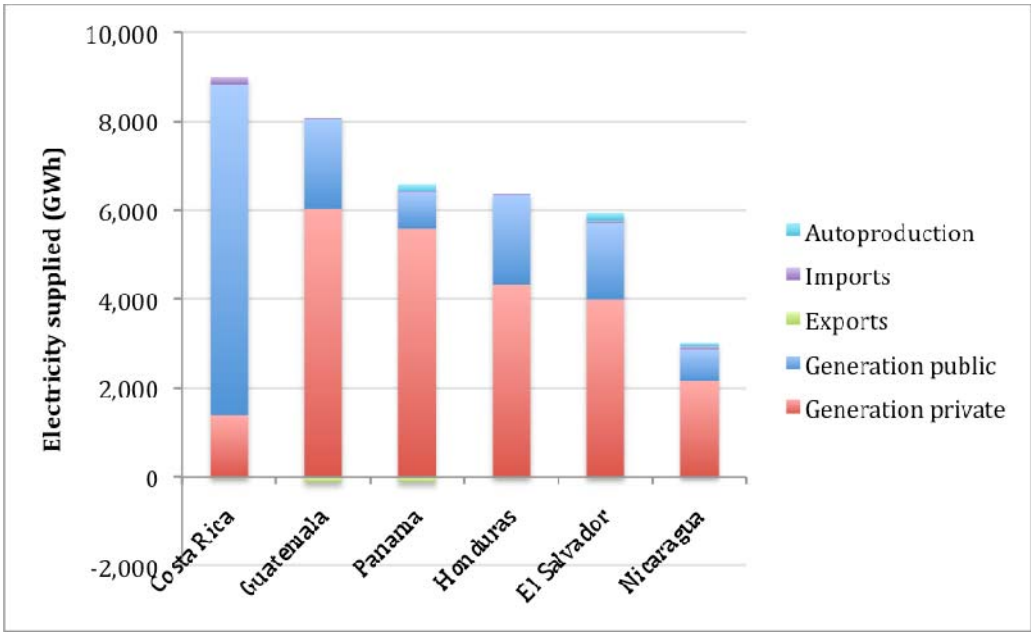
Figure 7 Evolution of the Central American Electricity Balance



Source: CEPAL (2007)*; Key in English (left to right): Generation from publicly owned plants, Imports, Generation from privately owned plants, Exports, Sales to end users.*

Private-sector generation dominates in Guatemala, while Costa Rica has retained most of its existing and new supply in the public sector. The split between publicly and privately owned generation and other sources of supply in each country is illustrated in Figure 8.

Figure 8 Generation by Ownership

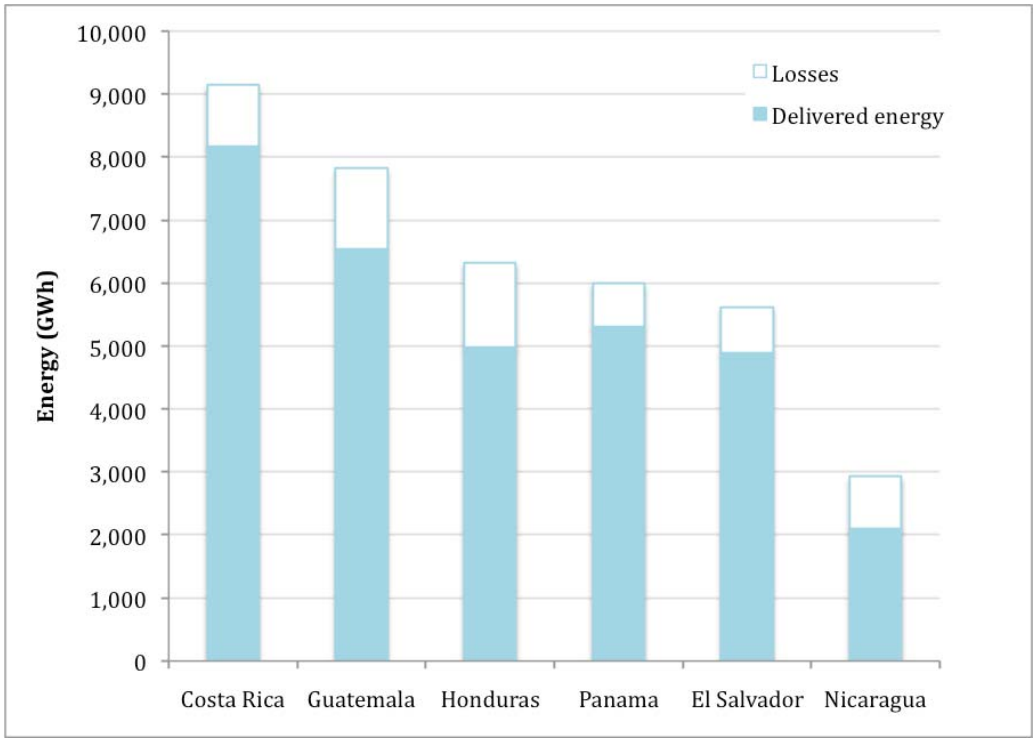


Source: CEPAL (2007)

2.3 Demand

Figure 9 shows delivered energy and losses in each country for 2007. Transmission and distribution losses are a particular problem in Nicaragua (28%) and Honduras (21%), but comparable to international standards in Costa Rica (11%).

Figure 9 Demand and T&D Losses



Source: CEPAL (2007)

In 2007, Costa Rica and Guatemala had the highest peaks of 1,500 MW and 1,443 MW, respectively, while Nicaragua was lowest at 505 MW. In 2007, the regional peak load factor was 66.4%, with Guatemala having the lowest load factor (62%) and El Salvador and Costa Rica the highest (around 70%).

While reserve margins appear to be high (see Table 2), much of the installed capacity is inefficient. This is especially so among thermal plant, as illustrated in the difference in the proportion installed and used in Figure 4 and Figure 5. As a result, although installed name plate capacity exceeds peak demand in all countries, Nicaragua and El Salvador both suffered unserved demand.

Table 2 Peak and Unmet Demand

	Installed Capacity (MW)	Peak Demand (MW)	Delivered Energy (GWh)	Unserved Demand (GWh)	% peak Met from Installed Capacity
Costa Rica	2,182	1,500	8,174	0	100%
Guatemala	2,154	1,443	6,534	0	100%
Panama	1,552	1,126	5,299	0	100%
Honduras	1,573	1,024	4,979	0	100%
El Salvador	1,437	906	4,889	6.3	99.3%
Nicaragua	822	505	2,096	147.3	70.8%
Regional total	9,719		31,971	153.6	97.6%

Source: CEPAL (2007)

Demand has been growing at 4.5% per annum on average since 2000. The regional expansion plan prepared by the Council of Electrification of Central America (CEAC) forecasts 4.7% demand growth in the medium case over the period 2006 to 2020. This implies a doubling of demand in around 15 years.

The expansion plan forecasts total energy consumption in the region to grow to 67,800 GWh by 2020, with installed capacity having to increase to 11,800 MW, requiring more than 2,000 MW of additional capacity.

The distribution of demand by tariff type (where available) is given in Table 3. Most sales in the region are to customers on regulated tariffs. Guatemala has the largest nonregulated tariff sector.

Table 3 Demand by Tariff Type (GWh)

	Reg. Tariffs [a]	Res.	Com.	Ind.	Other	Unreg. tariff [b]	Total
Costa Rica	8,174	3,284	2,443	2,246	202	0	8,174
	100%	40%	30%	27%	2%	0%	
Guatemala	4,149	na	na	na	na	2,384	6,534
	64%	-	-	-	-	36%	
Panama	5,247	1,629	2,326	471	821	53	5,299
	99%	31%	44%	9%	15%	1%	
Honduras	4,904	2,063	1,182	1,285	374	75	4,979
	98%	41%	24%	26%	8%	2%	
El Salvador	4,415	1,624	na	na	2,790	474	4,889
	90%	33%	-	-	57%	10%	
Nicaragua	1,970	659	587	438	287	126	2,096
	94%	31%	28%	21%	14%	6%	
Total	28,859	9,258	6,538	4,439	4,474	3,112	31,971
	90%	29%	20%	14%	14%	10%	

Source: CEPAL (2007); [a] Regulated tariff; [b] Unregulated tariff; na = Not available

2.3.1 Demand in neighboring countries

Mexico is the largest electricity consumer among the countries that share a border with Central America. In 2007, Mexico had 51 GW of generation capacity installed and produced a total of 231 TWh, fully six times the production of all of Central America combined.[2] The major Mexican demand growth centers are in the north and in the Yucatan peninsula area of the south, where demand is expected to grow by close to 7% per annum.[3] The Yucatan is well located for service by lines from Guatemala and Belize. Mexico relies on fossil fuels for around 75% of its generated power.

Colombia also has total demand greater than Central America's. Total generation in 2007 was 53.6 TWh. The Colombian system is dominated by hydropower, which makes up nearly 70% of the 13,410 MW installed. Colombia has significant natural gas reserves and large

[2] Secretaria de Energia, Mexico
[3] GENI Energy Overview of Mexico, http://www.geni.org/globalenergy/library/national_energy_grid/mexico/LatinAmericanPowerGuide.shtml

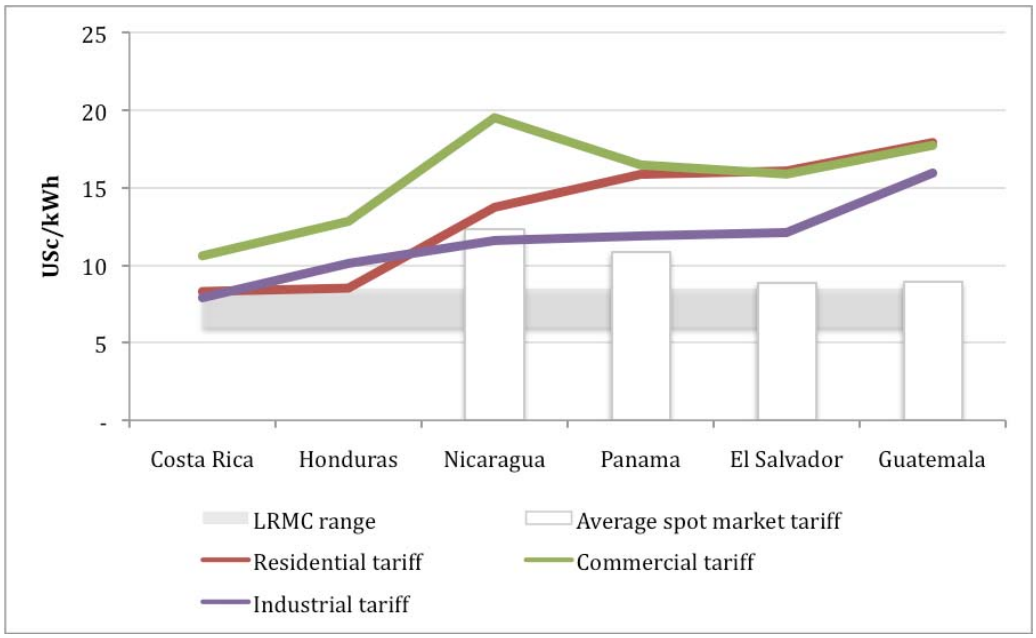
deposits of coal. Estimates of its potential generation cost advantage over Central America are on the order of 2 to 1.

2.4 Energy tariffs

Given the limited interconnections and differing market and regulatory environments, final consumer tariffs in the region vary. There is also some variation between distribution networks within some countries. Figure 10 shows average tariffs in each country in 2007 and the range of least-cost generation expansion options identified in the Indicative Regional Masterplan.

The two countries that have not instituted competitive spot markets for wholesale energy (Costa Rica and Honduras) have the lowest average tariffs in all three customer categories. In Costa Rica's case this partly reflects a low-cost generation mix. By contrast, average tariffs are higher in the four other countries, which make up the more advanced reform group.

Figure 10 Average End-User Tariffs and Estimated LRMC for New Generation



Source: CEPAL (2007), CEAC (2007)
All tariffs are for 2007.
"Average spot market tariff" is for purchases in the competitive (unregulated) market.
Commercial and Industrial for El Salvador and Guatemala are average tariffs to low- and medium-voltage connected customers, respectively. Commercial for Costa Rica is the "General" tariff. These averages incorporate a large regulated tariff component.
"LRMC range" covers range of new generation marginal costs for the eight least-cost generation expansion cases considered in the CEAC Indicative Regional Plan, 2006-2020. Costs are in 2005 dollars. Excludes cost of transmission and distribution.

3 History of scheme

3.1 Overview of SIEPAC

The Central American Electrical Interconnection System (SIEPAC)[4] project is an initiative to create an integrated regional electricity market among six countries: Guatemala, El Salvador, Honduras, Costa Rica, Nicaragua and Panama. The project aims to enhance the efficiency of the electricity sector in the region and to promote private-sector involvement in transmission infrastructure and generation capacity.

SIEPAC consists of two interdependent projects:

- The development of a **regional electricity market (MER)**[5] based on a standard set of trading rules at the regional (supranational) level. Part of the MER initiative is the creation of a regional institutional structure, including a regional regulator and a regional transmission operator.

- The development and completion of a new 1,800 km **international transmission line**, running from Panama in the south to Guatemala in the north, to provide the interconnection required to support increased trade in the region.

In this case study, SIEPAC is used to refer to the regional market and regional transmission line together as a single project. Where the constituent projects are discussed individually they will be referred to specifically.

The SIEPAC transmission line will physically enable a market at the regional level, and the regional market in turn provides the economic basis for the integrated transmission investment. Together they are intended to allow generation projects to achieve economies of scale and to increase the use of the region's hydro resources. Regional projects will serve customers through contracts backed by firm transmission rights to capacity on the regional transmission network.

The regional market is unique as a trading system that has been developed at the international level while accommodating different stages of development in the underlying national markets. It provides an example of countries with diverse national sectors finding a workable institutional solution to support trade.

The initiative was formalized in an intergovernmental framework agreement, known as the Marco Treaty.[6] This agreement provides the legal foundation on which the regional market and the supporting institutional and physical infrastructure are built.

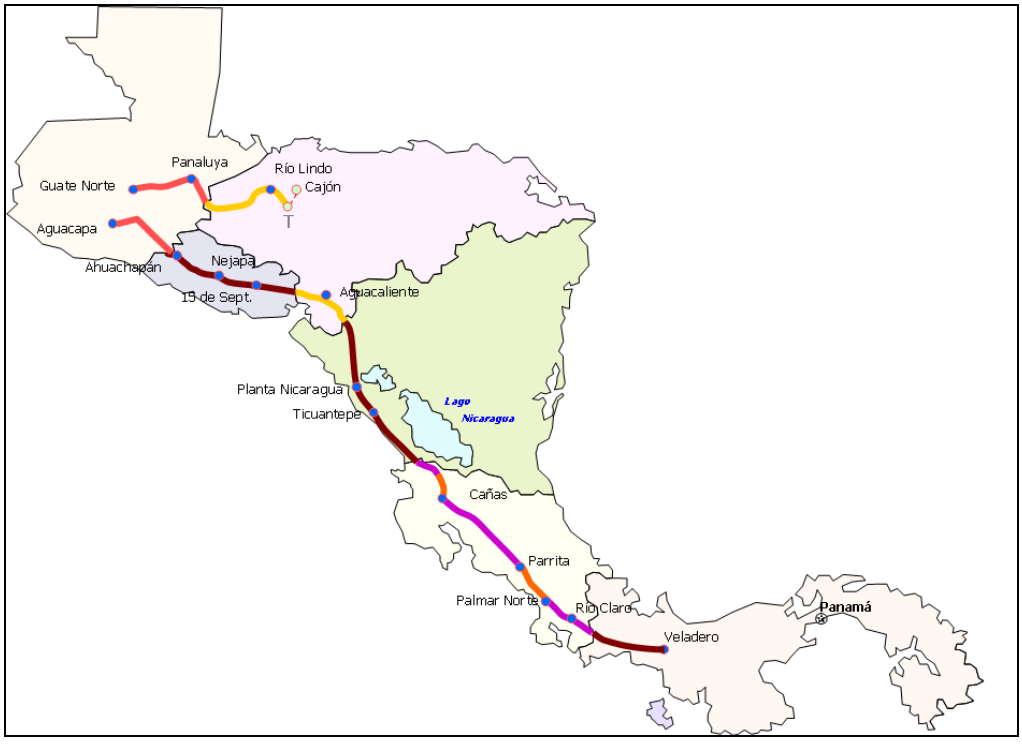
[4] SIEPAC is the acronym for the Spanish title: Sistema de Interconexión Eléctrica para los Países de América Central.
[5] MER is the Spanish acronym for Mercado Eléctrico Regional.
[6] This title comes from the Spanish name: Tratado Marco.

The main parties involved in the scheme are:

- The governments of the six host countries and their administrative agencies (e.g., environmental)
- The transmission, system and market operators in each country
- The regional planning body, the Central American Electrification Council (CEAC), which is directing the development of the institutions
- One private utility as a shareholder in the regional transmission company. State utilities of neighboring countries are also shareholders.
- Governments of neighboring countries; and regional cooperation organizations
- International Financial Institutions, led by the Inter-American Development Bank
- Private contractors for project design, management and supervision; construction works; and procurement

The route of the line is shown in Figure 11. The six SIEPAC systems are electrically synchronized. The SIEPAC line will form the backbone of the Regional Transmission Network (RTR), which is also made up of the tie-in lines and designated parts of the national grids that are essential to international trade.

Figure 11 Route of the SIEPAC Line



Source: EPR

SIEPAC is discussed and supported as part of a broader regional initiative under the Mesoamerica Project (until recently this was known as Plan Puebla-Panama, PPP).[7] The Mesoamerica Project aims to develop and integrate the energy, communications and transport infrastructure across nine countries, including the six SIEPAC countries plus Mexico, Belize and Colombia. The PPP was proposed in 2001 and formally institutionalized in 2004.

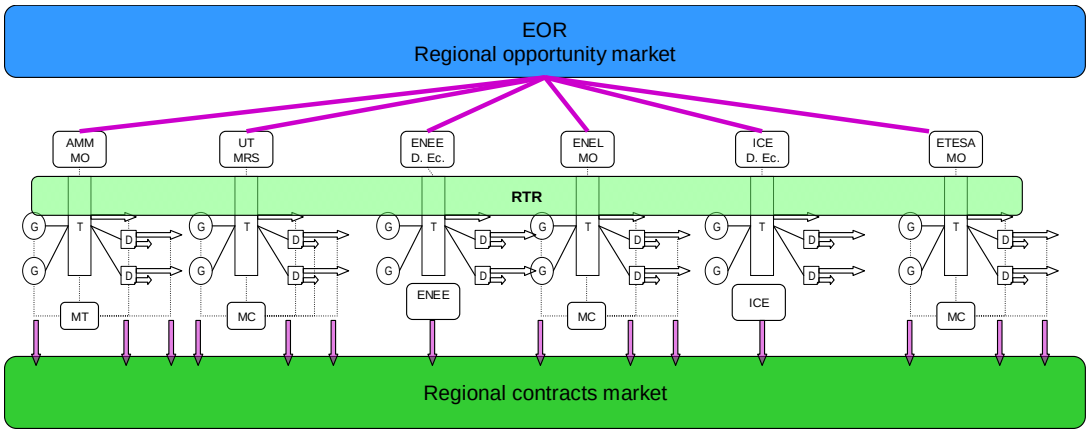
While the line itself is contained within the region, construction is underway on an interconnection north with the Mexican system, and there are plans for strengthened interconnection south to support trade with Colombia. The strengthening of the interconnection between southern Mexico and Guatemala is being carried out under the auspices of the Mesoamerica Project.

3.1.1 Overview of the regional electricity market

The six-country competitive regional electricity market (MER) began operating under a transition code in 2002 and moved to an updated code in 2005. It is a competitive market at the supranational level. As the seventh market in the region MER is additional to, rather than in replacement of, the six existing individual country markets. Each country retains its domestic market and regulations with the necessary changes to ensure compliance with MER and to ensure that it can interact with the regional market.

The MER is supported by a regional market and system operator (EOR) and a regional regulator, with associated technical and market codes. Consistent with the market itself, the market institutions are supranational and additional to their counterparts in the six countries. A schematic of the six national markets and MER's interrelation with them is shown in Figure 12.

Figure 12 MER as the Seventh Market Atop the Six National Markets



Source: World Bank
The organizations listed in the row above the RTR are the national system and market operators for Guatemala (AMM), El Salvador (UT), Honduras (ENEE), Nicaragua (ENEL), Costa Rica (ICE), and Panama (ETESA). ENEE and ICE are single buyers.
G = generation, T = transmission, D = distribution;

[7] Proyecto de Integración y Desarrollo de Mesoamérica, www.planpuebla-panama.org

MER consists of a firm and non-firm contracts market and a day-ahead and real-time spot market for short-term trades with prices set at specified physical trading points (nodes) in the RTR. The terms (e.g., duration and capacity) are freely decided by the buyers and sellers. Access and use of the RTR is auctioned in the form of financial and physical transmission rights by the regional market operator.

The MER design was carried out in three parts by separate consortia of international consulting firms. The three sets of studies were:

- The conceptual design, carried out from 1999 to 2001
- The first part of the detailed design developed the commercial and technical operation regulations, the institutional design of the regional systems and market operator and plans for its creation, and the design and supervision of the regional coordination and transactions center.
- The second part of the detailed design considered transmission and quality of service regulation.

The MER codes govern the actions and responsibilities of the system operators in the SIEPAC member countries in regard to dispatch, tariffs and transmission services, and clarify the role of the regional regulator in relation to MER.

Transmission use of system charges will incorporate a variable charge for losses and congestion, a charge based on volumes transmitted across the lines, and a top-up charge to meet the regulated revenue requirement of the transmission companies.

3.1.2 SIEPAC project history and timeline

The Central American countries have common culture and traditions and a shared history. What are now the Central American countries declared independence from Spain at the same time. For a period in the early 19th century, five of the SIEPAC partner countries (excluding Panama, which was then part of Colombia) had in fact formed a federal republic. During the 20th century several integration initiatives were attempted, some of which remain, and the past 30 to 40 years have seen continual movement toward integration (see Section 4.2 for more on some of the institutions established in this process).

The potential for interconnection to enable cross-border electricity trade had been discussed by the national utilities since the late 1970s, and by 1986 the countries were interconnected in two groups. However, further progress had been limited by armed conflict in three of the six countries. The last of these ended with a Peace Accord in 1996.

The concept of a regional market was first broached by the six Central American governments in 1987 with the encouragement of the government of Spain and the (then state-owned) Spanish utility, Endesa. The involvement of the Spanish government was part of its quincentennial celebrations marking the discovery of the Americas by Spanish explorers.

Endesa had conducted an interconnection feasibility study in 1987. Initially the concept had been for a physical interconnection only. However, it was difficult to provide economic

justification for the investment without an associated development at the level of international trade. This gave the impetus to direct the project concept toward market integration.

The Spanish government selected the IADB to manage its Quincentennial Fund, which included funding allocated to the Central American initiative.[8] The IADB funded a series of studies of the concept through grants for technical assistance. This led to the development of the intergovernmental Marco Treaty, which would provide the basis for the integration project.

In 1989 the Central American Electrification Council (CEAC) was formally established as a forum for discussion and coordination among the utilities in the region. As a regional planning body CEAC played a key role in overseeing and coordinating the development of the SIEPAC institutions.

A number of technical and economic studies of the proposed transmission interconnection were carried out between 1992 and 1997. The 1997 study concluded in favor of a 230 kV line from among a range of alternatives.

In 1997 the IADB approved a loan for the construction and an associated technical assistance grant and loan to CEAC. The IADB and other IFIs also pledged technical assistance funds toward the supporting studies for the line and the market.

The Marco Treaty was signed by the six governments in 1996 and came into force in 1999. It includes provisions for the establishment of an international transmission line company (EPR) and two regional market institutions: a regional regulator (Comisión Regional de Interconexión Eléctrica, CRIE) and a regional market operator (Ente Operador Regional, EOR).

CRIE began operations in 2000 and EOR was established in the following year. The general design of the MER, based on principles enshrined in the Marco Treaty, underwent a two-year development period before receiving approval from the six governments in 2000.

Work then began on the Transitional Regulations of MER, which were finalized by the regional regulator and signed by the governments in 2002, and MER began operating under these transition codes. More detailed market design followed, with the development of transmission codes, market rules and further organization of CRIE and the regional market and system operator. The transitional regulations were replaced in December 2005 with the approval by CRIE of updated regulations.

In 2001 the IADB reformulated its lending package. Although the loan had been approved in 1997, further progress had since stalled. The loan documents had not been signed and the related technical assistance had been only partially used. This reflected issues with the structure of the loans themselves, as well as uncertainties about the regional scheme that had developed as electricity sector reform at the country level accelerated in the second half of the 1990s.

[8] The Spanish quincentennial celebrations incorporated a range of activities throughout the region in addition to Central American electricity integration.

Also in 2001, the Plan Puebla-Panama (PPP) was established as a presidential-level forum for advancing integration in the region. This high-level group provided stimulus to overcome the impasse over the finance and physical infrastructure investment that had developed by this time.

In 2006, 10 years after the Marco Treaty was signed, ground was broken on construction of the transmission line. Construction has progressed since, and the line is planned for completion and commissioning in 2010.

A chronology of the major events related to electricity sector reform and integration in the region is provided in Table 4.

Table 4 Chronology of Regional Power Integration in Central America

Year	Event
1976	First interconnection in the region built between Honduras and Nicaragua.
1979	The governments and state utilities of the six countries agree to create the **Central American Electrification Council (CEAC)**.
1989	CEAC is formally established following ratification of its Constituent Agreement.
1990	Costa Rica is the first country in the region to begin reform of its electricity sector. Establishes a single-buyer model. Guatemala follows in 1991.
1993	**Protocol Treaty on Economic Integration of Central America** agreed to at summit of Central American Presidents.
1996	Peace accords signed in Guatemala ending the internal conflicts that began there in 1960. Conflicts had also ended in Nicaragua (1988) and El Salvador (1992).
	Guatemala implements a cost-based pool. All six countries have now reformed at least to the stage of introducing a single buyer.
	The six countries sign the **Marco Treaty of the Electrical Market of Central America.**
	Technical studies support the construction of a 230 kV regional transmission line.
1997	IADB and the government of Spain approve loans to the SIEPAC project.
1998	**Marco Treaty ratified.**
	Economic-technical study of SIEPAC carried out.
1999	**Marco treaty comes into effect.**
	Regional transmission line company (EPR) incorporated.
2000	**MER design approved** by six governments following two-year development process.
	Regional electricity market regulator (CRIE) established.
	Nicaragua launches its wholesale electricity market.
2001	**Regional electricity system and market operator (EOR)** established.
	IADB loan package reformulated to include concessionary loans to Honduras and Nicaragua.

Year	Event
	Interconexión Eléctrica S.A. (ISA) of Colombia becomes eighth shareholder in EPR.
	Plan Puebla-Panama (PPP) proposed by Mexico to support regional development and integration.
2002	New tie-line between Guatemala and El Salvador completes interconnection of all six countries. However, transfer capacities remain limited.
	Transitional Regulations for the Regional Electricity Market (MER) finalized by CRIE and signed by the governments.
	MER begins operation under transition code.
2003	Environmental impact assessments for the SIEPAC line completed for each of the six countries.
2004	A geological and geotechnical study and ground classification are carried out for the route.
	Plan Puebla-Panama institutionalized.
2005	Transitional MER regulations replaced by updated code approved by CRIE.
	Central American Free Trade Agreement (CAFTA) signed into US law.
2006	**Construction of the SIEPAC transmission line begins.**
	Construction begins on the strengthened interconnection between Mexico and Guatemala.
2008	Initially planned completion date for SIEPAC line missed. Completion now expected in 2010.
	Plan Puebla-Panama changes its name to the Mesoamerican Integration and Development Project (**The Mesoamerican Project**).
	The state-owned Mexican utility, Comisión Federal de Electricidad (CFE), becomes the ninth shareholder.
2009	La Corporación Andina de Fomento (CAF) signs a loan agreement with EPR.

3.2 Project concept, objectives, and development

The SIEPAC project aims to overcome size and efficiency restrictions imposed by the combination of small national markets and limited interconnection and the resulting fragmentation of the sector at the regional level. It is part of a broader initiative toward economic integration among the Central American countries and with their neighbors.

The stated objectives of the project are:

- To improve security of supply by widening reserve margins
- To reduce the problem of electricity rationing in capacity deficit countries (such as Nicaragua)

- To achieve improved operating efficiency and reduce generation fuel consumption
- To introduce greater competition into the domestic markets
- To lower end-user electricity costs
- To attract foreign investment to the region's energy sector
- To contribute to the economic development of the region

The related outcome of reduced greenhouse gas emissions has also been recognized.

The SIEPAC transmission line will enable greater exploitation and more efficient usage of the region's underdeveloped hydro resources, and more efficient operating scale for thermal plants:

- Since the individual markets (and the participants within each) are small, it is difficult to develop competition and to take advantage of economies of scale within individual countries.
- Currently, hydro plants are limited to serving the market in which they are located. This has restricted project size, with the result that 50% of hydroelectric stations in Central America have capacity of less than 150 MW.

In addition to trade within the region, the line will enable trade with the large Mexican market once the Mexico-Guatemala interconnection is upgraded. Interconnection of the region with Mexico, the largest economy in the region with total electricity demand six times larger than Central America combined, offers opportunities for the development of the hydro potential of the CA region for export. The estimated cost of US$55 million for the upgrade is being financed by BCIE, the government of Mexico, and the Guatemalan utility (INDE) under the auspices of the Mesoamerican Project.

Trade with Colombia may also follow if the interconnection to that country is built. Colombia has large potential energy resources and is thought to have a production cost advantage over the Central America region.

The systems are diverse in terms of the stages of market development and institutional capacity. The need for a regional institutional design that would recognize and accommodate the differences among countries was recognized early in the process and is required by the Marco Treaty. This feature, which is reflected in the institutions that have been developed, is one of the defining characteristics of the regional market.

A number of parties have been supportive of the project. The state-owned utilities in the region, who have a good history of communication and cooperation, were in favor of the project from the early stages. Endesa championed an integration project with the government of Spain, which was supportive of the idea and encouraged the involvement of the IADB. At the political level, the project has benefited from the favorable view toward integration that prevails among the governments in the region. There is a coincidence of aims between SIEPAC and other integration initiatives. The project has also received support from other multilateral and development institutions.

3.3 Feasibility studies done

The following feasibility studies have been carried out for SIEPAC:

- Pre-feasibility study, 1987
- Technical-economic studies, 1989
- Technical and economic studies conducted during 1992–1997
- Economic study, 1997
- Environmental impact assessments, 2003
- Geological and geotechnical study and ground classification, 2004

The first technical-economic studies of the proposed transmission project were completed in 1989 and were in favor of the transmission line.

Further technical and economic studies were carried out between 1992 and 1997. These sought to evaluate in greater detail the economic benefits and costs of a regional market and the technical requirements of the transmission line and its interconnection with the national systems. The planning departments of the state transmission utilities participated in the studies.

The 1997 economic study considered various future electricity sector scenarios for the region as well as different options for the transmission line. This study concluded that the 230 kV line was the lowest-risk option for a range of possible eventualities.

The Transmission Investments Task Force (GTRT)[9] within CEAC identified the investments required to strengthen the national transmission networks to allow secure interconnection with the SIEPAC system.

Environmental impact assessments (EIAs) were carried out for each of the six countries by private firms selected through competitive bidding. The final reports were presented in 2003. The project financing and concessions were conditional on the EIAs being approved by IADB and the environmental agencies of each country.

EPR was required to submit environmental management plans (EMPs) to each government along with the EIAs. These would include plans to mitigate direct and indirect impacts, resettlement plans, emergency plans, plans for monitoring during the construction and operation of the line, and a plan to provide the necessary environmental management capacity in each national utility.

A geological and geotechnical study and ground classification was carried out for the route in 2004. The construction design incorporates protections against seismic risk.

[9] Grupo de Trabajo de Refuerzos de Transmisión

3.4 Assets built and planned resulting from scheme

The major physical asset being built for the project is a new international transmission line. This will provide the interconnection required to support increased trade in the regional electricity market.

When completed, the SIEPAC line will consist of 15 substations and 28 access bays across 1,800 km. It will operate at 230 kV and have a transfer capacity of 300 MW throughout its length. This is equivalent to 20–60% of peak demands in the six countries. The towers are designed to accommodate a future expansion to a second circuit.

The planned transmission segment lengths in each country are:

- Guatemala: 282 km
- El Salvador: 287 km
- Honduras: 270 km
- Nicaragua: 309 km
- Costa Rica: 489 km
- Panama: 151 km

Additionally, a fiber optic cable is being installed with the transmission cable to strengthen the telecommunications infrastructure of the region (the "Mesoamerican Information Highway").

3.5 Interconnections and electricity trade

3.5.1 Physical infrastructure

The existing Central American electricity interconnections are shown in Figure 13. The first interconnection in the region was established in 1976 with the commissioning of a line connecting Honduras to Nicaragua. This was followed by connections between Nicaragua and Costa Rica in 1982, and Costa Rica–Panama and Guatemala–El Salvador in 1986. Until 2002 the region remained divided into two separate electrical areas, with Guatemala and El Salvador connected to each other but isolated from the other four countries. Since the commissioning of a tie-line between El Salvador and Honduras the transmission networks of all six countries have been electrically interconnected (there is no direct interconnection between Guatemala and Honduras).

Figure 13 Existing Interconnections in Central America

Source: World Bank

The existing interconnections between the national transmission systems are rated at between 30 MW and 100 MW depending on the interconnection and direction of transfer.[10] In reality some circuits are limited to 50 MW maximum transfers. These connections are in

[10] Most of the existing connections are rated at 80 MW. The 30 MW connection is north-south between Costa Rica and Panama, while the south-north connections between El Salvador and Guatemala and Panamaand Costa Rica are rated at 100 MW.

need of reinforcement to improve electrical security, and the limited capacities are insufficient to support large regional projects in the planned regional market.

The SIEPAC line will strengthen the interconnections and increase transfer capacity to 300 MW in both directions at all six border crossings. The tower design allows future expansion to a second circuit, which would increase SIEPAC transfer capacities at different borders by 30% to 100%. The ongoing strengthening work on the interconnection with Mexico will raise capacities to 200 MW south and 70 MW north between Mexico and the SIEPAC system. There are also plans to strengthen the interconnections between the Panama and Colombia. This would raise capacities to 300 MW in both directions between SIEPAC and Colombia.

3.5.2 Existing international trade

Trade currently flows from producers at the region's northern and southern ends (Guatemala and Panama) toward buyers in the center (Costa Rica in particular).

Total trade in the region has been falling since 2000, reaching a low of 220 GWh in 2006 (Figure 14). The 2000 peak of nearly 1,500 GWh represented less than 6% of total regional production (see also Table 11 in Annex A1).

The critical cause of the low level of existing regional trade is falling reserve margins within countries as rising demand outstrips new capacity additions. Countries have reduced exports in order to secure supply to their domestic markets. The fall in trade also reflects restrictions on wheeling capacity due to weaknesses in the centrally located transmission systems.

Figure 14 Evolution of Electricity Trade in the Region

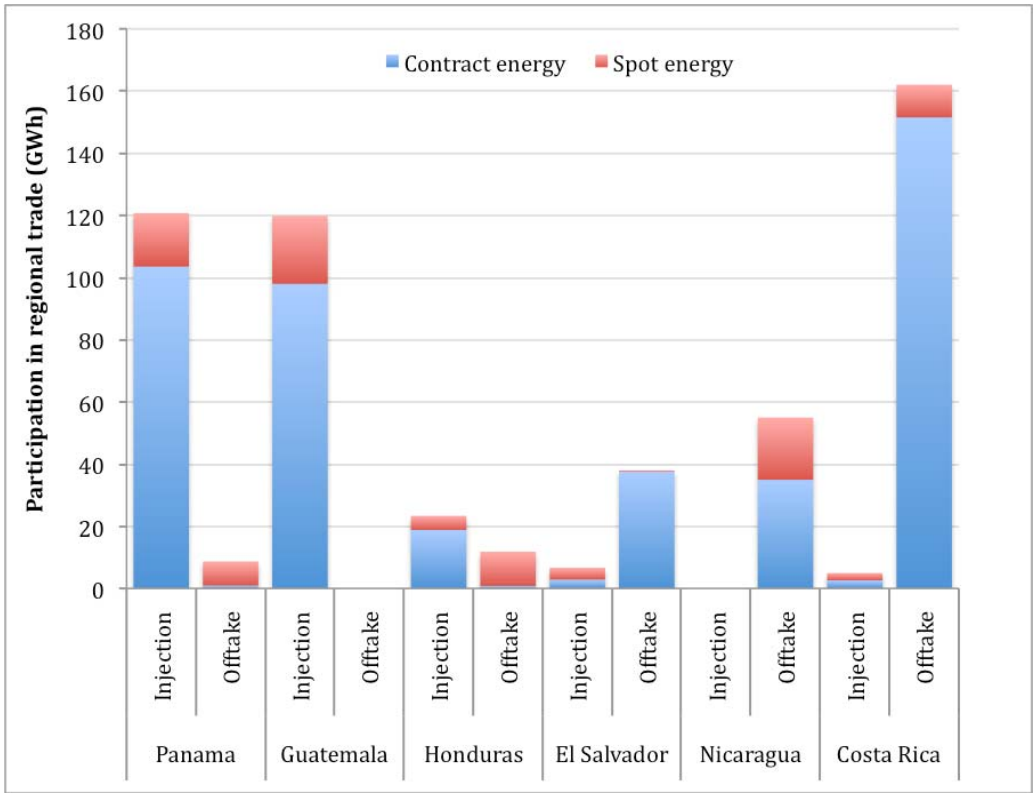
Source: CEPAL
Figures are total exports in each year. Total includes MER transactions and other trade.

In 2007, trade in the regional market (MER) using the existing interconnections was characterized by:

- Transactions totalling 275.5 GWh, of which 225.5 GWh was contracted and 50 GWh was short-term energy trades.
- The largest sellers in the market were Guatemala and Panama, each with injections of 120 GWh.
- Costa Rica was the largest offtaker with 157 GWh of purchases. Nicaragua was the next-largest buyer with 55 GWh, followed by El Salvador with 38 GWh.

Injections and offtakes in the regional market in 2007 are shown in Figure 15.

Figure 15 Injections and Withdrawals in Regional Market, 2007



Source: CEPAL

3.6 Environmental and social issues

Article 1 of the treaty includes sustainable development and environmental protection among the objectives of the project.

One of the focuses of the environmental impact of the study has been on deforestation along the route of the line. In addition to the EIAs, a forest inventory was carried out for the corridor. The construction project includes a reforestation plan under which 200,000 trees will be planted.

It is estimated (preliminary) that SIEPAC will result in 22 million tonnes of avoided CO_2 equivalent over 21 years.[11] This estimation is for the SIEPAC line with interconnections with Colombia and Mexico against the base case of no regional transmission expansion. The reduction will result from more efficient dispatch across the region as well as changes in the fuel mix.

The project is now being registered for the Clean Development Mechanism, although this was not a recognized opportunity at the inception of the project. The first CDM application was rejected by the CDM Panel of Experts on the basis of questions over the methodology and baseline used. A revised application is currently under submission to the panel.

[11] KPMG, "Descripción del PDD del Proyecto SIEPAC", presentation, March 2007.

4 Institutional arrangements

4.1 Overall coordination and governance

4.1.1 Coordination of the scheme's development

The Central American Electrification Council (CEAC), as the regional planning body representing each state-owned utility, took the role of coordinating the overall development of the project.[12] The technical assistance grants for SIEPAC were mostly made to CEAC as executing agency.

Within CEAC a number of committees and groups were formed to coordinate the design and implementation phase of the MER. This was a requirement of the IADB loan and technical assistance conditions. These groups were later phased out as the design and planning stages of the project were completed and the permanent SIEPAC institutions were able to take up their roles.

The core coordinating organization was the Execution Unit (Unidad Ejecutora del Proyecto), which consisted of a full-time manager and two expert advisors. This unit was financed from technical assistance, primarily from IADB.

Under this high-level coordinating unit sat the Steering Group (Grupo Director del Proyecto). This was tasked with leading the actual implementation of the project. The Steering Group was made up of one energy policy representative from each government. The group's role included developing the regulations for the regional regulator (CRIE) and the regional system and market operator (EOR).

Two further groups were formed to provide advice on the technical and market design aspects:

- *Programming and Evaluation Committee (CPE)*, consisting of two representatives of the electricity sector from each country and representatives of the IADB. The committee advised on the institutional and technical aspects of the MER design. It also acted as a supervisory body providing independent evaluation of the project
- *Advisory Group*, made up of individual consultants with experience in international market design. The Advisory Group provides assistance to the group director, CPE and Execution Unit on market design issues including regulation, administration, structure, operation and development.

The second amendment to the Marco Treaty, agreed upon in 2007, would create a permanent Director Council for the MER. This would be made up of one representative

[12] CEAC carries out regional planning exercises through its Indicative Regional Planning Working Group (GTPIR, Grupo de Trabajo de Planificacion Indicativa Regional)

from each country with decision-making authority regarding MER integration policy. The second amendment has not yet come into effect.

4.1.2 Governance institutions for the regional market

The SIEPAC project necessitated the development at the regional level of the capacity to design, implement, operate and regulate the regional market and to design, build and operate the transmission line. Prior to the Marco Treaty there were no regional organizations able to carry out the regional market operation and regulation functions.

The Marco Treaty facilitated the creation of three permanent international organizations as legal entities. These are the core regional market organizations:

- The **regional regulator**: the Regional Commission on Electrical Interconnection (Comisión Regional de Interconexión Eléctrica, CRIE)
- The **regional system operator and dispatcher and regional market administrator**: Ente Operador Regional (EOR)
- The **regional transmission line company**: La Empresa Propietaria de la Red (EPR)

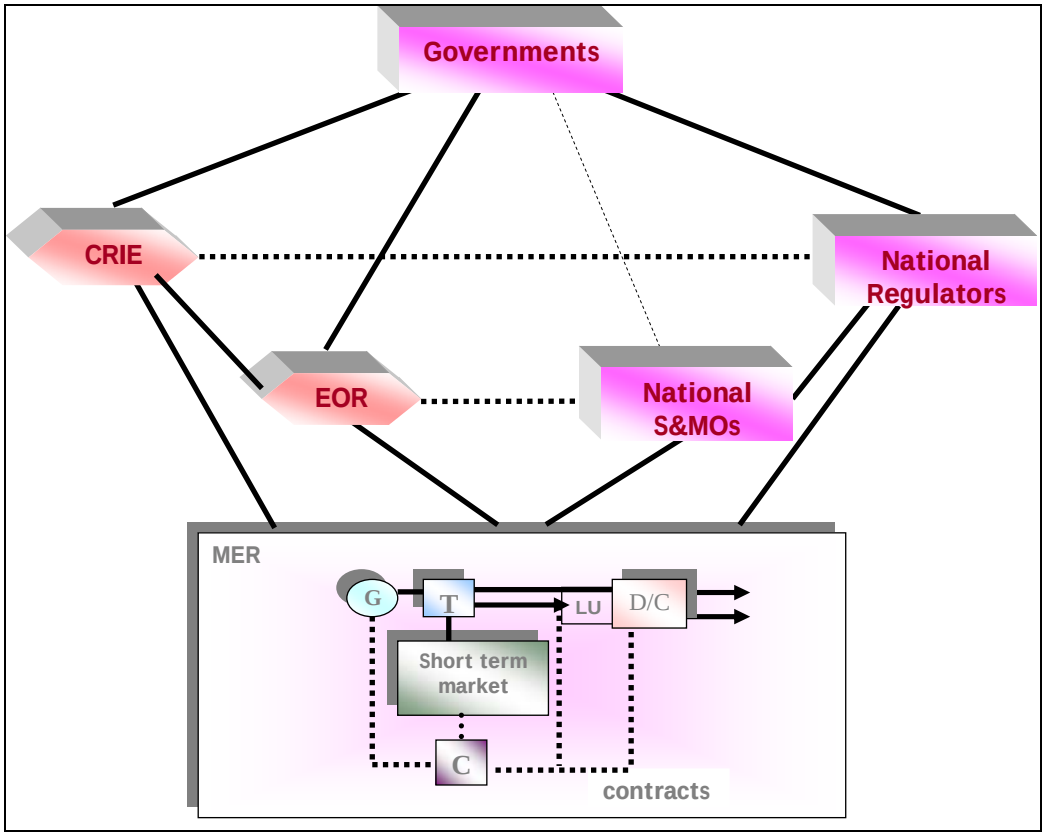
CRIE began functioning in 2000, EOR was established in 2001, and the MER itself began operating in 2002. EPR was incorporated in 1999. The development of the market and transmission codes and the organization of CRIE and EOR have been ongoing since 2002.

EPR will own the SIEPAC transmission line and will be required to make the line available as part of the Regional Transmission Network (RTR).[13] EOR will have authority over the operation of the RTR in coordination with the six national system operators. EOR will direct both the operation and maintenance of the RTR network.

The regional market institutional relationships are illustrated in Figure 16.

[13] RTR is the Spanish acronym for Red de Transmisión Regional.

Figure 16 Institutional Relationships in the Regional Market



Source: World Bank

The Marco Treaty establishes CRIE as a supranational entity with its own juridical identity and powers under public international law. As such, CRIE is subject to and governed by international law through the Central American Court of Justice and is outside the jurisdiction of national courts. This provides the multi-country market with a unified legal structure that sits above the legal structures supporting the individual country markets. This legal status creates a potentially powerful institution at the regional level that indicates a serious commitment on the part of the national governments that have ceded authority to it via the treaty.

CRIE's role is to regulate the MER with the objective of promoting market development and competition. It is required to coordinate with the national regulators. Its responsibilities include:

- approving regulations for the market and coordinating these with the country-level regulators,
- setting tariffs for use of the transmission system,
- progressing the market through increasing stages of competition and to guard against the exercise of a dominant position,
- imposing penalties for noncompliance with market rules, and

- settling disputes among participants.

CRIE also approves extensions to the regional transmission network.

CRIE is headed by a board of commissioners made up of one representative from each of the six member countries. Commissioners are appointed for a term of five years. It is based in Guatemala.

EOR's role includes:

- proposing rules for MER and transmission system use for approval by CRIE,
- ensuring quality and security of supply in the electricity system,
- carrying out the market operation function in an efficient manner, and
- settling market transactions among participants.

EOR is also responsible for providing information on market conditions as well as developing and publishing generation and transmission expansion studies and centrally planning extensions of the Regional Transmission Network (RTR).

EOR is in charge of the operation of the RTR and is responsible for coordinating market transactions made over the network. MER participants must send their bids and offers for day-ahead transactions in the regional market to EOR, which then verifies the technical feasibility of proposed transactions in coordination with the market operators of each country.

EOR's board of directors is made up of two representatives per country appointed for five-year terms. As for CRIE, the treaty provides for EOR to be established in international law with rights to act extrajudicially. EOR is a nonprofit organization based in El Salvador.

The administrative costs of CRIE and EOR are met through contributions from the governments, fees paid by market participants, and penalties imposed for noncompliance with the rules. Both CRIE and EOR have been supported during their design and setup and capacity building stages by technical assistance from IADB.

4.2 Role of national governments and regional institutions

The countries of Central America have a long history of efforts aimed at promoting cooperation and coordination in the region. There are currently several region-level institutions that promote cooperation among governments and economic integration. These include:

- The Central American Integration System (SICA)
- The Mesoamerican Integration and Development Project

In addition, multilateral institutions in the region include the Central American Bank for Economic Integration (BCIE) and the Central American Court of Justice.[14]

The establishment in 1991 of the Central American Integration System (SICA)[15] was an important recent development in terms of initiatives to promote integration. SICA consists of the seven Central American countries (including Belize) and the Dominican Republic. SICA aims to facilitate economic, political and social integration in the region and promotes the establishment and development of inter-governmental bodies.

Guatemala, El Salvador, Honduras and Nicaragua are leading the integration process with the formation of the Central America Four (CA4). The CA4 has introduced common borders and is working as a bloc toward free trade agreements, for example with Canada.

The Mesoamerican Integration and Development Project (previously Plan Puebla-Panama, PPP) is a regional initiative to promote economic integration and cooperation among the six Central American countries, Colombia, Belize and Mexico. It was initiated in 2001 by SICA and the government of Mexico, the largest country politically and economically in the group.[16]

SIEPAC is incorporated into the energy stream under the Mesoamerican Energy Integration Program (PIEM).[17] SIEPAC predates the Mesoamerican Project, and the major SIEPAC institutions were in place when the Mesoamerican Project was set up. However, the Mesoamerican Project has played an important role in achieving high-level political consensus on SIEPAC. It has also been involved in the interconnection strengthening between Mexico and Guatemala.

Another example of regional institutional cooperation is the Free Trade Agreement between the U.S. and Central America (CAFTA). Discussions on the agreement began in 2002 and were signed into US law in 2005. CAFTA includes a common legal framework for dispute resolution and for the management of direct foreign investment.

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[14] There have also been previous efforts to establish a Central American Parliament and the Central American Common Market. However, these were not successful.
[15] Sistema para la Integración Centroamericana
[16] The project is financially supported by the IADB and other IFIs including the World Bank, bilateral aid agencies, the participating governments, and private-sector participation. Colombia joined as an observer in 2004 and became a full member in 2006.
[17] The Dominican Republic is also a participant in the energy stream.

4.3 Regulatory agencies

Each country has created an electricity regulator, as summarized in Table 5. At the regional level, the responsibility for regulation of trade has been ceded to CRIE. The role of the national regulators with respect to the regional market is to monitor and approve firm contracts for international trade to ensure there is a corresponding firm transmission right. These approvals must be made by regulators in both the buyer and seller countries. If these conditions are not met, CRIE has authority to impose penalties on the generator.

Table 5 National Regulators

Country	Regulator	Year of Inception (operation)
Costa Rica	Public Services Regulatory Authority (ARESEP)	1996
Panama	Regulatory Authority for Public Services (ASEP)	1996
El Salvador	General Superintendency of Electricity and Telecommunications (SIGET)	1996 (1997)
Guatemala	National Electricity Commission (CNEE)	1996
Honduras	National Energy Commission (CNE)	1998 (1999)
Nicaragua	Nicaraguan Institute of Energy (INE)	1998

4.4 Role of outside agencies

The main agencies providing funding to the SIEPAC project are IADB and BCIE, which are together providing a significant portion of the overall debt financing as well as supporting the project development through technical assistance (see Section 0).

The IFIs sought to mitigate their financial exposure to planning and institutional development risk through the structure of the finance agreements. IFI funding for the transmission line was made contingent on the parties first reaching agreement on the market and regulatory structures. Funds would not be released and construction of the physical transmission infrastructure could not begin until after the finalization of the supporting institutional structures and agreements.

The conditions precedent to the release of financing specified by the IADB in its loan agreement included:

- Both CRIE and EOR had been created and were operating
- That the transitory rules for the MER and RTR operation had been agreed to by the governments

- That EPR had been created and all shareholders had agreed to build the SIEPAC line and make related reinforcements to their systems

Execution of the project was conditional on:

- Evaluation procedures being carried out at regular intervals
- Attainment of 85% of rights-of-way
- Submission of environmental impact assessments (EIAs) and environmental management plans (EMPs) to the national environmental authorities and approval of the EIAs by all six governments and the major funding IFIs

Additionally, the donors/IFIs requested that each of the participating governments provide sovereign guarantees to the transmission project.

Since the project was contingent on this funding, the requirements imposed by the IFIs had the effect of feeding back into the design and process of the project. In this way, the outside funding agencies played an influential role in setting standards for the project's development and execution.

5 Contractual, financial and pricing arrangements

5.1 Contracts

5.1.1 The Marco Treaty

The Marco Treaty of the Electrical Market of Central America (the Treaty) forms the intergovernmental Framework Agreement for the Central American Electricity Market and the SIEPAC project. It was signed on 29 December 1996, ratified in 1998 and went into effect in January 1999. At its heart, the SIEPAC project rests on legally enforceable agreements between governments as provided for in this intergovernmental Treaty.

The Treaty is based on the principles of competition in the electricity market, including nondiscriminatory access to the transmission system, gradualism in the development of the market and expansion to include new participants, and reciprocity in the dealings between countries on the basis of mutually agreed-upon rules. It stipulates the progressive development of the regional market in the context of and in a way that supports the infrastructure and stage of development in the individual country markets.

Under the Treaty, the six countries agree to:

- form a regional electricity market (MER).
- create a regional system and market operator (EOR).
- create a regional regulatory agency (CRIE).
- establish the regional transmission company (EPR), with each country taking a minority shareholding.
- build the international transmission line.

The Treaty makes provision for dispute resolution primarily through CRIE.

The Treaty also grants a concession to EPR to develop the SIEPAC line and requires the governments to enable future expansion of the transmission network (by EPR or other entity).

5.1.2 Dispute resolution in the regional market

Provision for the settlement of disputes by arbitration and binding resolution was incorporated into the Marco Treaty. The Treaty provides for two levels of arbitration:

- In relation to disputes between agents operating in the market, CRIE is to make binding resolution.
- In relation to disputes between states party to the Treaty, in relation to interpretation of the Treaty, or the obligations imposed directly on the states

under the treaty,[18] resolution is by the Central-American Court of International Justice.

Under the MER Regulations, States may also choose to submit the dispute to CRIE for resolution on a binding basis, or such other forum as the parties agree to.

The provisions and procedures for resolution of disputes through CRIE are set out in more detail in the MER Regulations.[19] These provisions provide for a three-step escalating process of negotiation, conciliation and, as a last resort, binding arbitration. CRIE is responsible for both the conciliation and arbitration processes. Dispute resolution is subject to the rules and regulations established within the SEIPAC structure, and is not governed by a domestic law.

The general MER provisions apply to all disputes between the following parties:

- agents in the market,
- national system operators,
- national regulators,
- the EOR and an agent in the market, or
- the EOR and a national system operator.

A three-person tribunal appointed from the board of the commissioners acts as the arbitration tribunal. A requirement of their selection is that their nationality does not match that of either party to the dispute.

The procedures do provide for only one, limited form of appeal of a decision, by appealing to CRIE on the basis that it acted outside its legal powers or the decision contravenes overriding norms and principles.

5.2 Ownership and finance

5.2.1 Ownership of the transmission line

The Marco Treaty requires each government to grant a 30-year concession across its territory to the transmission line company (EPR). Under the terms of the concession, EPR is responsible for developing and maintaining the line on a build, own and operate (BOO) basis.

EPR is a public-private joint venture between the governments of the six countries (through their state-owned transmission utilities), one private-sector company (Endesa of Spain), and the major transmission owners from Mexico and Colombia. EPR has its head office in Costa Rica and branches in each country.

[18] Including, for example, obligations to ensure freedom of transit and in relation to tariffs.
[19] Reglamento del Mercado Electrico Regional

The option of relying entirely on private-sector investment was considered. However, it was decided that the private sector would not be properly incentivized or have sufficient interest in the project. The stated reasons included the natural monopoly nature of transmission, and the risks associated with the project.

The public-private partnership grants Endesa, which has an equal ownership stake with the other eight partners, responsibility for managing the company. In the original equity structure, which has been diluted with the addition of new shareholders, Endesa had taken a slightly larger share than the other partners.

In 2006, Interconexión Eléctrica S.A. (ISA) of Colombia, in which the government of Colombia holds a 53% stake, joined EPR. The dominant vertically integrated Mexican utility, Comisión Federal de Electricidad (CFE), which is owned by the Mexican government, became the ninth shareholder in August 2008. ISA and CFE are directly interested in SIEPAC due to the planned interconnections with the Colombian and Mexican transmission systems.

Third parties are allowed to develop and construct new transmission lines to connect to the SIEPAC line. The owners of these lines will own the associated transmission rights.

Construction supervision, design finalization and testing was contracted by EPR in international tender to Canadian company Dessau-Soprin, which has established a head project office in Costa Rica and branch offices in each country. Actual construction was contracted through open tender to two private firms under turnkey contracts. These contracts were let in two lots of near-equal value covering a northern section (Guatemala, El Salvador and Honduras) and a southern section. Equipment procurement has also proceeded by international tender overseen by an Evaluation Committee formed by EPR.

5.2.2 Project financing

The estimated cost of the transmission line is now around US$405 million. The financing structure is summarized in Table 6. The Inter-American Development Bank (IADB) is the largest debt financier with 59.3%, followed by the Central American Bank for Economic Integration (BCIE) with 24.7%.

Table 6 Financing Structure for the SIEPAC Transmission Line

Source	US$M	Terms
IADB soft loans (Fund for Special Operations)	50	40 years, 5yr grace period, 1% interest
IADB ordinary capital loans	120	25 years, 5yr grace period, 6% interest
Spanish Fund loan (through IADB)	70	35 years, 5yrs grace period, 2% interest
BCIE loans	100	20 years, 5yrs grace period, 6.5% interest
CAF loans	15	
EPR Equity	50	11-12% TIR
Total	405	

Source: World Bank; IADB

The IADB approved an original loan package in 1997. The IADB loan package was reformulated in 2001 to include concessionary loans (to Honduras and Nicaragua) alongside the ordinary loans. A portion of the IADB loans ($70 million) originates with the Spanish Quincentennial Fund.

The IADB loans are to each of the six state utilities, which then applied the borrowing toward equal contributions to EPR. EPR is the executing agency for the loans, which are backed by sovereign guarantees from each government.

The BCIE loan is made up of US$40 million originating from the European Investment Bank (EIB). This is extended to EPR toward the cost of substation and access bay equipment.

La Corporación Andina de Fomento (CAF), a multilateral financing institution, signed a loan agreement with EPR in February 2009. In addition to construction of SIEPAC the loan will contribute to the interconnection with Mexico and Colombia.

The regional electricity market (MER) design and implementation is supported by technical assistance of US$16.4 million. Of this, the IADB provided US$5 million as a grant to CEAC and US$9.9 million funded through loans. The remainder was provided by the six countries. IADB has since approved a further US$1.5 million technical assistance for consolidation of the MER and is preparing for provision of another US$1.5 million.

5.3 Pricing arrangements

A basic design objective for the MER was to enable large-scale regional generation projects to trade over the regional network. This requires the availability of firm transmission rights. The original design concept also called for locational pricing signals to foster both short-term (consumption) and long-term (investment) efficiency.

The allocation and pricing of transmission capacity in MER was modelled on the approach taken in the PJM market in the United States. That market uses a nodal pricing system with capacity allocation through auctions of financial transmission rights. The MER design also foresees a system of nodal prices with auctioned capacity rights. Two types of capacity rights would be implemented in MER: the firm (physical) right and the financial hedge against a constrained network.

5.3.1 Transmission pricing and capacity allocations

Transmission Use of Service (TUoS) charges are set by CRIE for all transmission assets in the RTR. The MER Transmission Code provides for recovery of TUoS through three price components:

- A variable-cost component met through the nodal price residual and revenues from transmission right auctions
- A transmission toll based on actual flows on the lines
- A complementary charge levied on all participants to capture any remaining unrecovered cost

The nodal price residual reflects short-run marginal costs but is only sufficient to partially recover the revenue requirement of the transmission owners. The remaining long-run cost of the network is recovered from the toll and complementary charge. The toll, calculated on the basis of actual power flows (MW), allows for some locational signalling.

Contracts for firm energy must be matched by firm transmission rights (TR) to capacity on the RTR. This right entitles the holder to be scheduled for injecting and withdrawing the associated power. Initially, a portion of the total transmission rights will be allocated to customers in each country (this is intended to ensure access for ineligible customers). The market for TRs will then gradually be opened, with periodic auctions operated by EOR. EOR is tasked with developing the TR rules, subject to approval by CRIE. At the time of writing the final details of this process were still being worked out.

In addition to the firm rights there will be financial TRs that oblige the holder to pay or entitle him to be paid the difference in prices between specified nodes for all associated power.

Charges for transmission in the transitional market are calculated on the basis of a variable transmission charge (CVT) with an additional toll for using the tie-lines. The CVT is determined as the difference between the short-run costs of energy (border nodal prices) in the supplying and receiving systems. The CVT system will be phased out as part of the transition to the MER nodal price system.

5.3.2 MER dispatch and prices

The MER will operate as a seventh market separate from the individual country markets. It will have a day-ahead dispatch and real-time balancing market with hourly nodal prices.

The final dispatch at the regional level is achieved through an iterative process at the national and regional levels. Ahead of dispatch time, each of the national market operators sends the results of its own pre-dispatch to EOR. These are combined with bids and offers to arrive at an optimized dispatch at the regional level and associated nodal prices. This is subsequently returned to the national system operators for reoptimization or agreement on the final dispatch.

6 Future plans and challenges

The institutional structures to support increased regional trade have largely been formed. The next significant milestones for the project will be the completion of the SIEPAC transmission line itself, planned for 2010, and the completion of the strengthened interconnection with Mexico.

The line and market institutions have the potential to serve as the backbone supporting investments in energy integration and trade projects at the regional level. However, while construction of the line is now well advanced, to date no large-scale regional generation project has been realized. The ability of the project to achieve this goal will be a clear test of its long-run success. To do so the completed line and associated institutions must demonstrate their credibility to investors. The early use and performance of the line will act as pilots in this process.

6.1 Future plans

The SIEPAC institutions (CRIE and EOR) are still relatively newly established and require further strengthening. The IADB expected to extend new technical assistance to these institutions in 2009 and 2010.

The completion of the strengthened interconnection between Mexico and Guatemala and the ongoing development of interconnection with Colombia will be important future developments. Both of these national systems are separately larger than the whole of Central America. Southern Mexico is a rapidly growing demand center, and Colombia has large unexploited energy reserves and likely cost advantages as an exporter. These interconnections present opportunities for both exports from SIEPAC and improved security of supply and access to lower-cost imports. Additional institutional structures will need to be developed to support this trade between the SIEPAC system and its neighbors.

Several other energy sector development and integration initiatives are underway in the region under the Mesoamerican project's energy stream (PIEM). These include a Central American gasification project which would seek to build a natural gas transmission system through the region, connecting the Central American countries to gas supplies from Mexico and Colombia. This would allow natural gas to enter the region's electricity fuel mix. PIEM also includes a project to build a petroleum refinery in one of the Central American countries to serve the region. There is also discussion about building an LNG terminal in the region.

These initiatives are interrelated. Expanded natural gas and oil product availability would diversify the feedstocks for electricity production and potentially lead to reduced short- and long-run generation costs. In turn, the regional electricity transmission network is necessary to provide sufficient market scale needed to anchor large investments such as an LNG terminal or gas transmission network, as well as to support larger-scale generation projects.

6.2 Future challenges

Several challenges and opportunities exist:

- Encouraging trade while reserve margins are low
- Demonstrating the reliability of the new trading system, particularly its institutions
- The lack of regulatory harmonization among the countries

A challenge for SIEPAC going forward is that regional-level investments, especially in the private sector, are likely only once the line and institutions have proven their reliability. This implies a startup problem since trade across the line is necessary first in order to demonstrate reliability.

Some trade does occur already in the MER using the existing RTR infrastructure. This offers one avenue by which SIEPAC may build a history through small-scale transactions. Another possible development path is through investments by the national utilities, who are shareholders in the line.

The current low supply margins across the region are hampering trade as countries reduce exports in order to serve the home markets. This presents both an opportunity and a threat to trade in the region. On the one hand the low margins are limiting the development of transactions and hindering the demonstration effect. On the other hand, tight margins may present attractive opportunities for investors to develop production in low-cost countries for export.

Once the line is built there will be pressure to use it in order to generate revenues to meet the debt servicing obligations. This may prove to be an important motivating factor for the development of regional generation projects (i.e., projects designed to serve the international market using SIEPAC), particularly for the EPR shareholders.

The EPR shareholders may be most willing to bear the demonstration risk in the early stages of trade development. Through their financial stake in the line these companies have an incentive to undertake pilot regional projects in order to build up transactions and associated revenue. They are also well positioned to lead since they are established major players in their markets and they enjoy government backing.

However, building strength and credibility in the regional regulator and building ongoing support for CRIE (as well as for EOR) remains a significant challenge. CRIE will need to be able to enforce the obligations on the national regulators and transmission owners across the regional network for access to the national networks.

This is illustrated by a recent case of an auction for contracted energy. The auction, with a delivery date after the expected commissioning of the SIEPAC line, was closed to an international bidder by the national regulator on the basis that the transmission rights could not be guaranteed. There is clearly a hesitancy at the country level to be first to test the new system and to be exposed to regulatory weakness.

An interesting test of the regional market design will be how well it is able to integrate the varied country markets. The lack of regulatory harmonization among the countries is also likely to be a limiting factor for region-level investment. On this theme, the IADB is carrying out studies into the compatibility of the national regulations with the regional regulations. It remains to be seen how the investment and regulatory environments within the countries respond to the opening of large-scale trade opportunities, particularly with regard to the generation sectors and for tariff policies.

A further challenge is to complete and implement the rules for RTR transmission capacity allocation.

The availability of the physical and institutional infrastructure will bring to a close only the first stage in enabling regional integration. The second stage will involve securing investment to capitalize on the opportunities for trade that SIEPAC presents. This is likely to be an ongoing process for some time.

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A1 Electricity supply

Table 7 Private-Sector Participation in Generation Sector, 2007

	Installed Generation Capacity (MW)			Electricity Generated (GWh)		
	Public	**Private**	**%**	**Public**	**Private**	**%**
Panama	180	1,372	88%	812	5,591	87%
Guatemala	539	1,615	75%	2,028	6,037	75%
Honduras	502	1,070	68%	2,023	4,322	68%
El Salvador	472	965	67%	1,734	3,984	70%
Nicaragua	298	524	64%	722	2,148	75%
Costa Rica	1,854	328	15%	7,439	1,393	16%
CA Total	3,845	5,874	60%	14,758	23,475	61%

Source: CEPAL

Table 8 Central America Capacity Situation, 2007

	Installed Capacity (MW)	**Hydro (MW)**	**Thermal (MW)**	**Cogen (MW)**	**Renewables (MW)[a]**	**Auto-production (GWh)[b]**
Costa Rica	2,182	1,500	426	20	236	0
Guatemala	2,154	776	1,028	307	44	0
Honduras	1,573	520	985	68	0	173.5
Panama	1,552	859	693	-	0	0
El Salvador	1,437	484	635	113	244	167.3
Nicaragua	822	104	504	127	88	71.8
Total	9,719	4242	4,271	634	572	412.6

Source: CEPAL

[a] All geothermal except 70 MW of wind in Costa Rica. Excludes hydro.

[b] Autoproducers in Panama and Nicaragua are large commercial enterprises (fruit and sugar companies and the Panama Canal Authority).

Table 9 Central America Generation Situation, 2007

	Total Production (GWh)	Hydro (GWh)	Thermal (GWh)	Cogen (GWh)	Renewables (GWh)[a]
Costa Rica	8,990	6,771	726	13	1,480
Guatemala	7,940	3,006	3,750	951	233
Honduras	6,334	2,214	4,011	109	0
Panama	6,287	3,669	2,618	0	0
El Salvador	5,749	1,788	2,447	221	1,293
Nicaragua	2,935	301	2,116	307	211
Total	38,234	17,747	15,668	1,602	3,217

Source: CEPAL

[a] *All geothermal except 241 GWh of wind in Costa Rica. Excludes hydro.*

Table 10 Participation in the Regional Market (GWh), 2007

	Injection			Offtake		
	Contract Energy	Spot Energy	Total	Contract Energy	Spot Energy	Total
Panama	103.54	17.16	120.7	0.93	7.75	8.68
Guatemala	97.98	21.87	119.85	0	0	0
Honduras	18.8	4.56	23.36	0.8	11.02	11.82
El Salvador	2.86	3.78	6.64	37.68	0.32	38
Nicaragua	0	0	0	34.95	20.02	54.97
Costa Rica	2.6	2.36	4.96	151.51	10.52	162.03
Total	225.78	49.73	275.51	225.87	49.63	275.5

Source: CEPAL

Table 11 Evolution of Total Trade

	Total Exports (GWh)	Total Available Production (GWh)	Trade as % of Total
1985	206	10,596	1.9%
1990	422	14,237	3.0%
1995	290	19,524	1.5%
2000	1,479	26,652	5.5%
2002	986	29,500	3.3%
2003	848	31,138	2.7%
2004	1,089	32,767	3.3%
2005	561	34,100	1.6%
2006	218	36,081	0.6%
2007	292	37,822	0.8%

Source: CEPAL